

Supplement 9 - 2016

ISSN 0873 - 4704

# ARQUIPELAGO

## LIFE AND MARINE SCIENCES

Supplement 9

### Island Biology 2016: Conference program and abstracts

International Conference on Island  
Evolution, Ecology and Conservation

2nd Meeting | 18-22 July 2016,  
Angra do Heroísmo, Azores, Portugal

Rosalina Gabriel,  
Rui Bento Elias,  
Isabel R. Amorim  
& Paulo A.V. Borges (Eds)

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Life and Marine Sciences

### **SCOPE**

*ARQUIPELAGO* - Life and Marine Sciences, publishes annually original scientific articles, short communications and reviews on the terrestrial and marine environment of Atlantic oceanic islands and seamounts.

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### **FINANCIAL SUPPORT**

Governo Regional dos Açores  
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### **Indexed in:**

*Aquatic Sciences and Fisheries Abstracts (ASFA), Biological Abstracts, BIOSIS Previews, Zoological Record, ISI Web of Knowledge, Directory of Open Access Journals (DOAJ)*

Cover picture: View of Pico Island from the coast of São Jorge Island; Paulo A.V. Borges. Cover design: E. Arand



Island Biology 2016  
2nd International Conference on Island Evolution, Ecology and Conservation

***This supplement should be cited as follows:***

Gabriel, R., R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds) 2016. Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9: 565 pp.

Supplement 9 is available online at [www.arquipelago.info](http://www.arquipelago.info), the Azorean Biodiversity Group/cE3c website: <http://gba.uac.pt/> and the IslandLab Infrastructure: <http://islandlab.uac.pt/>

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PORTUGUESE ECOLOGICAL SOCIETY (SPECO) & AZOREAN BIODIVERSITY GROUP (CE3C/ABG)  
Rapid Assessment Visual Expedition

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## FOREWORD

Oceanic islands are at the core of research on biogeography and many other biological issues. Roughly halfway between Europe and North America, lies the archipelago of the Azores, the most remote archipelago of the North Atlantic Ocean. Composed of nine islands, divided into eastern, central and western groups, it is home to approximately 250.000 inhabitants and more than 6000 species (terrestrial and marine), including about 500 endemics.

Islands have long been recognized as of special scientific interest, especially in respect to their formation and development mechanisms, means of biotic colonization, evolution of unique biotas and ecosystems, and extensive loss of endemics, making island research and conservation an attractive and very active area of research.

The Island Biology 2016 international conference brings together the expertise of a wide spectrum of research fields, in order to expand knowledge and achieve a unified view of island biology. The conference includes poster presentations, plenary and regular sessions, and hosts 24 specialized symposia, aimed to accommodate in-depth discussions in topical areas in Island Biology.

Biodiversity, Global Changes, Conservation, Invasive Species, Evolutionary Biology, Species Interactions and Networks, Paleobiology and Biogeography are the key conference themes. We expect that the pioneering ideas, leading theories, novel methodological approaches and recent ground-breaking results presented at this conference will provide advances in island biology research and guidelines for the future development of this field.

In addition, the interdisciplinary expertise of participants is expected to contribute to inform decision-makers concerning effective conservation planning strategies in island ecosystems, following the inspiration provided by the Declaration of the Guadeloupe 2014 International Conference on Biodiversity and Climate Change.

We look forward to welcome you all in the Azores!

PAULO A.V. BORGES,

ROSALINA GABRIEL, RUI B. ELIAS, ISABEL R. AMORIM & ENÉSIMA MENDONÇA

Island Biology 2016

2nd International Conference on Island Evolution, Ecology and Conservation

# CONFERENCE SCHEDULE OF ISLAND BIOLOGY 2016

## II INTERNATIONAL CONFERENCE ON ISLAND EVOLUTION, ECOLOGY, AND CONSERVATION

Angra do Heroísmo, 18-20 of July, 2016

### MONDAY, 18 OF JULY

#### 8:00 Registration and mixer

9:00 Opening, Welcome and Announcements

**9:30 Plenary Talk I** [Auditorium - July, 18]  
The dynamic equilibrium theory of island biogeography: The origin, the legacy and the future  
DANIEL SIMBERLOFF

#### 10:30 Refreshment Break

**11:00 Symposium 1** [Auditorium, July, 18]  
Ec2. Functional diversity on islands: Challenges and opportunities for future research  
CHAIRS: FRANÇOIS RIGAL & P. CARDOSO

11:00 Functional diversity on islands: Challenges and opportunities for future research  
FRANÇOIS RIGAL, J.C. CARVALHO & P. CARDOSO

11:15 Global patterns of functional diversity and assemblage structure of island parasitoid faunas  
ANA M.C. SANTOS, M.V. CIANCARUSO, & P. MARCO JR.

11:35 Functional island biogeography: evaluating functional diversity patterns in fragmented landscapes  
THOMAS J. MATTHEWS & R.J. WHITTAKER

11:55 Functional diversity and composition of bryophyte communities along an elevational gradient in Terceira Island, Azores  
DÉBORA S.G. HENRIQUES, F. RIGAL, P.A.V. BORGES & R. GABRIEL

12:15 Patterns and drivers of functional diversity of epiphytic liverworts communities along an elevational transect in La Réunion (Mascarenes)  
CLAUDINE AH-PENG, S. MEEK, T.A.J. HEDDERSON, N. WILDING, D. STRASBERG & O. FLORES

12:35 Geological age and host polymorphism affect functional diversity and community composition in plant-insect interactions across a space-for-time chronosequence on the Hawaiian Islands  
ELSKE K. TIELENS & D.S. GRUNER

**11:00 Symposium 2a.** [Small audit., July, 18]  
Cv1. Biodiversity and conservation of island plants  
CHAIRS: MÓNICA MOURA, L. SILVA & J. CAUJAPÉ-CASTELLS

11:00 Oceanic island plant conservation in a changing world: Lagging or leading?  
JULI CAUJAPÉ-CASTELLS

11:30 Faial Botanic Garden – Nature conservation into practice  
PEDRO CASIMIRO, J. MELO & C. FREITAS

11:50 Isolation patterns affect the conservation of the critically endangered *Lactuca watsoniana*  
ELISABETE F. DIAS, M. MOURA, H. SCHAEFER & L. SILVA



- 12:10 Patterns of plant diversity in Cape Verde Islands: from genes to ecosystems  
MARIA M. ROMEIRAS
- 12:30 Seed Bank of Azores: Preserving the Azorean flora  
CÁTIA FREITAS, P. CASIMIRO & J. MELO
- 11:00 Ordinary Talks 1** [Large room, July, 18]  
Biological invasions  
MODERATORS: CHRISTOPH KUEFFER & I.S. ROCHA
- 11:00 Global patterns in extinction and threats to vertebrates by biological invasions in islands  
CÉLINE BELLARD, T. BLACKBURN, P. GENOVESI, P. CASSEY & J.M. JESCHKE
- 11:15 Invasive rat population dynamics and management by trapping in island tropical forests  
QUITERIE DURON, L. RUFFINO, T. CORNULIER & E. VIDAL
- 11:30 What is the role of vacant niches for alien species establishment on isolated islands?  
BERND LENZNER, F. ESSL, GLONAF CORE TEAM, C. CAPINHA, B. GUÉNARD, E. ECONOMO, H. SEEBENS, & D. MOSER
- 11:45 Introduced marine species in the Island Nation of Indonesia  
P. JOANA DIAS, M. HUHN, J.I. McDONALD & H. MADDUPPA
- 12:00 Alien reptiles on Mediterranean Islands: A biogeographic framework to aid conservation management  
IOLANDA SILVA-ROCHA, D. SALVI, M.A. CARRETERO & G.F. FICETOLA
- 12:15 The red-vented bulbul: Extreme pest or extreme prejudice?  
MARTIN THIBAUT, E. VIDAL, M. POTTER & F. BRESCIA
- 12:30 Natural history of a snake invasion in a Mediterranean island: The case of *Hemorrhois hippocrepis* (Reptilia, Colubridae) in the Island of Ibiza  
ELBA M. MONTES, A. HINCKLEY, E. AYLLÓN & J.M. PLEGUEZUELOS
- 12:45 Biogeographic reconstruction and dispersal dynamics of the carabid beetle *Merizodus soledadinus* invading subantarctic Kerguelen Islands  
TIPHAINE OUISSE, D. RENAULT & F. HENDRICKX
- 11:00 Ordinary Talks 2** [Small room, July, 18]  
Biodiversity & Macroecology  
MODERATORS: HOLGER KREFT & L. BORDA-DE-ÁGUA
- 11:00 Dissecting global turnover in vascular plants  
CHRISTIAN KÖNIG, P. WEIGELT & H. KREFT
- 11:15 Mosses and liverworts growing on bark in different archipelagos: A study of alpha and beta diversity patterns  
ROSALINA GABRIEL, P.A.V. BORGES, P. CARDOSO, O. FLORES, J. GONZÁLEZ-MANCEBO, T. HEDDERSON, S.C. ARANDA, M.C.M. COELHO, D.S.G. HENRIQUES, R. HERNANDEZ-HERNANDEZ, L. MARLINE, N. WILDING & C. AH-PENG
- 11:30 Dispersal ability determines the scaling properties of species abundance distributions  
LUÍS BORDA-DE-ÁGUA, H.M. PEREIRA & P.A.V. BORGES
- 11:45 Are reduced dispersal abilities in island floras fact or fiction? Global cross-species relationships between plant traits and dispersal distance offer new insights  
FIONA J THOMSON, T.D. AULD, R.T. KINGSFORD & A.T. MOLES
- 12:00 The niche variation hypothesis and its relationship to lizard population density

MARIA NOVOSOLOV, G.H. RODDA, A.  
GAINSBURY & S. MEIRI

ANTONIA S CASTELLANO, H. LÓPEZ, A. PEREZ-  
DELGADO, P. OROMÍ & B.C. EMERSON

**13:00 Lunch & Poster Session (P1) –**  
Biodiversity and Ecology

**14:00 Plenary Talk II** [Auditorium, July, 18]  
The role of psychology in biodiversity  
conservation  
SUSAN D. CLAYTON

**15:00 Symposium 3** [Auditorium - July, 18]  
Ev1. Diversification, colonisation and ecological  
limits on islands: A macroevolutionary  
perspective  
CHAIRS: LUÍS VALENTE & JOSSELIN CORNUAULT

15:00 Equilibrium and non-equilibrium dynamics on  
islands: insights from birds and bats  
LUÍS VALENTE, J.C. ILLERA, L. DÁVALOS, A.  
PHILLIMORE, K. HAVENSTEIN, R. TIEDEMANN &  
R. ETIENNE

15:20 Diversity-dependent diversification on islands  
RAMPAL ETIENNE

**16:00 Refreshment Break**

16:30 Isolated islands untangle universal patterns at the  
nexus of macroevolution and macroecology  
ANDY J. ROMINGER, J.Y. LIM, K.R. GOODMAN, J.  
HARTE, D. GRUNER & ROSEMARY G. GILLESPIE

16:50 An ecological and evolutionary framework for  
the analysis of insular biomes  
BRENT EMERSON, H. LÓPEZ, A. PEREZ-  
DELGADO, P. OROMÍ, J.M. FERNÁNDEZ-  
PALACIOS, J. CAUJAPÉ-CASTELLS, P. CARDOSO,  
D. STRASBERG, C. THÉBAUD & P.A.V. BORGES

17:10 Testing landscape effects on the evolution of  
island arthropod assemblages

17:15 Comparing the accumulation of species across  
multiple lineages and islands  
JOSSELIN CORNUAULT & C. THÉBAUD

17:35 Late Quaternary climate change shapes island  
biodiversity  
PATRICK WEIGELT, M.J. STEINBAUER, J.S.  
CABRAL & H. KREFT

17:55 Disentangling the drivers of species richness in  
island floras  
JONATHAN P. PRICE, M.K. BORREGAARD, R.H.  
WHITTAKER, H. KREFT, P. WEIGELT, L. VALENTE  
& BIG WORKING GROUP

18:15 Geology and ecology interact to drive  
evolutionary radiations and declines on Hawaii  
JUN YING LIM & C. MARSHALL

18:35 Island is the limit: Observing species turnover in  
bat species record from Siberut Island, Indonesia  
SABHRINA G. ANINTA, S. NOERFAHMY, S.  
WIANTORO & D.T. ISKANDAR

**15:00 Symposium 2b.** [Small audit - July, 18]  
Cv1. Biodiversity and conservation of island  
plants  
CHAIRS: MÓNICA MOURA, LUÍS SILVA & JULI  
CAUJAPÉ-CASTELLS

15:00 Threat analysis and conservation plans for  
selected Azorean endemic plants on Corvo Island  
JULIE A WEISSMANN & H. SCHAEFER

15:20 Phylogenetic and biogeographic patterns in the  
endemic flora of the Juan Fernández Islands,  
Chile  
TOD F STUESSY, D.J. CRAWFORD & E. RUIZ

15:40 Reproductive biology in the Canarian flora: Guidelines for the recovery and conservation of natural populations of threatened endemics  
JULIA PÉREZ DE PAZ, R. FEBLES, O.F.-P. ACOSTA & M.O. CORRAL

M.M. SEQUEIRA, M. MOURA, A. SANTOS-GUERRA, J.K. KELLY, M. GRUENSTAEUDL, J. CAUJAPÉ-CASTELLS & D. CRAWFORD

#### 16:00 Refreshment Break

16:30 Conservation genetics of the highly endangered Azorean endemics *Euphrasia azorica* and *Euphrasia grandiflora* using new SSR data  
MÓNICA MOURA, E.F. DIAS, L. SILVA & M.G.B. MACIEL

16:50 Towards a more holistic research approach to plant conservation: the case of rare plants on oceanic islands  
LUÍS SILVA, E.F. DIAS, J. SARDOS, E.B. AZEVEDO, H. SCHAEFER & M. MOURA

17:10 Case study of the Critically Endangered island endemic *Roussea simplex*: Crucial need to quantify and hierarchise threats  
CLAUDIA BAIDER, V. GRAEPEL, S. TROTZER, V. COUTTEE, M.A.A. KARGHOO, P. BISSESSUR & F.B.V. FLORENS

17:30 Population genetic structure in the tetraploid *Viola cheiranthifolia* (Teide violet), a high mountain endemic from the Canary Islands  
PRISCILA RODRÍGUEZ-RODRÍGUEZ, I. SARO, A. NARANJO & P.A. SOSA

17:50 Specific threats connected with climate change impacts on oceanic islands  
CARL BEIERKUHNLEIN, D.E.G. HARTER, A. PROVENZALE, S.D.H. IRL, D. KIENLE, A.H. SCHWEIGER, R. G. GILLESPIE, J.M. FERNÁNDEZ-PALACIOS, K.A. TRIANTIS, M.J. STEINBAUER & A. JENTSCH

18:10 Analyses of Multiplexed-Shotgun-Genotyping (MSG) data reveal cryptic biodiversity in Macaronesian Tolpis  
MARK E MORT, J.K. ARCHIBALD, M.J.S. GIBSON, H. BONTRAGER, D.P. HAUBER, L.B. SILVA,

#### 15:00 Ordinary Talks 3 [Large room, July, 18]

##### Ecology

MODERATORS: DONALD R. DRAKE & H. SERRANO

15:00 Patterns of flower visitation and nectar feeding in Hawaiian honeycreepers and lobeliads  
DONALD R. DRAKE & K.A.P. THOMPSON

15:15 Pollination of *Cneorum tricoccon* L. by the opportunistic nectar-feeder lizard *Podarcis lilfordi* (Günther, 1874) in an insular ecosystem  
FRANCISCO FUSTER & A. TRAVESET

15:30 Seasonal and interannual variation in forest flowering and fruiting in a two-decade record from Puerto Rico: Global climate drivers and hurricane effects  
JESS K ZIMMERMAN, J.A. HOGAN, C.J. NYTCH & J. BITHORN

15:45 Anticipating effects of climate change in the Hawaiian Islands: Defining plant community and climatic variation across the treeline ecotone  
ALISON AINSWORTH & D.R. DRAKE

#### 16:00 Refreshment Break

16:30 Peri-urban forest fragments as islands: The response of plants and lichens diversity to habitat fragmentation  
L. ROSATI, G. POTENZA, S. FASCETTI & MICHELA MARIGNANI

16:45 Cross-taxon and environmental surrogacy of bryophytes and lichens in a natural forest: Implications for conservation  
S. RUAS, A. BERGAMINI, P. CARVALHO, S. FONTINHA, C. LOBO, F. REIS, A. MARTINS & MANUELA SIM-SIM

17:00 Micro-endemism in New Caledonia: Estimating the distribution range of animal species by controlling for sampling effort

MARAM CAESAR, P. GRANDCOLAS & R. PELLENS

17:15 Linking soil biogeochemistry and plant-plant interactions during long-term succession

FERNANDO D ALFARO, S. ABADES, H. VILLCA,

F.I. PUGNAIRE, A. GAXIOLA & P.A. MARQUET

17:30 Geochemical Islands: Promised land or unintended refuge?

HELENA C SERRANO, M.A. MARTINS-LOUÇÃO & C. BRANQUINHO

17:45 Where is iodine? Seeking iodine bioavailability in the Azores

PATRÍCIA V GARCIA, D.P.S. LINHARES, A.

ALMADA, T. FERREIRA, G. QUEIRÓZ, J.V.C.

CRUZ & A.S. RODRIGUES

18:00 The microbiological toolbox: Assessing soil health in metal polluted agricultural volcanic soils

CAROLINA PARELHO, A.S. RODRIGUES, M.C.

BARRETO, N.G.C. FERREIRA & P.V. GARCIA

#### **15:00 Symposium 4 [Small room, July, 18]**

Cv3. Conservation of invertebrates in mid-Atlantic islands

CHAIRS: VICKY KINDEMBA & P.A.V. BORGES

15:00 IUCN Red Lists - adaptations to invertebrates and new tools under development

PEDRO CARDOSO

15:30 How can we transform the criterion B of IUCN' Red List in a useful tool for setting conservation priorities with Invertebrates of island regions?

JOSÉ LUIS MARTÍN-ESQUIVEL

16:30 What we know and what we don't know about the conservation status of island endemic invertebrates

AXEL HOCHKIRCH

16:50 Golden, Spiky and Blushing - establishing invertebrate conservation on the Atlantic island of St Helena

VICKY KINDEMBA

17:10 Planning for a long-term monitoring program for island forest mountain spiders and beetles – a simplified COBRA Protocol for monitoring beta diversity

PAULO A.V. BORGES, P. CARDOSO, P. OROMÍ, C.

THÉBAUD, D. STRASBERG & B.C. EMERSON

#### **19:30 Welcome reception**

Wine, cheese & music at the “Museu de Angra do Heroísmo”.

#### **16:00 Refreshment Break**

## TUESDAY, 19 OF JULY

### 8:30 Plenary Talk III [Auditorium, July, 19]

Long-term ecological research in Azores: What we have learned so far  
PAULO A.V. BORGES

### 9:30 Workshop - IUCN [Auditorium, July, 19]

WS – IUCN, Strategies for the conservation of island biodiversity  
CHAIR: THOMAS BROOKS

9:30 Strategies for the Conservation of Island Biodiversity  
PAULO A.V. BORGES

9:35 IUCN and Island Conservation  
THOMAS BROOKS

9:55 Species Conservation Profile (SCP): A streamlined workflow for collaborative authoring, peer-review and scholarly publication serving the IUCN Red Data List  
LYUBOMIR PENEV, P. STOEV, T. GEORGIEV, V. SENDEROV & P. CARDOSO

10:15 Comments from IUCN SSC leaders (I)  
COLIN CLUBBE, AXEL HOCHKIRCH, KRISTINE WESTERGAARD & PAULO A.V. BORGES

### 10:30 Refreshment Break

11:00 Comments from IUCN SSC leaders (II)  
PEDRO CARDOSO, TIGGA KINGSTON, VICKY KINDEMBA

11:10 Eight breakout discussion groups led by IUCN SSC leaders

11:55 Eight x 3-minute reports back from breakouts

12:20 General discussion and close  
PAULO A.V. BORGES & T. BROOKS

### 9:30 Symposium 5a. [Small audit, July, 19]

Cv4. Biodiversity and conservation of island vertebrates  
CHAIRS: CHRISTIAN E VINCENOT & SOPHIE PETIT

9:30 Cracks in island keystones: Threat synergies and life history traits push island flying foxes (*Pteropus* spp.) to the brink  
TIGGA KINGSTON

10:00 Prioritization frameworks for island vertebrate conservation  
FRANCK COURCHAMP, C. BELLARD, C. BERTELSMEIER, L.S. BULL, S.D. GREGORY & D.B. HARRIS

### 10:30 Refreshment Break

11:00 Overabundance of a parakeet on a Caribbean island threatens a keystone bat-cactus mutualism  
SOPHIE PETIT, A. ROJER & L. PORS

11:20 Conservation challenges in the Ryukyu Archipelago: Public perception of an endemic fruit bat and ongoing conflicts  
CHRISTIAN E VINCENOT

11:40 Mass culling of a globally threatened island flying fox: What lessons can we draw?  
FRANÇOIS B.V. FLORENS

12:00 Island restoration through invasive mammal eradication  
JAMES RUSSEL, N. HOLMES & H. JONES

12:20 Novel insights on cost-effective ways to protect island vertebrates from the impacts of invasive non-native carnivores  
LISE RUFFINO, T. CORNUILLER, M.K. OLIVER, E.J. FRASER & X. LAMBIN

**9:30 Symposium 6** [Large room, July, 19]

**Bg4. Islands within islands: Parasites on insular host populations**

CHAIRS: RICARDO J. LOPES & ROBERT E. RICKLEFS

9:30 Galapagos birds and their parasites: Arrival and host relationships  
PATRICIA PARKER

10:00 Why blackbirds are the main avian host of *Haemosporidia* in Azores and how they cope with infections  
RICARDO J. LOPES, J.A. RAMOS & P. RODRIGUES

**10:30 Refreshment Break**

11:00 Patterns of diversification of parasites infecting reptiles in the Canary Islands: Different parasites, same answers?  
ANA PERERA, B. TOMÉ, A. SOUSA, A. PEREIRA, M.A. CARRETERO, D.J. HARRIS, V. ROCA & F. JORGE

11:20 Do island species experience lower parasite pressure than mainland ones? Diversity, prevalence and host specificity of avian *Haemosporidia* in the Gulf of Guinea (West Africa)  
CLAIRE LOISEAU, R. COVAS, E. LOBATO, J.S. BEADELL, R.C. FLEISCHER, S. REIS, C. DOUTRELANT & M. MELO

11:40 Loss, gain and exchange: Avian malaria in naturally colonising hosts and related insular endemics  
FARAH ISHTIAQ, B.C. SHELDON, I.P.F. OWENS, N.J. CLARK & S.M. CLEGG

12:00 Forest fragmentation and parasite diversity in an insular system  
ANTÓN PÉREZ-RODRÍGUEZ, A. KHIMOUN, A. OLLIVIER, C. ERAUD, B. FAIVRE & S. GARNIER

12:20 Haemogregarines in Canarian reptiles: A distribution and diversity study

BEATRIZ TOMÉ, A. PEREIRA, F. JORGE, M. CARRETERO, D.J. HARRIS & A. PERERA

**9:30 Symposium 7** [Small room, July, 19]

**Cv2. Biodiversity and place: Exploring relationships from a psychological perspective**

CHAIRS: ANA MOURA ARROZ, LUÍSA LIMA, SUSAN CLAYTON & JUAN IGNACIO ARAGONÉS

9:30 The impact of environmental condition and identity on emotional responses to environments  
SUSAN D. CLAYTON

10:00 Using place identity and social norms to promote biodiversity  
LUÍSA LIMA & C.BRANCO

**10:30 Refreshment Break**

11:00 Representations of nature, environmental identity and connectedness with nature  
JUAN IGNACIO ARAGONÉS

11:20 Bonds to places: Suggestions for risk communication in the Azores  
ISABEL ESTRELA REGO, I.R. AMORIM, R.GABRIEL & A.M. ARROZ

11:40 Does nature play a central role for place identity in the Azores?  
ANA MOURA ARROZ, R. GABRIEL, I.E. REGO & I.R. AMORIM

12:00 Place identity and biodiversity conservation in the Azores  
ISABEL R AMORIM, A.M. ARROZ, M.L. LIMA, , P.A.V. BORGES & R.GABRIEL

**13:00 Lunch & Poster Session (P2) – Conservation**

**14:00 Plenary Talk IV** [Auditorium, July, 19]

Oceanic island biogeography through the lens of the General Dynamic Model macroscope

ROBERT J. WHITTAKER

**15:00 Workshop - iDigBio** [Auditorium, July, 19]

WS – iDigBio, Digitized natural history collections: Research uses for understanding island biodiversity, biogeography, and communities

CHAIR: SHELLEY A. JAMES

15:00 Integrated digitized biocollections (iDigBio): Mobilizing natural history collections for understanding island biodiversity

SHELLEY A. JAMES, D. PAUL, M. COLLINS & G. NELSON

15:20 Biological collections data: Best practices and trends for standards, digitization, and biodiversity informatics literacy for research use of collections data

DEBORAH L. PAUL & K.C. SELTMANN

15:40 Collecting experiences in Melanesia: Best practices for efficient digitization

SHELLEY A. JAMES

**16:00 Refreshment Break**

16:30 Accessing digital collections data sources for research: A tour of iDigBio data services

MATTHEW COLLINS & D.L. PAUL

16:50 The Guam Ecosystem Collaboratorium's biorepository project

TERRY J. DONALDSON, D.P. LINDSTROM, J.A. PETERSON, & J.S. BIGGS

17:10 Digitizing the Azorean bryophyte, vascular plant and arthropod' collections: The Azores Bioportal initiative

ROSALINA GABRIEL, E. MENDONÇA, R.B. ELIAS, I.R. AMORIM, F. PEREIRA & P.A.V. BORGES

17:30 HOLOS: Integrating biological and environmental data to assess ecological and evolutionary response to change

ROSEMARY G. GILLESPIE, A. HILLER, M. KOO, M. KELLY, K. KOY, C.M. MARSHALL, G. RAPACCIUOLO

17:50 An insight about species turnover from bat species records on Siberut Islands, Indonesia

SABHRINA G. ANINTA, S. NOERFAHMY, S. WIANTORO & D.T. ISKANDAR

18:10 The role of niche differentiation and conservatism in the diversification of island plant clades

JUN LING LIM

18:30 Documenting and digitizing specimens from a weird and scenic landscape: Utilizing and enhancing collections to understand patterns of biodiversity

KATIE L. PETERSON & C.E. PARENT

18:35 Harnessing biocollections data with hierarchical models to understand homogenization of island biotas

ANDY J. ROMINGER

18:40 The role of herbaria in research on Pacific Island floras

JONATHAN P. PRICE

19:00 Herbarium data mining to assess invasion risks and trace invasion histories of nuisance Algae in tropical Pacific Islands

TOM SCHILS, C. BOEDEKER, A. SIMEON & F. LELIAERT



**15:00 Symposium 5b.** [Small audit, July, 19]

**Cv4. Biodiversity and conservation of island vertebrates**

*CHAIRS:* CHRISTIAN E. VINCENOT & SOPHIE PETIT

15:00 Management of rare and endemic species within a dynamic natural disturbance regime and among anthropogenic threats in the Commonwealth of the Mariana Islands

JIM KEANY & L. ZARONES

15:20 Interactive effects of marine subsidies, herbivory and predation on the ecology of Mediterranean island reptile populations

JOHANNES FOUFOPOULOS, Z. GIZICKI & P. PAFILIS

15:40 A conservation strategy for the amphibians of Madagascar: An overview of the main threats and of the planned conservation activities

ANGELICA CROTTINI, J. DAWSON, J.P. LEWIS, F. RABEMANANJARA, N. RABIBISOA, T. RAKOTONANAHARY & F. ANDREONE

**16:00 Refreshment Break**

16:30 The masked owls of Lord Howe Island - consequences of the introduction of a top-order predator to an oceanic island

DAVID MILLEDGE

16:50 Please don't eat the birds! - Wildlife hunting in São Tomé Island

MARIANA CARVALHO, J.M. PALMEIRIM, R.F. LIMA, F.C. REGO & J.E. FA

17:10 Conservation of Macaronesian sparrowhawk and Laurissilva habitat in Madeira Island

CÁTIA GOUVEIA, L. CASTELLÓ, A.I. FAGUNDES, S. HERVIAS, M. NUNES, C. GONZALEZ, J.A. LORENZO, D. MENEZES, N. COELHO, C. MEDEIROS, P. FREITAS, A. MARTINS & N. SERRALHA

17:30 Praia Islet: Two decades of ongoing seabird conservation

VERÓNICA NEVES, L. AGUIAR, M. BOLTON, M.C. MAGALHÃES, C.P. NAVA, L.F. PALOU, C. PÍCANÇO, P. RAPOSO & J. BRIED

17:50 Using ancient DNA to inform conservation of Caribbean land mammal fauna

ROSEINA WOODS, I. BARNES, M.J.F. BROWN & S.T. TURVEY

**15:00 Symposium 8** [Large room, July, 19]

**Cv5. From extinction to restoration: Madagascar, the Mascarenes and the Seychelles**

*CHAIRS:* ERIK DE BOER & DAVID A. BURNEY

15:00 Extinction and restoration from Madagascar to Rodrigues: Conservation paleobiology on the eighth continent and the last place on Earth

DAVID A. BURNEY

15:30 Restoring and conserving the remains of the ecosystem of the Dodo: Lessons from a 4200 year old multitaxic bone bed

KENNETH F. RIJSDIJK, P.G.B. DE LOUW, H.J.M. MEIJER, L.P.A.M. CLAESSENS, F.B.V. FLORENS, C. BAIDER, N. PORCH, V. TATAYA, A. JANOO & E.J. DE BOER

**16:00 Refreshment Break**

16:30 Historical land use change and soil loss on Mauritius (Indian Ocean)

SIETZE J. NORDER, A.C. SEIJMONSBERGEN, S.D.D.V. RUGHOOPUTH, E.E. VAN LOON, V. TATAYAH, T.A. KAMMINGA & K.F. RIJSDIJK

16:50 Revisiting patterns of habitat transformation and extinction in La Réunion (Mascarene Islands)

DOMINIQUE STRASBERG, O. FLORES & C. AH-PENG

17:10 Introduced mammals on western Indian Ocean islands

JAMES RUSSELL, N. COLE, N. ZUËL & G. ROCAMORA



- 17:30 Incorporating evolutionary and ecological traits of the iconic coco de mer palm in forest restoration  
CHRISTOPHER N. KAISER-BUNBURY, P.J. EDWARDS, F. FLEISCHER-DOGLEY, L. LATORRE PIÑERO & N. BUNBURY
- 17:50 Achievements and challenges in conserving and restoring native terrestrial ecosystems on Mauritius  
FRANÇOIS B.V. FLORENS & BAIDER, C.
- 18:10 Future directions for island rewilding in the Western Indian Ocean  
DENNIS M. HANSEN
- 15:00 Symposium 9** [Small room, July, 19]  
Ec1. Freshwater systems in oceanic islands  
CHAIRS: PEDRO RAPOSEIRO, V. GONÇALVES & A. C. COSTA
- 15:00 Are the food-web dynamics in species poor Island lakes different from those in the more species rich mainland lakes?  
NICOLAS VIDAL, S.L. AMSINCK, V. GONÇALVES, J.M.N. AZEVEDO, L.S. JOHANSSON, K.S. CHRISTOFFERSEN, T.S. LAURIDSEN, M. SØNDERGAARD, R. BJERRING, F. LANDKILDEHUS, K.P. BRODERSEN, M. MEERHOFF & ERIK JEPPESEN
- 15:30 Islands within islands: The Azorean lakes  
ANA C. COSTA, V. GONÇALVES & P.M. RAPOSEIRO
- 16:00 Refreshment Break**
- 16:30 Cyanotoxins in Azorean lakes: Introducing molecular methods for the awareness of production potential  
RITA I.P. CORDEIRO, R. LUZ, V. SILVA, D.M. PACHECO, V. GONÇALVES & A. FONSECA
- 16:50 Effects of prolonged drought on rainforest streams in the Luquillo  
ALAN P. COVICH, T.A. CROWL & O. PEREZ-REYES
- 17:10 Environmental drivers of change in macroinvertebrate assemblages on isolated oceanic island streams: Madeira Island as case study  
JULIE-CAMILLE RIVA, V. GONÇALVES, A.C. COSTA, S.J. HUGHES & P.M. RAPOSEIRO
- 17:30 Stream biota in remote oceanic islands: The role of local, regional and geographical factors in structuring diatom and macroinvertebrate communities  
VÍTOR GONÇALVES, P.M. RAPOSEIRO, H.S. MARQUES & A.C. COSTA
- 17:50 Leaf litter decomposition in Atlantic Islands is driven by microbes and depends on litter quality and environmental conditions  
VERÓNICA FERREIRA, P.M. RAPOSEIRO, A. PEREIRA, A.M. CRUZ, A.C. COSTA, M.A.S. GRAÇA & V. GONÇALVES
- 18:10 Allometric relationships, feeding preferences, growth and survival of the endemic stream shredder *Limnephilus atlanticus* (Trichoptera, Limnephilidae)  
ANA BALIBREA, V. GONÇALVES, V. FERREIRA & P.M. RAPOSEIRO
- 18:30 Network analysis of tropical drainage basins: Habitat connectivity among migrating species  
ALAN P. COVICH, T.A. CROWL & O. PEREZ-REYES
- 19:00 Meeting of the "Island Biology Society"**  
[Auditorium, July, 19]  
CHAIRS: CHRISTOPHE KUEFFER, JOSÉ MARÍA FERNÁNDEZ-PALACIOS, DONALD R. DRAKE & PAULO A.V. BORGES

## WEDNESDAY, 20 OF JULY

**8:30 Field trip I** [Meeting point at the University of the Azores, July, 20]

**8:30 Symposium 10a.** [Auditorium, July, 20]

Bg5. Palaeobiogeography, palaeocology and palaeoclimatology in oceanic islands

*CHAIRS:* SÉRGIO ÁVILA, PEDRO RAPOSEIRO & VÍTOR GONÇALVES

8:30 Pleistocene glacial/interglacial contrasts in North-West North Atlantic prior vs after MIS 11

CLAUDE HILLAIRE-MARCEL, A. VERNAL, O. TÉBOULE & A. AUBRY

9:00 Transatlantic dispersal of the coral-dwelling barnacles belonging to *Ceratoconcha* and their Neogene spread to the North Atlantic islands

B. GUDVEIG BAARLI, MARKES E. JOHNSON, M.C.D. MALAY, A. SANTOS, J. MECO, C.M. SILVA, E.J. MAYORAL & M. CACHÃO

9:20 Biodiversity and biogeographical patterns of the Pleistocene and Holocene littoral gastropod fauna from the Azores

RICARDO CORDEIRO, C. MELO, P. MADEIRA & S.P. ÁVILA

9:40 Biodiversity and biogeography of the recent echinoderms from the Azores

PATRÍCIA MADEIRA, R. CORDEIRO, A.C. REBELO, C. MELO, A. KROH & S.P. ÁVILA

10:00 The human colonization of islands: A paleo perspective

SANTIAGO GIRALT

10:30 Refreshment Break

11:00 Marine island biogeography: testing large-scale biogeographic patterns of marine organisms in oceanic islands (Atlantic Ocean)

SÉRGIO P. ÁVILA, R. CORDEIRO, P. MADEIRA, L. SILVA, A. MEDEIROS, A.C. REBELO, C. MELO, A.I. NETO, R. HAROUN, A. MONTEIRO, K. RIJSDIJK & M. JOHNSON

11:20 The role of sea-level changes in oceanic island biodiversity: the Mis 5e in the Azores

CARLOS A.S. MELO, A.C. REBELO, R. CORDEIRO, P. MADEIRA, V. RAPOSO & S.P. ÁVILA

11:40 Rhodolith beds on volcanic oceanic islands: Paleobiology and biogeography

ANA CRISTINA REBELO, M.W. RASSER, C.A.S. MELO, P. MADEIRA, R. CORDEIRO, A.I. NETO & S.P. ÁVILA

12:00 Pleistocene area as predictor of species richness on volcanic islands

SIETZE J. NORDER, K.F. RIJSDIJK, E.E. VAN LOON, W.D. KISSLING, R. OTTO, S.P. ÁVILA, T. HENGL, P. STOCCHI & J.M. FERNÁNDEZ-PALACIOS

12:20 Quantifying palaeogeographical rates of changes of continental islands in the Aegean Sea by sea level rise: Towards a novel framework for assessing biogeographical implications of palaeogeographical change

STYLIANOS M. SIMAIAKIS, K.F. RIJSDIJK, E.F.M. KOENE, J.H. VAN BOXEL, P. STOCCHI, E.E. VAN LOON, C. HAMMOUD, S.J. NORDER, E. GEORGOPOULOU, K. TRIANTIS & E. TJØRVE

12:40 The last interglacial in northeastern North America and the northern North Atlantic: Evidence for warmer climate and ocean conditions than during the Holocene and possibly MIS11

ANNE DE VERNAL, B. FRÉCHETTE, C. HILLAIRE-MARCEL, & N. VAN NIEUWENHOVE

**8:30 Symposium 11** [Small audit, July, 20]

Ec5. Similarities and dissimilarities of biodiversity patterns on oceanic, terrestrial and experimental islands

*CHAIRS:* TEJA TSCHARNTKE & HOLGER KREFT

- 8:30 Oceanic and terrestrial islands: biophysical similarities and differences and implications for theory  
HOLGER KREFT
- 9:00 Toward a mechanistic understanding of edge effects in fragmented systems  
RAPHAEL K. DIDHAM
- 9:30 Revisiting species-area-relationships – the case of German barrier islands  
HAGEN ANDERT, C. SCHERBER & T. TSCHARNTKE
- 9:50 Effects of habitat fragmentation on plant and animal diversity: research in a land-bridge island system  
JIAJIA LIU, X. SI, G. HU, Y. WANG, P. DING & M. YU
- 10:10 Taxonomic and functional diversity of birds on subtropical fragment islands in China  
XINGFENG SI & P. DING
- 10:30 Refreshment Break**
- 11:00 Springs: geographical isolates for the groundwater meiofauna?  
SIMONE FATTORINI, B. FIASCA, A. DI CIOCCIO, T. DI LORENZO & D.M.P. GALASSI
- 11:20 Islands within islands: arthropod diversity within a volcanically fragmented landscape on Hawaii island  
DANIEL S. GRUNER
- 11:40 Colonization of experimental islands in the Wadden Sea, Germany  
MICHAEL KLEYER, T. BALKE, & K. LOMUS
- 12:00 Non-convergent mammal community diversity and assembly in shared ecoregions: A test in Madagascar and Australia  
KATHERINE H. BANNAR-MARTIN
- 12:20 Fragmentation effects depend on biodiversity measure applied - examples on grassland plants and insects  
PETER BATÁRY, V. RÖSCH & T. TSCHARNTKE
- 8:30 Symposium 12** [UAz, Main hall, July, 20]  
Bd2. Island Forests: present status and future challenges  
CHAIRS: LUÍS SILVA & RUI B. ELIAS
- 8:30 Island forests, an overview  
LUÍS SILVA
- 9:00 Natural forests of the Azores: Conservation status, threats and guidelines for the future  
RUI B. ELIAS
- 9:20 Management of exotic woodland resources in the Azores: Biomass availability from *Pittosporum undulatum* stands  
LURDES B. SILVA, A. TEIXEIRA, E.B. AZEVEDO, M. ALVES, R.B. ELIAS & S. SILVA
- 9:40 Restoration of the Azorean Laurel Forest in S. Miguel Island, home of the Azores Bullfinch: Lessons learned  
RUI BOTELHO, R.H. HELENO, J. RAMOS, F. FIGUEIREDO, L. PEÑIL, A. SALVADOR, C. SILVA, R. COELHO, A. CRUZ, J. TEODÓSIO & L. COSTA
- 10:00 Madeira natural forests: Current status and future prospects  
MIGUEL MENEZES DE SEQUEIRA, R. JARDIM, J. CAPELO, C.A. GÓIS-MARQUES, A. FIGUEIREDO, & A. PUPO-CORREIA
- 10:30 Refreshment Break**
- 11:00 Abandoned agricultural terraces in Madeira Island: A glimmer of hope for passive restoration?  
AIDA PUPO-CORREIA, M.M. SEQUEIRA & J.T. ARANHA

- 11:20 Invaded indigenous forests remnants of Mauritius: What lessons for island forest conservation?  
CLAUDIA BAIDER & F.B.V. FLORENS
- 11:40 Population structure of *Juniperus brevifolia* forests along an altitudinal gradient at the Special Protection Area of Pico da Vara - Ribeira do Guilherme, São Miguel, Azores  
LOURDES PEÑIL, V. GOMEZ-SANZ, S. MERINO-DE-MIGUEL, R. BOTELHO & J. TEODÓSIO
- 8:30 Symposium 13** [UAz, Room 2.4, July, 20]  
Bd4. Subterranean biology on islands  
CHAIRS: ISABEL R AMORIM & ANA SOFIA P.S. REBOLEIRA
- 8:30 A review of the subterranean biology research performed in the Azores  
ISABEL R. AMORIM, F. PEREIRA, R. GABRIEL & P.A.V. BORGES
- 9:00 Cave-adapted faunas in volcanic islands vs. continental areas  
ANA SOFIA P.S. REBOLEIRA & P. OROMÍ
- 9:30 Fossil birds from Graciosa island (Central Azores): A preliminary list  
JOSEP ANTONI ALCOVER, F. PEREIRA, H. PIEPER & J.C. RANDO
- 9:50 An unexpected vertebrate fossil assemblage on Mallorca (Balearic Islands, Western Mediterranean Sea)  
ENRIQUE TORRES ROIG, J.A. ALCOVER, P. BOVER, S. BAILON, J. AGUSTÍ & J. ROFES
- 10:10 The pyroclast deposits, an important subsurface habitat for troglobionts on recent volcanic islands  
A.J. PÉREZ, H. LÓPEZ & P. OROMÍ
- 10:30 Refreshment Break**
- 11:00 Sardinia, a hotspot of diversity for subterranean terrestrial isopods (Crustacea, Oniscidea)  
STEFANO TAITI, P. MARCIA, M. CASU & R. ARGANO
- 11:20 Makauwahi Cave Reserve, Kauai: Limestone caverns on a volcanic island  
DAVID A. BURNEY & L.P. BURNEY
- 11:40 Variation of the subterranean fauna along an island chain  
PEDRO OROMÍ, A.J. PÉREZ & H. LÓPEZ
- 8:30 Symposium 14** [UAz, Room 2.5, July, 20]  
Ec4. Polar Islands  
CHAIRS: INGER GREVE ALSOS
- 8:30 Biogeography, isolation and evolution in the peri-Antarctic islands  
PETER CONVEY
- 9:00 Resilience of high latitude island ecosystems  
INGIBJÖRG S. JÓNSDÓTTIR
- 9:30 Dispersal and survival of disjunct arctic plant species  
KRISTINE B. WESTERGAARD
- 9:50 North Atlantic island insect faunas, from palaeoecology to conservation  
EVA PANAGIOTAKOPULU, A. BUCHAN & P. BUCKLAND
- 10:10 The aquatic fauna of the North Atlantic islands with emphasis on Iceland  
GÍSLI MÁR GÍSLASON
- 10:30 Refreshment Break**
- 11:00 Patterns of vascular plant endemism in high latitude islands  
THÓRA ELLEN THÓRHALLSDÓTTIR

- 11:20 The role of sea ice for vascular plant dispersal in the Arctic  
INGER GREVE ALSOS, D. EHRICH, M.-S.  
SEIDENKRANTZ, O. BENNIKE, A. KIRCHHEFER & A. GEIRSDOTTIR
- 10:00 First revision of the current status of seahorses (Syngnathidae) and their distribution throughout the Macaronesia (NE Atlantic)  
FRANCISCO OTERO-FERRER, J.A. GONZÁLEZ, M. FREITAS, R. ARAÚJO, J.M.N. AZEVEDO, W. HOLT & R. HAROUN
- 8:30 Ordinary talks 4** [UAz, Room 3.6, July, 20]  
Conservation  
MODERATORS: DOMINIQUE STRASBERG & MARIA TERESA FERREIRA
- 8:30 Biodiversity conservation in the Socotra Archipelago: Current challenges and future prospects  
KAY VAN DAMME, U. ZAJONZ, A. BENSADA & E. ZANDRI
- 10:15 Movement and activity drivers of an ecosystem engineer – the giant Aldabra tortoise (*Aldabrachelys gigantea*) on Aldabra Atoll  
RICHARD BAXTER, G. SCHAEPMAN-STRUB, A. OZGUL, E. POSTMA, L.A. TURNBULL, F. FLEISCHER-DOGLEY, N. BUNBURY, W. FALCON & D.M. HANSEN
- 10:30 Refreshment Break
- 8:45 Effects of climate change on the distribution of indigenous species in oceanic islands (Azores)  
MARIA TERESA FERREIRA, P. CARDOSO, P.A.V. BORGES, R. GABRIEL, E.B. AZEVEDO, F. REIS, M.B. ARAÚJO & R.B. ELIAS
- 11:00 Comparing trace metal content in *Pachygrapsus marmoratus* from sites with different land uses and environmental attributes  
NUNO V. ÁLVARO, J.M.N. AZEVEDO, A. RODRIGUES, & A.I. NETO
- 9:00 Connecting pristine forest areas to face climate change effects under high uncertainty: A case study with arthropods in Terceira Island  
BRUNO APARÍCIO, J. CASCALHO, M.J. CRUZ, P.A.V. BORGES & F. ASCENSÃO
- 11:15 Landscape structure influences within-island gene flow in a forest specialist bird species  
AURELIE KHIMOUN, N. NAVARRO, B. FAIVRE & S. GARNIER
- 9:15 Susceptibility to climate change by the laurel forests of Madeira Island: How changes on suitable area might promote floristic adjustments  
ALBANO FIGUEIREDO & M.M. SEQUEIRA
- 11:30 Land use and land cover assessment by using high resolution satellite imagery and landscape metrics – the Terceira Island (Azores) case-study  
RITA GODINHO, P.A.V. BORGES, H. CALADO & R.B. ELIAS
- 9:30 Conserving native insect communities on islands: Insights from management projects in Hawaii  
PAUL D. KRUSHELNYCKY, K. KAWELO, S. PLENTOVICH, C. KING, L. YOUNG & D.R. DRAKE
- 11:45 Social aspects to successful island conservation: Lessons from the proposed rodent eradication on Lord Howe Island  
IAN HUTTON, D. KELLY, C. MURRAY & L. BRICE
- 9:45 Galapagos giant tortoises and farmers: Coexistence or conflict?  
GIORGIA CAMPERIO-CIANI, F. BENITEZ-CAPISTROS, J. HUGÉ, F. DAHDOUH-GUEBAS & N. KOEDAM

**8:30 Symposium 15a.** [UAz, Room 3.7, July, 20]  
**Ev4. Invertebrate evolution on islands**

*CHAIRS:* BRENT EMERSON, HERIBERTO LÓPEZ &  
CHRISTINE PARENT

8:30 Linking macro- and microevolutionary perspectives to evaluate the role of Pleistocene sea-level oscillations in driving island diversification patterns

ANNA PAPADOPOULOU & L.L. KNOWLES

9:00 Adaptive radiation and parallel evolution in the sheet-weaving spiders (Linyphiidae) of the south Pacific Archipelago of Juan Fernández

MIQUEL A. ARNEDO & G. HORMIGA

9:20 Phylogenetics of a Hyper-diverse Hawaiian moth radiation yield insight into the timing and tempo of adaptation in speciation

DANIEL RUBINOFF

9:40 The role of allele sorting in a parallel speciation gradient of Calosoma beetles in the Galápagos archipelago

CARL VANGESTEL & F. HENDRICKX

10:00 Near and far: Contrasting remote and near continent island radiations

DIANA M. PERCY

**10:30 Refreshment Break**

11:00 Galapagos land snail's metabolic rate: a relationship of shell morphology and environment

YANNIK ROELL, J. VOYLES & C.E. PARENT

11:20 Flightless versus Winged – How dispersal ability shapes colonization and speciation processes of grasshoppers on the Canary Islands

AXEL HOCHKIRCH

11:40 What are we losing? The ecomorphology of decline in Galápagos land snails

A.C. KRAEMER & CHRISTINE E. PARENT

12:00 The role of morphological evolution and prey specialization in adaptive radiations: the spider genus *Dysdera* in the Canary Islands

NURIA MACÍAS-HERNÁNDEZ, O.S.

WANGENSTEEN, S. TOFT & M. ARNEDO

12:20 The thin line between in-situ radiation and among island dispersal in the genesis of replicated species assemblages on the Galapagos

FREDERIK HENDRICKX, C. DE BUSSCHERE, S.M.

VAN BELLEGHEM, Z. DE CORTE & C. VANGESTEL

**13:00 Lunch**

**13:45 Field trip II** [Meeting point at the University of the Azores, July, 20]

**14:30 Symposium 10b.** [Auditorium, July, 20]

**Bg5. Palaeobiogeography, palaeocology and palaeoclimatology in oceanic islands**

*CHAIRS:* SÉRGIO ÁVILA, PEDRO RAPOSEIRO &

VÍTOR GONÇALVES

14:30 Spatial distribution of subfossil diatom and chironomid assemblages' in surface sediments of a remote oceanic lake: The case of Lake Azul (Azores archipelago)

PEDRO M. RAPOSEIRO, A. SAEZ, S. GIRALT, A.C.

COSTA & V. GONÇALVES

14:50 Lost ecosystems of Corvo Island, Azores

SIMON E. CONNOR, A. GOMES, S. HABERLE,

W.O. VAN DER KNAAP, P. KUNEŠ, J.F.N. VAN

LEEUVEN, T. LEWIS, S. PIVA & N. PORCH

15:10 Reconstructing the palaeovegetation of Madeira and Azores Islands: overview and future perspectives

CARLOS A. GÓIS-MARQUES, L. DE NASCIMENTO,

M.M. SEQUEIRA, J.M. FERNÁNDEZ-PALACIOS & J.

MADEIRA

15:30 A first approach to the Canarian pine forest long-term ecology  
LEA DE NASCIMENTO, S. NOGUÉ, C. CRIADO, R.J. WHITTAKER, K.J. WILLIS & J.M. FERNÁNDEZ-PALACIOS

**14:00 Symposium 15b.** [UAz, Room 3.7, July, 20]

Ev4. Invertebrate evolution on islands

CHAIRS: BRENT EMERSON, HERIBERTO LÓPEZ & CHRISTINE PARENT

14:00 Community Assembly over Evolutionary Time: Application of next generation sequencing for high throughput assessment of Hawaiian arthropod diversity  
HENRIK KREHENWINKEL, S. KENNEDY, J. HENDERSON, J. RUSSACK, B. SIMISON & R.G. GILLESPIE

14:20 Island colonisation: Do species jump, or are they pushed?  
BRENT C. EMERSON, V. GARCIA OLIVARES, H. LÓPEZ, J. PATIÑO, A. MACHADO & N. ALVAREZ

14:40 A bottom up approach to understand the origins of an island superradiation  
VÍCTOR GARCIA OLIVARES, H. LÓPEZ, J. PATIÑO, U. LOPEZ DE HERREDIA, M. BÁEZ, A. MACHADO, M. SEPPY, N. ALVAREZ & B.C. EMERSON

15:00 Relation between wing development and diversification in the Macaronesian Rhopalomesites beetles (Coleoptera: Curculionidae)  
DAVID HERNÁNDEZ-TEIXIDOR, H. LÓPEZ, V. GARCÍA OLIVARES & P. OROMÍ

**14:00 Symposium 16** [UAz, Main hall, July, 20]

Ec3. Network approaches to island biology

CHAIRS: ANNA TRAVESET, RUBEN H. HELENO & MANUEL NOGALES

14:00 Spatiotemporal stability of island endemic plant-pollinator interactions  
JEFF OLLERTON

14:20 Spatiotemporal variation in pollinator species and functional diversity influences the structure of pollination networks in Japanese islands  
ATUSHI USHIMARU & M.K. HIRAIWA

14:40 Non-modular systems, dissimilarity and homogenization in Azorean pollinator communities  
ANA PICANÇO, F. RIGAL, T.J. MATTHEWS, P. CARDOSO, J.M. OLESEN & P.A.V. BORGES

15:00 Habitat restoration improves functional resilience of plant-pollinator communities  
CHRIS N KAISER-BUNBURY, A.E. WHITTINGTON, J. MOUGAL, T. VALENTIN, R. GABRIEL, J.M. OLESEN & N. BLÜTHGEN

15:20 The dispersal of native and exotic seeds by São Tomé forest birds  
ANA COELHO, J.M. PALMEIRIM, R.H. HELENO & R.F. LIMA

**15:25 Refreshment Break**

16:00 Frugivory networks of nonnative birds across Hawaiian forest communities  
AMY M. HRUSKA, J.P. KELLEY, J.M. GLEDITSCH, C.E. TARWATER, J.T. FOSTER, J.H. SPERRY & D.R. DRAKE

16:20 Using the intact seed dispersal network of Aldabra Atoll as a baseline for the conservation of interactions in the Western Indian Ocean  
WILFREDO FALCÓN, C. KAISER-BUNBURY, N. BUNBURY & D.M. HANSEN

16:40 Predicting the consequences of disperser extinction in the Galapagos Islands: richness matters the most when abundance is low  
RUMEU, B., M. DEVOTO, A. TRAVESET, J.M. OLESEN, P. VARGAS, M. NOGALES & RUBEN H. HELENO



- 17:00 Frugivory and seed dispersal networks: Should we look for a more realistic interpretation of interaction outcomes? Insights from an island community  
AARÓN GONZÁLEZ-CASTRO, M. NOGALES & A. TRAVESET
- 14:00 Symposium 2c.** [UAz, Room 2.4, July, 20]  
Cv1. Biodiversity and conservation of island plants  
CHAIRS: MÓNICA MOURA, LUÍS SILVA & JULI CAUJAPÉ-CASTELLS
- 14:00 Breeding and mating systems, and breeding relationships in Macaronesian *Tolpis*: Applications to the conservation of diversity  
DANIEL J. CRAWFORD, D.P. HAUBER, L.B. SILVA, M.M. SEQUEIRA, M. MOURA, A. SANTOS-GUERRA, J.K. KELLY, M.J.S. GIBSON & M.E. MORT
- 14:20 Phylogenetic evidence of wild beets (*Beta* s.l. Amaranthaceae) radiation as a putative consequence of the Messinian Salinity Crisis  
MARIA M. ROMEIRAS, A. VIEIRA, D. SILVA, M. MOURA, A. SANTOS-GUERRA, D. BATISTA, M.C. DUARTE & O.S. PAULO
- 14:40 Conservation genetics of *Vachellia anegadensis*, a British Virgin Island endemic plant  
SARA BÁRRIOS
- 15:00 Anagenetic speciation and genetic variation in *Dysopsis hirsuta* (Müll Arg) Skottsbo (Euphorbiaceae), an endemic of Robinson Crusoe Island, Juan Fernández Archipelago, Chile  
PATRICIO LÓPEZ-SEPÚLVEDA, H. MONTOYA, G. FUENTES, K. TAKAYAMA, P. PEÑAILILLO, J. GREIMLER, D.J. CRAWFORD, M. BAEZA, E. RUIZ, L. LETELIER & T.F. STUESSY
- 15:30 Refreshment Break
- 16:00 Phylogenetic diversity of the Campanulaceae in Macaronesia  
TIAGO MENEZES, M.M. ROMEIRAS, M.M. SEQUEIRA & M. MOURA
- 16:20 Genetic diversity and structure of the endemic *Ammi* populations in the Azores  
ÂNGELA VIEIRA, E.F. DIAS, & M. MOURA
- 14:00 Symposium 17** [UAz, Room 2.5, July, 20]  
Bg1. Biogeography of species interactions in the Japanese Izu Islands  
CHAIRS: MASAMI HASEGAWA & HARUE ABE
- 14:00 Biogeography and evolution in the Japanese Izu Islands system, a unique geological setting of formation and collision/accretion dynamics of volcanic islands to mainland through tectonic movement  
MASAMI HASEGAWA
- 14:30 Colonization of two early successional plant species with different nitrogen usage affects abundance of soil animals and herbivorous insects, and ecosystem process on volcanic deserts in Miyake-jima Island, Japan  
TAKASHI KAMIJO, Y. MORI, Y. KADOKURA, H. HASHIMOTO, K. YAMAJI, Y. MINAMIYA & N. KANEKO
- 14:50 Impacts of volcanic activity on bird pollination system in an island ecosystem  
HARUE ABE & M. HASEGAWA
- 15:10 Is tetraploid *Clerodendrum trichotomum* in Japanese archipelago derived from hybridization of diploid ancestors?  
LEIKO MIZUSAWA, S. FUJII, M. HASEGAWA & Y. ISAGI
- 15:30 Refreshment Break**
- 16:00 Low pollinator functional diversity in oceanic islands influences pollinators' floral niches  
MASAYOSHI K. HIRAIWA & U. USHIMARU



- 16:20 Evolution of color pattern among island lizard populations with different predation regimes  
TAKEO KURIYAMA
- 16:40 Prey-predator dynamics and ongoing co-evolution between lizard and snake on the Izu Islands  
MASAMI HASEGAWA
- 14:00 Symposium 18** [UAz, Room 3.6, July, 20]  
Ev5. Patterns of adaptation on islands and the Insularity Syndrome  
CHAIRS: RITA COVAS & CLAIRE DOUTRELANT
- 14:00 Life-history and morphological evolution in island birds  
RITA COVAS, P.-A. CROCHET & C. DOUTRELANT
- 14:30 Worldwide patterns of bird colouration on islands  
CLAIRE DOUTRELANT, M. PAQUET, E. LOBATO, J.P. RENOULT, C. LOISEAU, A. GRÉGOIRE, , M. MELO, P.A. CROCHET & R. COVAS
- 14:50 Island syndromes: What do we think we know  
SHAI MEIRI
- 15:10 Immune function and the island syndrome  
KEVIN D. MATSON
- 15:30 Refreshment Break**
- 16:00 Transcriptome analysis to infer about the Reversed Island Syndrome  
MARTINA TRAPANESE, V. MASELLI, M. BUGLIONE, S. PETRELLI, V. MARESCA & D. FULGIONE
- 16:05 The evolutionary shift from herbaceous towards woody flowering plants: a remarkable case of convergent evolution  
FREDERIC LENS, L. CHACON DÓRIA & M. DEL ARCO
- 16:25 Tracking the effect of isolation time on morphological variation: Brandt's hedgehog (*Paraechinus hypomelas*) in Persian Gulf islands as a case study  
GHOLAM HOSEIN YUSEFI, B.H. KIABI & N.M. MONTEIRO
- 16:45 Evolution of island life histories in lizards: Evidence from Mediterranean islands  
JOHANNES FOUFOPOULOS, P. PAFILIS, E. VALAKOS, C. DONIHUE & K. BROCK
- 17:05 Evolutionary patterns in deer on Mediterranean islands  
LEILA D'SOUZA, A.M. LISTER & D.A. RICHARDS
- 17:00 Field trip III** [Meeting point at the University of the Azores, July, 20]

## THURSDAY, 21 OF JULY

### 8:30 Plenary Talk V [Auditorium, July, 21]

Processes of ecology and evolution in the context of global change: Modelling a complex island ecosystem

GEORGE RODERICK

### 9:30 Special Day Event – a. [Auditorium, July, 21]

WS – Biodiversity and biological invasion on islands

CHAIRS: ANTÓNIO ONOFRE SOARES & H. ROY

9:30 Biological invasions: the importance of collaborations and communication

HELEN ROY & COST ACTION TD1209 ALIEN

CHALLENGE

9:55 *Harmonia axyridis* did not establish in the Azores: The role of species richness, intraguild interactions and resource availability

ANTÓNIO ONOFRE SOARES, A. HONĚK, Z.

MARTINKOVA, J. SKUHROVEC, P. CARDOSO & I. BORGES

10:10 Do gut symbionts play a role in the invasion strategies of subterranean termites?

SÓNIA DUARTE, T. NOBRE, P.A.V. BORGES & L.

NUNES

### 10:30 Refreshment Break

SESSION CHAIRS: FRANZ ESSL & A.C. CARDOSO

11:00 The biogeography and macroecology of biological invasions on islands: what global databases have taught us?

FRANZ ESSL, C. CAPINHA, B. LENZNER, H.

SEEBENS & GLONAF CORE TEAM

11:25 Early warning and rapid response

ANA CRISTINA CARDOSO, K. TSAMIS, E.

GERVASINI, E. D'AMICO & I. DERIU

11:50 *Harmonia axyridis* (Pallas) (Coleoptera: Coccinellidae) did not invade the Azores (Portugal): Is invasibility to blame?

ISABEL BORGES, A. MAGRO, A. GIL, & A.O.

SOARES

12:05 Alien Species Profile (ASP): A streamlined workflow for collaborative authoring, peer-review and scholarly publication of information on invasive species

LYUBOMIR PENEV, P. STOEV, T. GEORGIEV, V.

SENEROV & P. CARDOSO

12:20 The impact of invasive plant species on native communities in UK Overseas Territories

COLIN CLUBBE

### 9:30 Symposium 19 [Small audit, July, 21]

Ev6. The role of topography and elevation in diversification on islands

CHAIRS: LAWRENCE R. HEANEY

9:30 The role of topography and elevation in biological diversification on islands

LAWRENCE R. HEANEY

9:35 The role of topography in speciation by mammals within a complex plate-margin island

LAWRENCE R. HEANEY, D.S. BALETE, S.A.

JANSA, E.A. RICKART & S. STEPPAN

10:05 Islands within islands: A global perspective on within-island isolation and its effect on diversification

MANUEL J. STEINBAUER

### 10:30 Refreshment Break

11:00 Patterns of plant endemism on a high elevation island - the role of climate and topography

SEVERIN D.H. IRL, D.E.V. HARTER & C.

BEIERKUHNLEIN

11:25 Island ontogeny, environmental heterogeneity, and the build-up of island diversity  
JOAQUÍN HORTAL, J. SARMENTO-CABRAL, S. MEIRI, A.B. PHILLIMORE, A.M.C. SANTOS, & C. VIOLLE

11:50 Arthropod diversity across gradients of elevation on Society and Hawaiian islands: Environmental and anthropogenic effects  
GEORGE RODERICK, N. DAVIES, S. CHARLAT, P.E. EWING, P.T. OBOYSKI, J. DECK, A.J. ROMINGER, L. CAYETANO, N.R. GRAHAM, H. KREHENWINKEL, T. RAMAGE, D.S. GRUNER & R.G. GILLESPIE

**9:30 Symposium 20a.** [Large room, July, 21]  
Bd1. Biodiversity in the Gulf of Guinea Islands  
CHAIRS: MARTIM MELO, RICARDO FAUSTINO DE LIMA, ROBERT C. DREWES & LUIS M.P. CERÍACO

9:30 Endemism unsung: The California Academy of Sciences Gulf of Guinea Expeditions  
ROBERT C. DREWES

10:00 Geological evolution of the Gulf of Guinea Islands: Possible constraints on biodiversity  
RITA CALDEIRA

10:20 Bird Speciation in the Gulf of Guinea  
MARTIM MELO & P. JONES

#### 10:40 Refreshment Break

11:00 Príncipe Island UNESCO Biosphere Reserve: A living lab to promote sustainability, awareness and conservation  
ESTRELA MATILDE & A. ABREU

11:15 An unknown Scops-owl in the genus *Otus* discovered in the remote forests of Príncipe Island (Gulf of Guinea, West Africa)  
P. VERBELEN, C. DO BOM JESUS, SÁTIRO, F. SPINA & MARTIM MELO

11:20 Reed frog diversification in the Gulf of Guinea: land-bridges, overseas dispersal, and in situ speciation  
RAYNA C. BELL

11:40 The population genetics of a *Drosophila* hybrid zone  
DANIEL R. MATUTE

#### **9:30 Ordinary Talks 5** [Small room, July, 21] Biogeography

MODERATORS: JOSÉ MARÍA FERNÁNDEZ-PALACIOS & K. BURNS

9:30 Complex interactions between ecological, evolutionary, and environmental processes explain island biodiversity dynamics  
JULIANO SARMENTO CABRAL, K. WIEGAND & H. KREFT

9:45 A theory of island biogeography for exotic species  
KEVIN C. BURNS

10:00 More than calibrating the tree: In search of fossils for deciphering the history of New Caledonian biota  
PHILIPPE GRANDCOLAS, A. NEL, P. MAURIZOT, N. FOLCHER, D. CLUZEL, J. MUNZINGER, P.P. LOWRY, A.B. LESLIE, D. CANTRILL, H. JOURDAN & R. GARROUSTE

10:15 Islands, pleistocene climate change, and connectivity help to better understand current plant distributions  
HENRY HOOGHIEMSTRA, S.G.A. FLANTUA, R.G. BOGOTÁ-ANGEL, M.H.M. GROOT, Z. GONZÁLEZ-CARRANZA, J.C. BERRIO, A. BOOM, & E.J. DE BOER

#### 10:30 Refreshment Break

11:00 Evolution, composition and historical biogeography of the flora in the Indian Ocean Biodiversity Hotspot  
JOERI S. STRIJK & T. LE PÉCHON

11:15 Isolation effects on island plant diversity: testing theoretical predictions with a biogeographical eco-evolutionary mode  
JULIANO SARMENTO CABRAL, R.J. WHITTAKER, K. WIEGAND & H. KREFT

- 11:30 Quantifying island isolation and its effect on insular fauna  
YUVAL ITESCU, J. FOUFOPOULOS, P. PANAYIOTIS & S. MEIRI
- 11:30 Genomic insights into speciation in widespread Pacific island bird lineages  
ROBERT G. MOYLE, J.D. MANTHEY, M.J. ANDERSEN, C.H. OLIVEROS & C.E. FILARDI
- 11:45 Tarsier tales: How the evolution of tiny primates portrays Sulawesi's turbulent past  
STEFAN MERKER, Y. BOHR, C. DRILLER & D. PERWITASARI-FARAJALLAH
- 11:50 What are we learning about speciation and extinction from the Canary Islands?  
JUAN CARLOS ILLERA
- 12:00 Turnover dynamics of breeding landbirds on islands: 'True but trivial' over decadal time-scales?  
DUNCAN MCCOLLIN
- 12:10 Genetic and morphological differentiation in an island bird, the Azorean Woodpigeon (*Columba palumbus azorica*)  
PEDRO A.M. ANDRADE, T.M. RODRIGUES, R. FONTAINE, V. NEVES, A. FONSECA, P.C. ALVES, M. CARNEIRO & D GONÇALVES
- 12:15 Proper taxonomy improves the biogeographic signal of austral rove beetles (Coleoptera: Staphylinidae: Staphylinini)  
JOSH JENKINS SHAW & A. SOLODOVNIKOV
- 12:30 Genomic approaches to assess phylogeny and adaptation in the Hawaiian honeycreeper radiation  
ROBERT C. FLEISCHER, L.C. SACKETT, T. CALLICRATE, M.G. CAMPANA & H.F. JAMES
- 12:30 Rove beetles (Coleoptera: Staphylinidae) as a model group for describing biogeography of the Aegean archipelago  
LINE KRÆMER, A. SOLODOVNIKOV & A. BRUNKE
- 12:50 The genetic basis and genomic consequences of plumage divergence in incipient flycatcher species of the Solomon Islands  
JOHN ALBERT C. UY
- 10:00 Symposium 21a.** [Praia da Vitória, July, 21]  
Ev2. Dynamics of speciation and diversification in island birds  
CHAIRS: BORJA MILÁ & CHRISTOPHE THÉBAUD
- 13:00 Lunch & Poster session**  
Biological invasions
- 10:00 Taxon cycles and diversification of Lesser Antillean birds  
ROBERT RICKLEFS
- 14:00 Plenary Talk VI** [Auditorium, July, 21]  
Applications of artificial intelligence to island ecology and biogeography  
PEDRO CARDOSO
- 10:30 Microevolution in white-eyes of southwest Pacific islands  
SONYA M. CLEGG, G. OATLEY & B.C. ROBERTSON
- 15:00 Special Day Event – b.** [Auditorium, July, 21]  
WS – Biodiversity and biological invasion on islands  
CHAIRS: ANTÓNIO ONOFRE SOARES & HELEN ROY
- 10:50 Montane bird speciation and conservation across oceanic sky islands  
CHRIS E. FILARDI, M.J. ANDERSEN & R.G. MOYLE
- 11:10 Refreshment Break**
- SESSION CHAIRS: GEORGE RODERICK & DANIEL SIMBERLOFF

15:00 Eradication of island invasives: Major incremental improvements and dramatic new possibilities  
DANIEL SIMBERLOFF

15:15 Invasions facilitation: Novel mutualisms between alien plants and native insects  
MARIA ROSA PAIVA & M. ALMEIDA

15:30 Effectiveness of seed dispersal of fleshy fruits by *Turdus* and wind on Robinson Crusoe Island, Chile  
CECILIA SMITH-RAMÍREZ & V. ZAPATA

15:45 Final stage of the mongoose eradication project on Amami-Oshima Island, Japan  
YUYA WATARI, K. FUKASAWA, T. HASHIMOTO, T. MOROSAWA, H. KOMINE, F. YAMADA, C. IWAMOTO & S. ABE

#### 16:00 Refreshment Break

16:30 Listen to the crickets: An innovative approach to improving tropical island biodiversity monitoring in context of invasive spread and biodiversity crisis. Insights from the New Caledonian biodiversity hotspot  
JÉRÉMY ANSO, L. DESUTTER-GRANDCOLAS, E. BOURGUET & H. JOURDAN

**SESSION CHAIRS:** JAN PERGL & ANGELIKI F. MARTINOU

16:45 Harmonization and integration of databases: Linking impact and pathways  
JAN PERGL

17:10 Analysis of the impacts of invasive alien species in an island context. Implications for management  
ANGELIKI F. MARTINOU

17:35 When invasive ants are more efficient than natives ones to disperse seeds. Implications for restoration of highly perturbed shrublands in

New Caledonian biodiversity hotspot  
MAUREEN CATEINE, I. GAYRAL, O. BLIGHT, E. PROVOST & H. JOURDAN

17:50 Marine invasions in offshore islands – a perspective from the Macaronesia region  
JOÃO CANNING-CLODE, P. CHAINHO, T. MARQUES, R. HAROUN, P. FOFONOFF, L. MCCANN, J.T. CARLTON, G. RUIZ & R.S. SANTOS

18:05 Marine protected areas as biotic resistance hotspots against non-indigenous species invasions  
IGNACIO GESTOSO, P. RAMALHOSA, P. OLIVEIRA & J. CANNING-CLODE

18:20 The role of plant fidelity and habitat disturbance on the species richness of indigenous and exotic canopy spiders on an oceanic island  
MARGARITA FLORENCIO, F. RIGAL, P.A.V. BORGES, P. CARDOSO, A.M.C. SANTOS, & J.M. LOBO

18:35 Ancient DNA and microfossil analysis of ancient rat faeces reveals new insights into the impact of the introduced Pacific rat (*Rattus exulans*) on the prehistoric New Zealand biota  
JANET M. WILMSHURST

**15:00 Symposium 20b.** [Large room, July, 21]  
Bd1. Biodiversity in the Gulf of Guinea Islands  
**CHAIRS:** MARTIM MELO, RICARDO FAUSTINO DE LIMA, ROBERT C. DREWES & LUIS M.P. CERÍACO

15:00 Biodiversity conservation in São Tomé and Príncipe: An overview  
RICARDO FAUSTINO DE LIMA

15:30 Bird conservation in São Tomé and Príncipe: Islands for biodiversity and people  
LUÍS T. COSTA, H. SAMPAIO, G.M. BUCHANAN, R.F. LIMA & A. WARD-FRANCIS

- 15:50 Ecology and distribution of endemic pigeons in São Tomé: potential implications of hunting  
JORGE M. PALMEIRIM, M. CARVALHO, R.F. LIMA & J.E. FA
- 16:10 Refreshment Break
- 16:30 Adopting an integrated approach to island-wide conservation and sustainable development in the Island of Príncipe, São Tomé & Príncipe  
FELIPE A SPINA, BOLLEN, A, MARQUES GARRO, A, ALVES, R & MATILDE, E
- 16:50 Studying cetaceans in a small archipelago: Challenges and perspectives in the conservation of highly mobile top predators on São Tomé and Príncipe  
INÊS CARVALHO, A. PEREIRA, C. PICANÇO, B. LOLOUM & C. BRITO
- 17:10 Sea turtle research and conservation at Príncipe Island, West Africa  
ROGÉRIO N.L. FERREIRA, T.C. BORGES & A.B. BOLTEN
- 17:30 Inferring the migratory connectivity and habitat use of the sea turtles occurring in São Tomé Island using genetics and stable isotopes  
JOANA M. HANCOCK, R. REBELO, S. VIEIRA & N. FERRAND
- 17:50 Improving marine biodiversity and livelihoods of coastal communities in Príncipe  
ANA NUNO, K. METCALFE, B.J. GODLEY & A.C. BRODERICK
- 13:45 Symposium 21b.** [Praia da Vitória, July, 21]  
Ev2. Dynamics of speciation and diversification in island birds  
CHAIRS: BORJA MILÁ & CHRISTOPHE THÉBAUD
- 13:45 Eastern Polynesian landbirds did not follow hotspot diversification models  
ALICE CIBOIS & J.-C. THIBAULT
- 14:05 Sympatric speciation in an island giant involves isolation, hybridization and selection  
MARTIN STERVANDER, M. MELO, P. JONES & B. HANSSON
- 14:25 Intra-island variation in the Réunion grey white-eye: what we know 50 years after Frank Gill's classic study?  
CHRISTOPHE THÉBAUD & B. MILA
- 14:45 Diverse evolutionary histories of endemic avian taxa on Guadalupe Island, Mexico  
BORJA MILÁ & J. HERNÁNDEZ-MONTOYA
- 15:05 Field Trip: Wetlands in Praia da Vitória**  
TECHNICIANS FROM THE LIFE CWR PROJECT
- 15:00 Symposium 22** [Small audit, July, 21]  
Ev3. Evolutionary processes in the Macaronesian Island Flora  
CHAIR: HANNO SCHAEFER
- 15:00 Speciation processes in the Macaronesian fern flora  
FRED RUMSEY
- 15:30 Why do different oceanic archipelagos harbour contrasting levels of species diversity? Diversification processes in the Macaronesian archipelago floras  
MARK CARINE
- 15:50 Homoploid hybrid speciation in *Argyranthemum* (Asteraceae)  
OLIVER WHITE, M. CARINE & M. CHAPMAN
- 16:10 Refreshment Break
- 16:30 Hybridization to explain the diversification pattern of island taxa: Using codominant markers to investigate the “surfing syngameon” and alternative hypotheses in *Micromeria*  
HARALD MEIMBERG, M. CURTO & P. PUPPO

16:50 Postzygotic isolating barriers, divergence and speciation in Macaronesian *Tolpis*

DANIEL J CRAWFORD, D.P. HAUBER, L. BORGES SILVA, M.M. SEQUEIRA, M. MOURA, A. SANTOS-GUERRA, J.K. KELLY, M.E. MORT, B. KERBS, J. RESSLER & M.J.S. GIBSON

17:10 The utility of Multiplexed-Shotgun-Genotyping (MSG) for resolving phylogenetic relationships within and among oceanic archipelagos: An example from Macaronesian *Tolpis* (Asteraceae)

MARK E. MORT, J.K. ARCHIBALD, M.J.S. GIBSON, H. BONTRAGER, D.P. HAUBER, L. BORGES SILVA, M.M. SEQUEIRA, M. MOURA, A. SANTOS-GUERRA, J.K. KELLY, M. GRUENSTAEUDL, J. CAUJAPÉ-CASTELLS & D.J. CRAWFORD

17:30 From single lineages to entire floras: What are the main evolutionary processes forming the Macaronesian flora?

HANNO SCHAEFER

**20:30 Conference dinner at Hotel Caracol**

## FRIDAY, 22 OF JULY

**8:30 Plenary Talk VII** [Auditorium, July, 22]  
Bayesian statistical approaches to island biogeography: progress and challenges  
ISABEL SANMARTIN & FREDRIK RONQUIST

**9:30 Symposium 23a.** [Auditorium, July, 22]  
Bg3. How Macaronesia influenced our perspective on island systems  
CHAIRS: ANA M.C. SANTOS, ANNA TRAVESET, JAIRO PATIÑO, MARGARITA FLORENCIO, SANDRA NOGUÉ & PAULO A.V. BORGES

9:30 The Island Biology Interest Group (IBIG)  
ANA M.C. SANTOS

9:35 The outstanding contribution of Macaronesia to the development of island sciences: past, present and future  
JOSÉ MARÍA FERNÁNDEZ-PALACIOS

10:05 Colonization and speciation of an invader: the western house mouse (*Mus musculus domesticus*) in Madeira Island  
SOFIA GABRIEL, J.B. SEARLE & M.L. MATHIAS

10:25 The impact of edge effects on arthropod Beta spatial and temporal variation in an Azorean native forest  
RUI M. NUNES, P. CARDOSO, F. RIGAL & P.A.V. BORGES

### 10:30 Refreshment Break

11:00 Snipe in the Azores: Assessing gene flow in the middle of the North Atlantic  
TIAGO M. RODRIGUES, P. ANDRADE, M. RODRIGUES & D. GONÇALVES

11:20 The evolutionary origin of the Macaronesian flora: Lessons from bryophytes  
JAIRO PATIÑO & A. VANDERPOORTEN,

11:40 The signatures of Anthropocene defaunation: Cascading effects of the seed dispersal collapse on islands  
ALFREDO VALIDO, N. PÉREZ-MÉNDEZ, P. JORDANO & C. GARCÍA

12:00 Combined effects of altitude and invasive herbivores on a vulnerable, endemic violet species in an oceanic high mountain ecosystem  
JAUME SEGUÍ, M. LÓPEZ, A.J. PÉREZ, M. NOGALES & A. TRAVESET

**9:30 Symposium 24.** [Small audit., July, 22]  
Cv6. Protected areas in islands: Are we doing everything wrong?  
CHAIRS: ARTUR GIL

9:30 The Opens Standards for the Practice of Conservation: Strategically planning and adaptively managing island biodiversity  
ANDREW S. BRIDGES

10:00 Improving conservation education strategies in integrating totally protected area with their surroundings: Scientific evidence and theoretical approaches of Lambir Hills National Park  
JANUARIE KULIS

10:20 Vulnerability assessment of Azorean marine resources to climate change  
CRISTIANA A. BRITO, M.J. CRUZ, A. SOUSA & M.R.R. PINHO

### 10:25 Refreshment Break

11:00 Conservation projects by external partnerships as success stories for management of Macaronesian Protected Areas  
LUÍS T. COSTA, J. TEODÓSIO, A.I. FAGUNDES, C. GOUVEIA, & P.L. GERALDES

11:20 Combining genetic and landscape tools for reserve design on islands: The reptiles of Socotra as a model study  
RAQUEL VASCONCELOS & P. TARROSO



11:40 The vulnerability to climate change of the forest in the protected areas of Tenerife (Canary Islands)  
JOSÉ LUIS MARTÍN-ESQUIVEL

12:00 Key biodiversity areas and conservation priorities in Macaronesia: The BEST III initiative  
FRANCISCO W. MACEDO, L.M.C. MADRUGA & J.M.N. AZEVEDO

### 9:30 Ordinary Talks 6 [Large room, July, 22]

Evolution and genetics

MODERATORS: ROSEMARY G. GILLESPIE & BEN WARREN

9:30 Repeated evolution of large seeds on islands  
PATRICK KAVANAGH & KEVIN C. BURNS

9:45 Integrating island assembly models and comparative population genetics  
ISAAC OVERCAST & M.J. HICKERSON

10:00 A new "evolutionary scandal": Asexual ladybirds (Coccinellidae: Coleoptera) in Macaronesia and the Mascarene Islands  
ALEXANDRA MAGRO, B. DUTRILLAUX, A.O. SOARES, E. LECOMPTE, J. MURIENNE, A.-M. DUTRILLAUX, H. FÜRSCH, & J.-L. HEMPTINNE

10:15 Eco-evolutionary feedbacks in fish-zooplankton communities on the Scottish island of North Uist  
TALIB CHITHEER & A. MACCOLL

### 10:30 Refreshment Break

11:00 Understanding phylogenetic patterns of extinction in island settings  
BEN H. WARREN

11:15 Is insular woodiness in the genus *Argyranthemum* (Asteraceae) driven by drought?  
LARISSA CHACON DÓRIA, M. DEL ARCO, S. DELZON & F. LENS

11:30 Using phylogenomic approaches to study maintenance of morphologically identical species in *Micromeria* (Lamiaceae) from the Canary Islands  
MANUEL CURTO, P. PUPPO & H. MEIMBERG

11:45 Diversification and species assembly among Hawaiian arthropods: The play of adaptive radiation in four acts  
ROSEMARY G. GILLESPIE

### 12:30 Lunch & Poster Session 4

Evolution and Climate Change

### 13:30 Symposium 23b. [Auditorium, July, 22]

Bg3. How Macaronesia influenced our perspective on island systems

CHAIRS: ANA M.C. SANTOS, ANNA TRAVESET, JAIRO PATIÑO, MARGARITA FLORENCIO, SANDRA NOGUÉ & PAULO A.V. BORGES

13:30 Where are we in the parasite biogeography of land vertebrates in Macaronesia?  
JUAN CARLOS ILLERA

13:50 Biogeography and conservation of the reptiles of the Cabo Verde Archipelago: Insights from diversity and distribution patterns  
RAQUEL VASCONCELOS

14:10 The butterflies of the Canary Islands and Madeira: Aspects of colonization, differentiation, ecology, and conservation  
MARTIN WIEMERS

### 14:30 Plenary Talk VIII [July, 22]

Ecological networks on islands

JENS M. OLESEN

### 15:30 Refreshment Break

16:00 Discussion & Conclusions

CHAIR: PAULO A.V. BORGES & C. KUEFFER

17:15 Closing

## POSTER SESSION 1

### MONDAY, 18 OF JULY

- P1-01. First record of aquatic hyphomycetes associated with decomposing leaf litter in Azorean streams  
VERÓNICA FERREIRA, A. PEREIRA, P.M. RAPOSEIRO & V. GONÇALVES
- P1-02. Biodiversity ecology function across marine and terrestrial ecosystems (BEFmate): Linking microbial diversity and dispersal with function  
SIMONE HANEKAMP, B. WEMHEUER & R. DANIEL
- P1-03. Positive relationship between genetic- and species diversity on a mainland archipelago  
ANNA MARIA CSERGÓ, L. HUFNAGEL & M. HÖHN
- P1-04. Isolation, production and maintenance of axenic cultures of freshwater species of Cyanobacteria from the Azorean Islands  
LUZ, R., RITA I.P. CORDEIRO, A. FONSECA & V. GONÇALVES
- P1-05. A new combination and status in *Andryala* (Asteraceae) from Madeira Island (Portugal)  
MARIA ZITA FERREIRA, R. JARDIM, I.Á. FERNÁNDEZ & M.M. SEQUEIRA
- P1-06. Mangroves of São Tomé Island: A preliminary assessment  
RICARDO FAUSTINO DE LIMA, P. CHAINHO, P.M. FÉLIX, J.L. COSTA, A.J. ALMEIDA, I. DOMINGOS, T. SILVA, C. BELTRÁN, F. CARVALHO, G. OQUIONGO, E. SOARES, M. GONÇALVES & A.C. BRITO
- P1-07. The dragonflies of the Azores and Madeira  
VIRGÍLIO VIEIRA & A. CORDERO-RIVERA
- P1-08. Freshwater diatoms from Desertas Islands (Madeira, Portugal)  
VÍTOR GONÇALVES, H.S. MARQUES, D. TEIXEIRA & P.M. RAPOSEIRO
- P1-09. Preliminary study of bryophytes from Azorean wetlands I: Bryophytes from "Paul do Belo Jardim" (Praia da Vitória, Terceira Island, Azores)  
CECÍLIA SÉRGIO, D. CLARO, J. DIAZ CASTILLO & R. GABRIEL
- P1-10. Preliminary study of bryophytes from Azorean wetlands II: Bryophytes from "Paul da Pedreira do Cabo da Praia" (Praia da Vitória, Terceira Island, Azores)  
ROSALINA GABRIEL, C. PIMENTEL, M.R. BRITO & C. SÉRGIO
- P1-11. Preliminary study of bryophytes from Azorean wetlands III: Bryophytes from "Paul da Praia da Vitória" (Praia da Vitória, Terceira Island, Azores)  
CÉSAR PIMENTEL, R. GABRIEL, M.R. BRITO & C. SÉRGIO
- P1-12. Bryophyte functional groups along an elevational gradient: response to climatic conditions  
HERNÁNDEZ-HERNÁNDEZ, R., A. RODRÍGUEZ-ROMERO, J. KLUGE, , CLAUDINE AH-PENG & J.M. GONZÁLEZ-MANCEBO
- P1-13. Exploring effects of climate and habitat disturbance on endemic, native and invasive species along an elevation gradient on an oceanic island  
GONZÁLEZ-MANCEBO, J.M., R. HERNÁNDEZ-HERNÁNDEZ, J. KLÜGE, JAIRO PATIÑO, M. STEINBAUER, & M. DEL ARCO
- P1-14. Pollen-transport: Which plants do wild insects prefer to interact in Azores?  
ANA PICANÇO & P.A.V. BORGES

- P1-15. Tree age determination at laurel forest remains in São Miguel Island, Azores  
CÂMARA, M., L.B. SILVA, , RUI BENTO ELIAS & L. SILVA
- P1-16. Leaf litter decomposition on insular lentic systems: Effects of macroinvertebrate presence, leaf species and environmental conditions  
PEDRO M. RAPOSEIRO, V. FERREIRA, , R.G. FLORENSA, V. GONÇALVES & G.M. MARTINS
- P1-17. Testing neutral vs. niche species assembly in Azorean canopy arthropod communities after defaunation: Preliminary results  
RUI M NUNES, P. CARDOSO, A.O. SOARES & P.A.V. BORGES
- P1-18. Water retention pathways in bryophytes: A characterization and quantification study in native vegetation of the Azores  
MÁRCIA C.M. COELHO, F. PEREIRA, C. AH-PENG & R. GABRIEL
- P1-19. Spatiotemporal variation in macroinvertebrate assemblages on an oceanic island: The singular ponds of the Azorean island of Terceira  
MARGARITA FLORENCIO, L. LAMELAS-LÓPEZ, V. GONÇALVES, L. SERRANO & P.A.V. BORGES
- P1-20. The effect of geological origin of islands on soil microbial communities during long-term succession  
FERNANDO D ALFARO, M. MANZANO, P.A. MARQUET & A. GAXIOLA
- P1-21. Cloud layer, trade wind inversion and cloud water interception by bryophytes on an oceanic island  
CLAUDINE AH-PENG, O. FLORES, J. LECLAIR DE BELLEVUE, E. JEAMBLU, F., MOUREAU, A. PITEAU, P. STAMÉNOFF, D. STRASBERG & V. DUFLOT
- P1-22. The dynamics of *Ocotea foetens* (Lauraceae) on current laurel forests of Macaronesia  
ALBANO FIGUEIREDO, M.E AROZENA CONCEPCIÓN & J.M. PANAREDA
- P1-23. Interaction networks over time: Using next generation sequencing to determine changes in predation and competition across substrates of different age in Hawaii  
MARTHA ALEXANDRA RUEDA, S. KENNEDY, H. KREHENWINKEL & R.G. GILLESPIE
- P1-24. Taxonomic and functional diversity of phytophagous insects associated with trees from the Azorean native laurel forests  
CARLA REGO, M. BOIEIRO, F. RIGAL, S.P. RIBEIRO, P. CARDOSO & P.A.V. BORGES
- P2-01. Epilithic biofilms diversity and assembly across the three domains of life in island tropical rivers (Guadeloupe) submitted to chlordecone contamination pressure  
C. HUBAS, FRANÇOIS RIGAL, D. MONTI, S. PENNARUN, A. CARBON, H. BUDZINSKI, R. DURAN & B. LAUGA
- P2-02. BEST: Fostering biodiversity conservation and sustainable development in regions of the world  
CAROLE MARTINEZ, F. WALLENSTEIN, & J.M.N. AZEVEDO
- P2-03. Volunteer tourism for island conservation: Case of Lord Howe Island  
IAN HUTTON

## POSTER SESSION 2

### TUESDAY, 19 OF JULY

- P2-04. From null to full protection: Challenges and novel approach in implementing a new sea turtle protection legislation in Gulf of Guinea  
SARA VIEIRA, V. JIMÉNEZ, A. BESUGO, J. HANCOCK, H. LIMA, L. OLIVEIRA & B. LOLOUM
- P2-05. Islands in interdisciplinary education: Balancing connectivity and isolation  
SIETZE J. NORDER & K.F. RIJSDIJK
- P2-06. Constraints to species' elevational range shifts as climate changes; insights from an oceanic high mountain violet (*Viola cheiranthifolia*) using niche modeling and genetic diversity data  
FERNÁNDEZ DE CASTRO, AG, P. RODRÍGUEZ-RODRÍGUEZ, J. SEGUÍ COLOMAR, P.A. SOSA & A. TRAVESET
- P2-07. Using species distribution modelling for IUCN Red Listing  
EMAD KAKY & F. GILBERT
- P2-08. Mauritius on fire: a charcoal record of the last thousand years shows the human destruction of an oceanic island  
ERIK J. DE BOER, J. DE KRUIF & W.D. GOSLING
- P2-09. Improving the monitoring of fish communities in Azorean freshwater lakes  
VÍTOR GONÇALVES, A.C.L. PRESTES, A. DALLAIRE, G. GEA, J.C. RIVA, D.M. PACHECO, M. MATIAS, A. FONSECA, P.M. RAPOSEIRO & J.M.N. AZEVEDO
- P2-10. Insular frugivore communities: extinction and its consequences for functional diversity  
JULIA H. HEINEN, D.M. HANSEN & W.D. KISSLING
- P2-11. Updates on whole-dataset analyses using Spark and the GUODA Data Service  
MATTHEW COLLINS, J. POELEN, & A. THOMPSON
- P2-12. Habitat characteristics and population dynamics of the endangered species *Lotus kunkelii* in the Protected Scientific Site of Jinámar (Gran Canaria-España)  
AGUSTÍN NARANJO CIGALA, J.R. ARÉVALO SIERRA, M. SALAS PASCUAL, F. DÍAZ PEÑA, A.M. GONZÁLEZ GARCÍA, S. SANTANA VEGA & A. RAMOS MARTÍNEZ
- P2-13. Feeding preferences, growth and survival of the endemic stream shredder *Limnephilus atlanticus* (Trichoptera, Limnephilidae) when offered leaf litter conditioned in stream water naturally contaminated with heavy metals  
ANA BALIBREA, V. GONÇALVES, V. FERREIRA & P.M. RAPOSEIRO
- P2-14. Factors limiting the establishment of canopy-forming algae on artificial structures  
EVA CACABELOS, G.M. MARTINS, R. THOMPSON, A.C.L. PRESTES, J.M.N. AZEVEDO & A.I. NETO
- P2-15. The conservation status of the endemic flora of French Polynesia: La maison brûle (the house is burning)!  
JEAN-YVES MEYER
- P2-16. The Cabo Verde islands as important biogeographical refuge areas for some remarkable bryophytes  
CECÍLIA SÉRGIO, C.A. GARCIA & M. SIM-SIM
- P2-17. Effects of land use on macroinvertebrate communities on oceanic island streams (Azores archipelago)  
SOUED, C., V. GONÇALVES, ANA C. COSTA & P.M. RAPOSEIRO
- P2-18. Makauwahi Cave Reserve, Kauai: Research, conservation, and tourism  
DAVID A BURNEY & L.P. BURNEY
- P2-19. Rewilding Rodrigues Island with Aldabra giant tortoises: An experimental assessment

of soft- and hard-release methods  
N.X. PFISTER, W.L. FALCÓN & DENNIS M  
HANSEN

R. MESEGUER, V. VIEIRA, I. BORGES, P. ARRUDA,  
T. ELEUTÉRIO, J. CABRAL, C. NÓBREGA, C.  
QUINTELA & ANTÓNIO ONOFRE SOARES

P2-20. Conservation status of Príncipe Island  
biodiversity: A preliminary assessment of its  
herpetofauna  
ESTRELA MATILDE & A. ABREU

P2-21. Genetic structure of the red-headed wood  
pigeon *Columba janthina nitens*, an  
endangered subspecies endemic to the  
Ogasawara Islands, Japan  
OGAWA HARUKO ANDO, H. SUZUKI, K.  
HORIKOSHI, S.-I. SEKI, F. NAKAHARA, M.  
TAKAYANAGI, K. KAWAKAMI & Y. ISAGI

P2-22. Island Studies Journal' special section on  
sustainable development and environmental  
conservation in the Outermost European  
Regions  
ARTUR GIL

P3-03. Expansion dynamics of introduced *Pinus  
halepensis* plantations at short and long  
distances in an oceanic island  
VÍCTOR BELLO-RODRÍGUEZ, A. FERNÁNDEZ-  
LÓPEZ, M.J.DEL ARCO & J.M. GONZÁLEZ-  
MANCEBO

P3-04. Competitive interactions between invasive  
and endemic species is mediated by water  
availability in the Trindade Island, Brazil  
ANABELE S. GOMES, B.T. TRINDADE & F.  
BORGHETTI

P3-05. Selective predation on island endemic  
vertebrates by feral cats revealed by cat diet  
and prey availability  
YUYA WATARI, N. KOTAKA, H. TORIKAI, K.  
YAMAMURO, N. KUDAKA, Y. ABE & T.  
WATANABE

P3-06. Biological control: Feasible reality or  
"pipe dream"? The case of *Ageratina  
adenophora* (Spreng.) R.King & Rob.  
(Asteraceae) in Madeira Island  
AIDA PUPO-CORREIA & M.M. SEQUEIRA

P3-07. Acquired interspecific interactions  
influence the population growth rates of an  
invasive orchid in Puerto Rico  
WILFREDO FALCÓN, J.D. ACKERMAN & R.L.  
TREMBLAY

P3-08. The first aerial poison application project  
to eradicate black rat populations in the  
French Mediterranean islands: The case  
study of Riou Archipelago in the Calanques  
national Park  
MATHILDE MEHEUT, E. DEBIZE, O. LORVELEC &  
LE L. MIRE PECHEUX

P3-01. Antagonist effects of rabbits on endemic  
plants as drivers of the vegetation changes in  
subtropical high mountain insular  
environments  
JONAY CUBAS, M. NOGALES, J.L. MARTÍN-  
ESQUIVEL, M. LÓPEZ-DARIAS, R. HERNÁNDEZ-  
HERNÁNDEZ, M. MARRERO GÓMEZ, M. DEL  
ARCO AGUILAR & J.M. GONZÁLEZ-MANCEBO

P3-02. Population dynamics of aphid species  
(Hemiptera: Aphididae) infesting endemic  
plants reared in forestry nurseries in the  
Azores

## POSTER SESSION 3

### THURSDAY, 21 OF JULY

- P3-09. Impacts of control of an invasive tree, *Casuarina equisetifolia*, on soil water contents in North Pacific Islands, Ogasawara  
KENJI HATA, K. KAWAKAMI & N. KACHI
- P3-10. The impact of RHDV in the RHD naïve European rabbit populations of Flores, Azores  
PEDRO JOSÉ ESTEVES, T. ALMEIDA, A.M. LOPES, M. LEITÃO, T.M. RODRIGUES, J. ABRANTES & D. GONÇALVES
- P3-11. Feral cat in the Azores islands: Habitat preferences and biological interactions  
LUCAS LAMELAS-LÓPEZ, P.A.V. BORGES, J.G. CASANOVAS, J.F.G. MANGAS, X. PARDAVILA, I.R. AMORIM, & M. SANTOS-REIS
- P3-12. Triple eradication of invasive alien species improves degraded biota on Nishijima in the Ogasawara Islands, Japan  
KAZUTO KAWAKAMI
- P3-13. The expansion of the pantropical *Guilandina bonduc* promotes population decline of the endemic *Cyperus atlanticus* in the Trindade Island, Brazil  
ANABELE S GOMES, B.S. RABELO, G. PETRY & F. BORGHETTI
- P3-14. Vascular plant diversity of Pinhal da Paz Recreational Forest Reserve (São Miguel, Azores)  
A. TAVARES, V. MEDEIROS & LUÍS SILVA
- P3-15. Tolerance of seeds of *Guilandina bonduc* (L.) to seawater  
ANABELE S. GOMES & F. BORGHETTI
- P3-16. Exploring biotic and abiotic factors predicting native and alien parasitoid wasps across the Hawaiian Islands using environmental niche modeling  
NATALIE R. GRAHAM, R.W. PECK & R.G. GILLESPIE
- P3-17. An ecophysiological background for the dissimilar biogeographic patterns of two insular lizards?  
RAQUEL VASCONCELOS, E. LOPES & M.A. CARRETERO
- P3-18. Community assembly and disassembly in a volcanic national monument in the Pacific Northwest: Island biogeography within a continental context  
KATIE L. PETERSON & C.E. PARENT
- P3-19. The biogeographical regions of the Aegean archipelago (Greece)  
KOSTAS A TRIANTIS, K. KOUGIOUMOUTZIS, A. LEGAKIS, P. LYMBERAKIS, A. TRICHAS, S. SIMAIKIS, P. ANDRIOPOULOS, C. GEORGIADIS, A. PARMAKELIS, G. ANASTASIOU, N. PROBONAS, V. SPANELI, P. TRIGAS & S. SFENTHOURAKIS
- P3-20. Biogeography meets geophysics: A geophysical workflow to model relative sea levels and to reconstruct its palaeogeographic effects on islands  
PAOLO STOCCHI, E.F.M. KOENE, S.M. SIMAIKIS, S.P. ÁVILA, C. HAMMOUD, P.A.V. BORGES, J.M. FERNÁNDEZ PALACIOS, S.J. NORDER & K.F. RIJSDIJK
- P3-21. Quantifying palaeogeographic rates of changes of continental islands in the Aegean Sea: Towards a novel framework for assessing biogeographical implications of palaeogeographic change  
CYRIL HAMMOUD, S.M. SIMAIKIS, K.F. RIJSDIJK, E.F.M. KOENE, J.H. VAN BOXEL, P. STOCCHI, E.E. VAN LOON, S.J. NORDER, E. GEORGOPOULOU, K.A. TRIANTIS & E.TJØRVE
- P3-22. Plant diversity on oceanic islands: A computer simulation  
MADLI JÖKS & M. PÄRTEL

# POSTER SESSION 4

## THURSDAY, 22 OF JULY

- P4-01. The more the merrier: The use of NGS for the development of new markers for parasitic nematode phylogenetics in the Canary Islands  
BEATRIZ TOMÉ, K. MULDER, F. JORGE, A. SOUSA, A. PERERA & D.J. HARRIS
- P4-02. Geology and ecology interact to drive evolutionary radiations and declines on Hawaii  
JUN YING LIM & C. MARSHALL
- P4-03. On the phylogenetic diversity of Azorean beetles  
SOFIA TERZOPOULOU, A. PARMAKELIS, I.R. AMORIM, F. RIGAL, R.J. WHITTAKER, P.A.V. BORGES & K.A. TRIANTIS
- P4-04. Screening for potential hybrids reveals new insights about *Laurus* phylogeography in the Azores  
ÂNGELA VIEIRA, M. MOURA, C. SILVA & L. SILVA
- P4-05. Ancient DNA analysis of the Caribbean 'Island Shrew' (Nesophontes)  
ROSEINA H WOODS, I. BARNES, M.J.F. BROWN & S.T. TURVEY
- P4-06. The genomics of parallel adaptation to temperature-divergent niches in Macaronesian *Echium* (Boraginaceae)  
RACHAEL GRAHAM, M. CARINE, M. RIUS & M. CHAPMAN
- P4-07. An endemic radiation of deer in the Late Pleistocene of Malta  
LEILA C D'SOUZA, A.LISTER & D.A. RICHARDS
- P4-08. Genetic variation of *Terminalia catappa*, pantropical plants with sea-drifted seeds, in the Bonin Islands  
SUZUKI SETSUKO, MASATO OHTANI, KYOKO SUGAI, TERUYOSHI NAGAMITSU, HIDETOSHI KATO & HIROSHI YOSHIMARU
- P4-09. Gene flow between genetically differentiated groups of *Elaeocarpus photiniifolia* (Elaeocarpaceae) on Chichijima Island, Japan  
KYOKO SUGAI, S. SETSUKO, T. NAGAMITSU, N. MURAKAMI, H. KATO & H. YOSHIMARU
- P4-10. Morphological adaptations to insularity in the Azorean Blackbird (*Turdus merula azorensis*)  
F.S. MARTINS, P. A.M. ANDRADE, T.M. RODRIGUES & D. GONÇALVES
- P4-11. The evolutionary history of talitrid amphipods (Crustacea) from Atlantic and Mediterranean Islands  
DOMENICO DAVOLOS, E. DE MATTHAEIS, L. LATELLA & R. VONK
- P4-12. Transcriptome sequencing and Simple Sequence Repeat (SSR) marker development for three Macaronesian endemic plant species  
OLIVER WHITE, M. CARINE & M. CHAPMAN
- P4-13. Patterns of reproductive isolation in Sardinian orchids of the subtribe Orchidinae  
M. LUSSU, ANNALENA COGONI, M. MARIGNANI & P. CORTIS
- P4-14. Sensory competition and acoustic niche partitioning: Island/mainland comparisons  
ALOÏS ROBERT, T. LENGAGNE, M. MELO, R. COVAS, D. GOMEZ & C. DOUTRELANT



- P4-15. A screening for putative hybridization in Azorean *Ilex* provides phylogenetic support for an endemic species status  
A. VIEIRA, L. SILVA, C. SILVA & MÓNICA MOURA
- P4-16. The impact of crabs (*Pachygrapsus* spp.) on intertidal algal communities of cobble beaches  
I. MOREU, N.V. ÁLVARO, JOSÉ M.N. AZEVEDO, A.I. NETO & T.M. COSTA
- P4-17. The Macaronesian Laurel forest as a model system to analyse pollen rain dynamics in island ecosystems  
SANDRA NOGUÉ, L. DE NASCIMENTO, L.A. GÓMEZ GONZÁLEZ, R.J. WHITTAKER, J.M. FERNÁNDEZ-PALACIOS & K.J. WILLIS
- P3 P4-18. Endemic mutualistic interactions between geckos and the dragon blood's tree in Socotra Island (Yemen)  
CRISTINA GARCÍA & R. VASCONCELOS
- P4-19. Can local assemblages mediate the recruitment of limpets and barnacles? A time-series survey in Azores (NE Atlantic)  
I. MOREU, M. PASTOR, ANA I. NETO & G.M. MARTINS, J. FARIA
- P4-20. Surf's up: Structure of decapod communities in cobble beaches varies with wave exposure  
NUNO VAZ ÁLVARO, J.M.N. AZEVEDO & A.I. NETO
- P4-21. Changes in precipitation with climate change in Europe  
BARTOSZ KAŻMIERCZAK & M. WDOWIKOWSKI
- P4-22. Thirty seven (37) years of climate change on islands  
D.N. KARGER, L. MO, PATRICK WEIGELT, H. KREFT, N. ZIMMERMANN, J. BÖHNER, O. CONRAD, R.W. SORIA-AUZA, H.P. LINDER & M. KESSLER
- P4-23. Evolutionary ecology of microbial communities in Hawaii  
BENOIT PEREZ, H. KREHENWINKEL & R.G. GILLESPIE





## PLENARY TALKS



Lagoa do Fogo in São Miguel Island (Photo: Paulo A.V. Borges)

# The dynamic equilibrium theory of island biogeography: The origin, the legacy and the future

DANIEL SIMBERLOFF



Simberlof, D. 2016. The dynamic equilibrium theory of island biogeography: The origin, the legacy and the future. Pp. 2 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. Arquipelago. Life and Marine Sciences. Supplement 9.

Key words: Location: Global; Taxa: All; Other: assembly, extinction, immigration, metapopulation, priority effect.

*Daniel Simberloff (e-mail: [dsimberloff@utk.edu](mailto:dsimberloff@utk.edu)), University of Tennessee, Knoxville, TN, USA.*

The general dynamic model of oceanic island biogeography (GDM) provides a theoretical framework incorporating the dynamics of island platforms alongside the key biological drivers of immigration, extinction and speciation. It provides an essentially non-equilibrium framework generating novel predictions for emergent diversity properties of oceanic islands and archipelagos. Based on efforts of the *biodynamics of islands* workshop group I review progress, both in testing the GDM's predictions and in developing and enhancing ecological–evolutionary understanding of oceanic island systems, through the lens of the GDM. In particular, I focus on four main themes: 1, macroecological tests using a space-for-time rationale; 2, extensions of theory to islands following different patterns of ontogeny; 3, the implications of GDM dynamics for lineage diversification and trait evolution; and 4, the potential for downscaling GDM dynamics to local-scale ecological patterns and processes within islands.

## The role of psychology in biodiversity conservation

SUSAN D. CLAYTON



Clayton, S.D. 2016. The role of psychology in biodiversity conservation. Pp. 3 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. Arquipelago. Life and Marine Sciences. Supplement 9.

Key words: Location: Global; Taxa: All; Other: conservation, psychology, environmental concern, environmental identity.

*Susan D. Clayton (e-mail: [sclayton@wooster.edu](mailto:sclayton@wooster.edu)), The College of Wooster, Wooster, Ohio, USA.*

Successful conservation of biodiversity depends on a number of factors, including the reactions and support of local communities as well as potentially a worldwide audience. This talk will review some of the psychological factors that might be influential. How do people think about biological conservation? What are some ways to encourage behavioral support? And how can we promote increased care and concern for biodiversity? I will present theory and research on experiences that might lead to greater environmental concern and concern about the conservation of biodiversity. I focus in particular on the development of an environmental identity, defined as a stable sense of oneself as being connected to the natural world. I argue that conservation organizations need to consider the human factor as part of the system that supports or fails to support the protection of endangered species and habitats.

## Long-term ecological research in Azores: What we have learned so far

PAULO A.V. BORGES



Borges, P.A.V. 2016. Long-term ecological research in Azores: What we have learned so far. Pp. 4 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: Arthropods; *Other*: macroecology, inventory, alpha-beta-gamma diversity; SADs; spatial and temporal beta diversity.

*Paulo A.V. Borges (e-mail: paulo.av.borges@uac.pt), cE3c/ABG – Centre for Ecology, Evolution and Environmental Changes/Azorean Biodiversity Group & University of the Azores, 9700-042 Angra do Heroísmo, Azores, Portugal.*

Here I review ongoing long-term inventorying and/or monitoring initiatives in Azores ecosystems, focusing on arthropods. In Azores, BALA project (1999-2020) is an exemplary case in which occurrence and abundance data were gathered using standardized sampling techniques in the soil and canopy of 100 plots in seven Azorean Islands. With this large scale survey it was possible to overcome several biodiversity shortfalls, with the description of new taxa in new habitats (Linnean shortfall), the study of the distribution of species at different spatial scales and beta diversity (Wallacean shortfall), the study of species' relative abundances (Prestonian shortfall), the relationship between abundance and distribution and the knowledge of life history and niche of many species (Hutchinsonian shortfall). In addition, indicators of mountainous forest biotic integrity and selection of priority areas for arthropod conservation in the Azorean archipelago contributed for new strategies for conservation of Azorean native forests and inspired new visions for invertebrate conservation strategies worldwide. The same data has been used as proof-of-concept for testing non-parametric biodiversity estimators, to evaluate beta diversity partition indices and to propose estimators of phylogenetic and functional diversity. More recently, within NETBIOME-ISLANDBIODIV project (2012-2020) a total of 24 slam traps were distributed in several native forest plots in seven Azorean Islands, aiming to investigate the seasonal and between year variations of the biomass and diversity of flying insects. With the current framework it will be possible to address the following objectives: 1) collect long-term ecological data to evaluate species distributions and abundance at multiple spatial and temporal scales; 2) identify pathways impacting oceanic indigenous assemblages under global change for conservation purposes. I will show that long-term observations are a necessity for two reasons: (i) to provide quantitative evidence of changes within island ecosystems, (ii) to allow scientists to disentangle general mechanisms from unique outcomes by using island systems as repeated 'natural experiments'.

# Oceanic island biogeography through the lens of the General Dynamic Model macroscope

ROBERT J. WHITTAKER



Whittaker, R.J. 2016. Oceanic island biogeography through the lens of the General Dynamic Model macroscope. Pp. 5 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: diversification, general dynamic model, island biogeography, island evolution, ontogeny.

*Robert J. Whittaker (e-mail: robert.whittaker@ouce.ox.ac.uk), School of Geography and the Environment, University of Oxford, South Parks Road, OX1 3QY, Oxford, UK and Center for Macroecology, Evolution and Climate, National Museum of Natural History, University of Copenhagen, Universitetsparken 15, 2100 Copenhagen, Denmark.*

The general dynamic model of oceanic island biogeography (GDM) provides a theoretical framework incorporating the dynamics of island platforms alongside the key biological drivers of immigration, extinction and speciation. It provides an essentially non-equilibrium framework generating novel predictions for emergent diversity properties of oceanic islands and archipelagos. Based on efforts of the biodynamics of islands workshop group I review progress, both in testing the GDM's predictions and in developing and enhancing ecological-evolutionary understanding of oceanic island systems, through the lens of the GDM. In particular, I focus on four main themes: 1, macroecological tests using a space-for-time rationale; 2, extensions of theory to islands following different patterns of ontogeny; 3, the implications of GDM dynamics for lineage diversification and trait evolution; and 4, the potential for downscaling GDM dynamics to local-scale ecological patterns and processes within islands.

## Processes of ecology and evolution in the context of global change: Modelling a complex island ecosystem

GEORGE K. RODERICK



Roderick, G.K. 2016. Processes of ecology and evolution in the context of global change: Modelling a complex island ecosystem. Pp. 6 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Pacific Islands, Society Islands, Moorea, French Polynesia; *Taxa*: terrestrial and marine biota; *Other*: sustainability, biodiversity, Moorea IDEA, avatar.

George K. Roderick (e-mail: [roderick@berkeley.edu](mailto:roderick@berkeley.edu)), University of California, Berkeley, CA, USA.

Accelerated global change, especially as a result of changes in climate and land use and the impact of invasive species, threaten not only the biodiversity of islands, but also the fundamental ecological and evolutionary processes that created and maintain this diversity. Addressing these issues and planning for a sustainable future requires a far better understanding of complex socio-ecological systems at local and national scales of management action. To that end, a key research goal is to build functioning whole ecosystem models, or, ‘avatars’, of model islands, cities, and eventually countries. The outcome: communities and countries managing their ecosystem wellness and avoiding the social consequences of ecological collapse. The Island Digital Ecosystem Avatars (IDEA) Project is inspired by efforts to digitize an entire island ecosystem from ‘genes to satellites’ and will harness and extend these efforts to build advanced computational models of a range of complex socio-ecological systems. Identifying clearly defined units of socio-ecological organization for study is essential: island systems are particularly attractive for sustainability science because they are clearly bounded (relatively closed) and ongoing studies at larger scales (e.g., global climate models) can help incorporate external influences simply and effectively. The Moorea Island Digital Ecosystem Avatar (<http://mooreaidea.org/>) is a multi-national collaborative effort that will incorporate observations, experiments, data, and theory across a coupled 3-D terrestrial-marine “ridge to reef” landscape to model how physical, chemical, biological, and social processes, interact to shape the island’s phenotype. Moorea—a volcanic oceanic island about the size of San Francisco, 15 km northwest of Tahiti—has a well characterized biota and a significant scientific capacity through its two international research stations. The Moorea IDEA will support process-oriented research along with open data-sharing platforms to provide a wealth of science driven data. Combined with new analytical techniques and theory, this will develop a virtuous cycle whereby data driven discovery informs the design of mechanistic research, including experiments and further long-term observations. In this way, the project will be able to assess how alternate policy scenarios might influence biodiversity and ecosystem services, as well as the processes that sustain them.



## Applications of artificial intelligence to island ecology and biogeography

PEDRO CARDOSO



Cardoso, P. 2016. Applications of artificial intelligence to island ecology and biogeography. Pp. 7 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global, with focus on Azorean/Macaronesian examples; *Taxa*: all; *Other*: agent-based models, automation of science, evolutionary computation, genetic programming, species-area relationship, symbolic regression.

*Pedro Cardoso (e-mail: pedro.cardoso@helsinki.fi), Finnish Museum of Natural History, University of Helsinki, P.O. Box 17 (Pohjoinen Rautatiekatu 13), 00014 Helsinki, Finland and cE3c/ABG – Centre for Ecology, Evolution and Environmental Changes/Azorean Biodiversity Group & University of the Azores, 9700-042 Angra do Heroísmo, Azores, Portugal.*

Ecological systems are the quintessential complex systems, being composed of individuals and populations from different species, interacting and exchanging energy in multiple ways, and responding to (and influencing) the physical environment at different spatial and temporal scales in often difficult to describe non-linear relationships. As a consequence, ecology is dominated by idiosyncratic results and general principles and models are few. Two complementary approaches have been used in the study of ecology. The classical, top-down, approach primarily studies emerging patterns. Mechanistic, bottom-up, models directly study the processes, providing biological explanations of how the components work causally together. Yet, in both classical and mechanistic modelling, common statistical techniques can hardly reflect the complexity of ecological patterns and processes. Finding hidden relationships in complex data is now possible through the use of massive computational power, particularly by means of Artificial Intelligence (AI) methods, such as evolutionary computation. Among a plethora of methods, symbolic regression (SR) is proving to be particularly useful, as it searches for both the formal structure of equations and the fitting parameters simultaneously, hence providing the required flexibility to characterize complex ecological systems. I will demonstrate how SR can deal with complex datasets for modelling species richness and species spatial distributions on islands. I will also illustrate how SR can be used to find general models in ecology, by using it to develop new equations for the species-area relationship and the general dynamic model of oceanic island biogeography. All the examples suggest that evolving free-form equations purely from data, often without prior human inference or hypotheses, may represent a very powerful tool for ecologists and biogeographers to become aware of hidden relationships and suggest general theoretical models and principles. Finally, I will delve into the consequences of replacing or complementing humans with computers in all kinds of tasks, from daily chores to major advancements in science.



## Bayesian statistical approaches to island biogeography: Progress and challenges

ISABEL SANMARTÍN & FREDRIK RONQUIST



Sanmartín, I & F. Ronquist 2016. Bayesian statistical approaches to island biogeography: progress and challenges. Pp. 8 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Canary Islands; *Taxa*: multiple lineages of plants and animals; *Other*: biogeography, dispersal, extinction, Markov chain process, carrying capacity.

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Oceanic Islands have long fascinated biogeographers because of their geographical isolation, small size, and replicated nature, with islands within an archipelago serving as distinct ecological and evolutionary units. Since MacArthur & Wilson's Equilibrium Theory of Island Biogeography, there have been many important theoretical and empirical advances in understanding community assembly on islands. In general, this work has taken a profoundly ecological approach, using data on species richness and abundance to estimate the rate of relevant processes, such as immigration, speciation, and extinction, though lately there has been an effort to incorporate evidences such as the geological evolution of islands. In contrast, the historical signal of phylogenies and how these can contribute to our current understanding of the long-term dynamics of biotas has been largely ignored, despite the wealth of phylogenetic data made available by the popularization of genetic tools. Here, I explore the development of "island-centric" approaches that use phylogenetic data from multiple clades to extract generalities about the process of island community assembly. In particular, I focus on biogeographic stochastic models (BIB) that use Bayesian MCMC simulations to estimate dispersal rates and area carrying capacities (equilibrium frequencies) from DNA sequences and their geographic locations. Advantages of these models include: a spatially explicit approach that integrates the connectivity of islands within archipelagos; their relative mathematical simplicity which gives them flexibility to fit more complex scenarios; and the use of Bayesian hierarchical inference to integrate over clade-specific biological traits (e.g., dispersal ability) in the estimation of global biogeographic parameters, thus correcting the "ecological neutrality" of other approaches. Finally, I describe recent advances, including the development of time-heterogeneous models to incorporate the temporal dynamics of the dispersal process, partitioning the contribution of abiotic factors to migration rates and carrying capacities, or the modelling of mass extinction events through non-stationary models.

## Ecological networks on islands

JENS M. OLESEN



Olesen, J.M. 2016. Ecological networks on islands. Pp. 9 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: islands; *Taxa*: all; *Other*: biotic interaction, colonization, density compensation, global connector, sea-land interface, web.

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“Insular food webs represent one endpoint of the marine web” (Polis & Hurd 1995). Inspired by this clever statement, I intend to bring the sea back to island biology and present ecological network models for different kinds of island. Island network structure and dynamics are shaped by different drivers, especially by colonization processes, sea-land interface dynamics and marine subsidies, global connectors, latitude and catastrophes. Colonization is influenced by dispersal barriers, such as island isolation, and may result in species poverty, i.e. low species density. In addition, among-taxon variation in dispersal ability causes species disharmony. In addition, I explore how reduced island resources and high island isolation may restrict island establishment of large birds of prey and how this cascades down through an island network, causing competitive exclusion and density compensation in communities of potential prey. Sea-land interface dynamics is determined by sea-land connectors (many seabirds and a few marine mammals), marine productivity and amount of shoreline detritus (subsidies). Global connectors are migrant birds and their parasite and pathogen load, which arrive to islands seasonally, and may have a strong impact upon the synchrony of island and marine network dynamics. Latitudinal effects are plenty, e.g. presence or absence of glaciations and seasonal ice cover of the sea surrounding islands. High-latitude islands, for example, have largely been ignored in general island biology. Finally, catastrophes such as volcanic activity, hurricanes and fire influence island network structure and dynamics. These drivers are especially influenced by island area, isolation and geographic location, and primary and secondary marine productivity. I build the ecological network models on available literature, unpublished/published data from several islands/archipelagos, and my colleagues’ and my own fieldwork.

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## CONTRIBUTED TALKS

### CT 1. BIOLOGICAL INVASIONS

CHRISTOPH KUEFFER & IOLANDA SILVA ROCHA



The invasive spider *Phidippus audax* (Hentz, 1845) found in Terceira Island: Paúl da Praia da Vitória  
(Photo: Paulo A. V. Borges)

## Global patterns in extinction and threats to vertebrates by biological invasions in islands

CÉLINE BELLARD, T. BLACKBURN, P. GENOVESI, P. CASSEY & J. M. JESCHKE



Bellard, C., T. Blackburn, P. Genovesi, P. Cassey & J.M. Jeschke 2016. Global patterns in extinction and threats to vertebrates by biological invasions in islands. Pp. 12 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: vertebrates; *Other*: biological invasions, IUCN classification, islands, spatial analyses.

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Alien species have a range of impacts documented in their new environments, and there are well-documented examples of native species that have been driven extinct by aliens. However, biological invasions as drivers of biodiversity loss have recently been challenged. Some of the arguments about the impacts of alien species have been based on data on extinction, and extinction risk from the IUCN Red List. This is a dynamic resource, for which regular updates add ever greater and more accurate information on the conservation status of increasing numbers of species. Here, we revisit this resource to assess the current state of knowledge about biological invasions on islands. We report links between vertebrates threatened by more than 200 invasive alien species from the completely revised Global Invasive Species Database. Our results show that invasive alien species are the second most common threat associated with species that have gone extinct from these taxa since AD 1500, especially on islands (>85%). New maps of the vulnerability of threatened vertebrates show that centres of IAS-threatened vertebrates are concentrated in the Americas, India, Indonesia, Australia and New Zealand, especially on islands. We found that the threat posed by invasive alien species in relation to other threats (i.e, habitat loss, pollution, overexploitation, climate change) is greater on islands than mainland areas, except in South America. Overall, there tend to be fewer threats on islands than on mainland areas. The differences in invasive threats between regions and taxa can help efficiently target invasive alien species, which is essential for achieving the Strategic Plan 2020 of the Convention on Biological Diversity. Fundamentally, we must know where species that are threatened by invasive alien species live, and the degree to which they are threatened.

## Invasive rat population dynamics and management by trapping in island tropical forests

QUITERIE DURON, L. RUFFINO, T. CORNULIER & E. VIDAL



Duron, Q., L. Ruffino, T. Cornulier & E. Vidal 2016. Invasive rat population dynamics and management by trapping in island tropical forests. Pp. 13 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: New Caledonia; *Taxa*: *Rattus rattus*, *Rattus exulans*; *Other*: predator control, rodent population dynamics, large-scale island conservation, modeling of management scenarios, invasive species, island biodiversity.

*Quiterie Duron (e-mail: quiterie.duron@ird.fr) and Eric Vidal, Institut Méditerranéen de Biodiversité et d'Écologie marine et continentale (IMBE), Aix-Marseille Université, UMR CNRS – IRD – UAPV, Centre IRD Nouméa - BP A5, 98848 Nouméa Cedex, Nouvelle-Calédonie; Lise Ruffino and Thomas Cornulier, Institute of Biological and Environmental Sciences, University of Aberdeen, Aberdeen, UK.*

Rodents harbor some of the world's most pervasive invasive species that greatly contribute to ecosystem degradation and biodiversity loss on islands. On large islands, where invasive rodent eradication through large-scale broadcasting of rodenticide is often not appropriate, population management using mechanical trapping may prove to be a useful alternative. However, control by trapping is very time consuming and need efforts in the long term to limit reinvasion risks. Invasive Black and Pacific rats (*Rattus rattus* and *R. exulans*) have a strong impact on endemic and micro-endemic species in the dense evergreen rainforests of Pacific islands. The main pristine remnants of those forests often lie in remote, montaneous areas which present great logistical challenges, hence the feasibility and the sustainability of rodent control by trapping is uncertain. This study aimed to provide background data on rat population dynamic parameters in a high-elevation, and protected rainforest of New Caledonia in order to inform optimal long-term management design. We used a combination of experimental lethal control and live-trapping data. Spatially explicit capture-recapture (SECR) analyses allowed us to estimate rat densities, capture probabilities and spatial scale of the detection function (a proxy for home range size). Rat densities fluctuated seasonally (9.1-32.3 rats/ha). Capture probability and home ranges varied greatly between sessions, age class, sex and species. SECR estimates enabled us to parameterize simulation models of trapping efficiency, and to identify suitable trapping designs in relation to target densities for each species and sets of financial, spatial and temporal logistical constraints on control. Our study shows that non-toxic lethal control may be a viable approach even under very challenging environmental conditions and suggests that community-based management may be the best way to deal with such complex environmental and social systems. Our analytical approach could be used elsewhere to inform invasive species control strategies.

## What is the role of vacant niches for alien species establishment on isolated islands?

BERND LENZNER, F. ESSL, GLONAF CORE TEAM, C. CAPINHA, B. GUÉNARD,  
E. P. ECONOMO, H. SEEBENS & D. MOSER



Lenzner, B., F. Essl, GloNAF Core Team, C. Capinha, B. Guénard, E.P. Economo, H. Seebens & D. Moser 2016. What is the role of vacant niches for alien species establishment on isolated islands?. Pp. 14 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Global; *Taxa*: ants, amphibians, mammals, reptiles, vascular plants; *Other*: alien species, biogeography, introduction effort, isolation, macroecology, vacant niches.

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Globally, islands are major biodiversity hotspots. The intrinsic properties of islands promote the evolution of highly specialized and range-restricted native biota which is mainly driven by island area, age and isolation. Isolation restricts natural dispersal of species, leading to the absence of some functional groups in the local species pool that play a key role in mainland regions. It has been suggested that such empty ecological space may facilitate establishment of new species and contribute to the high levels of biological invasions widely observed on islands worldwide. We test the importance of “vacant niches” to explain differences in the level of invasion a wide range of subtropical and tropical islands and island groups. The dataset encompasses information on established alien species richness from a range of important taxonomic groups that represent plants (vascular plants), vertebrates (mammals, amphibians, reptiles) and invertebrates (ants). We assess the effect of island isolation on alien species numbers and on the observed level of invasion while accounting for area, climate and physical as well as economic properties of islands by means of generalized linear mixed effect models. We will present results of this analysis, which are highly relevant for understanding the biogeography and macroecology of island invasions and to inform alien species management and policy.



## Introduced marine species in the Island Nation of Indonesia

P. JOANA DIAS, M. HUHN, J.I. McDONALD & H. MADDUPPA



Dias, P.J., M. Huhn, J.I. McDonald & H. Madduppa 2016. Introduced marine species in the Island Nation of Indonesia. Pp. 15 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Indonesia; *Taxa*: marine invertebrates; *Other*: marine biosecurity, Indo-Pacific, invasive species, early-warning, biodiversity, conservation.

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The transport and establishment of introduced marine species (IMS) is regarded as one of the greatest threats to the ocean's biodiversity, with significant environmental, economic, social and health impacts worldwide. In response to biosecurity risks associated with IMS, Australia implemented a National System for the Prevention and Management of Marine Pest Incursions. In Western Australia (WA) early-warning detection systems, consisting in regular surveys using settlement arrays have been developed and implemented in order to attempt to detect IMS at an early stage of establishment. In any given geographic region, research and management on introduced invasive species tends to be primarily concentrated to developed countries such as Australia. However, exchange of expertise between industry, research and governments in the Indo-Pacific region is crucial to increase the knowledge on IMS across the region. The current collaboration project represents the first established marine biosecurity research project in Indonesia. Through the trial of an early-warning system for IMS in the Banda Islands (Moluccas, Indonesia) we aim to obtain baseline data on fouling communities and foster the discussion and inclusion of biosecurity issues in marine biodiversity conservation, education programs and policies in Indonesia. The Banda Islands sit in what is considered the center of global marine biodiversity, the Coral Triangle. The port of Banda Naira is an excellent study site because of its safety, easy accessibility and significant role in national and international (recreational) ship traffic. This study will help to identify whether the Banda islands' marine communities are threatened by marine biological invasions from other biogeographic regions of Indonesia or Australia. More importantly, it is hoped that this model early-warning system and information can later be applied for establishing similar marine biosecurity approaches in other parts of the Indonesian archipelago.



## Alien reptiles on Mediterranean Islands: A biogeographic framework to aid conservation management

IOLANDA SILVA-ROCHA, D. SALVI, M. A. CARRETERO & G.F. FICETOLA



Silva-Rocha, I., D. Salvi, M.A. Carretero & G.F. Ficetola 2016. Alien reptiles on Mediterranean Islands: A biogeographic framework to aid conservation management. Pp. 16 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Mediterranean Basin; *Taxa*: reptiles; *Other*: Introduced species, GLMM, Biological Invasions, Reptiles, Diet, Human-features.

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Biological invasions are a major threat to biodiversity but island ecosystems are probably the most vulnerable. The Mediterranean basin has a long history of human-biota interaction which makes it a good model to study these phenomena at different temporal scales. Reptiles since are among the most introduced vertebrates and, simultaneously, some species are also highly threatened by biological invasions. Here, we present a conservation-oriented biogeographical analysis performed with reptiles within Mediterranean islands. The main aims of this work are: 1) to identify the species with the highest frequency as non-native species; 2) to assess the factors more important to introduction and establishment, while taking into account natural biogeographic factors processes; and 3) to identify which islands are the most prone to be invaded. We gathered a database with information on 90 reptiles distribution in > 900 Mediterranean Islands and their native status as well as human activities, land use and geographical features. Data were analysed using Generalized Linear Mixed Models, which allow the analysis of non-normal data, while taking into account non-independence of data. Preliminary results suggest that human-features are not the main drivers of reptile introductions, but instead, distance to native range and diet, specifically, a plant based diet will increase the probability of a species to be allochthonous. Our results allow the proposition of an explicit framework of invasion risk by species and area for the Mediterranean to be applied in conservation management policies of the countries with many Mediterranean islands (e.g. Spain, Italy, Croatia and Greece).

## The red-vented bulbul: Extreme pest or extreme prejudice?

MARTIN THIBAUT, E. VIDAL, M. POTTER, E. DYER & F. BRESCIA



Thibault, M., E. Vidal, M. Potter, E. Dyer & F. Brescia 2016. The red-vented bulbul: extreme pest or extreme prejudice?. Pp. 17 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Pacific; *Taxa*: birds; *Other*: *Pycnonotus*, invasive, biodiversity hotspots, tropical islands.

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Lists of “worst” invasive alien species such as that produced by the IUCN Invasive Species Specialist Group were designed in response to pressing conservation management issues caused by invasive alien species (IAS). IAS are considered to be one of the main causes of biodiversity loss, especially on islands where the high endemism and naivete of insular species accentuate their impacts. Recently, debate has flourished about inadequacies in the simplistic “worst invasive species” approach. For example, the extreme pest status ascribed to the red vented bulbul (*Pycnonotus cafer*), a tropical passerine bird, has been criticized. This species has been widely introduced across Pacific islands and is commonly blamed for its impacts on agriculture and biodiversity via dispersal of invasive plant seeds and competition with native fauna. We reviewed the scientific literature and information from three databases (ABBA, GAVIA, EBIRD). The red-vented bulbul has established on 39 islands and in seven continental locations outside its native range. We have compiled lists of 110 consumed plant species among which 35 are likely to be dispersed. This invasive alien bird also potentially competes with 15 bird species. But almost all of these impacts are only suspected and the mechanisms that favor each category of impact are still unknown. Consequently, the attention paid to this species by scientists and managers varies a lot between islands and contexts and we found no clear support for considering this species to be the “world’s worst”. Decisive recommendations are required to inform management actions on islands where the invasion process is in progress such as on the tropical archipelago of New Caledonia, one of the world’s biodiversity hotspots. This case-study evaluates all available data on the impacts of this invasive alien species and offers a solid foundation for further studies that aim to assess the impacts of the red-vented bulbul on islands.

## Natural history of a snake invasion in a Mediterranean island: The case of *Hemorrhois hippocrepis* (Reptilia, Colubridae) in the Island of Ibiza

ELBA M. MONTES, A. HINCKLEY, E. AYLLÓN & J.M. PLEGUEZUELOS



Montes, E.M., A. Hinckley, E. Ayllón & J.M. Pleguezuelos 2016. Natural history of a snake invasion in a Mediterranean island: The case of *Hemorrhois hippocrepis* (Reptilia, Colubridae) in the Island of Ibiza. Pp. 18 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Ibiza, Balearic Islands, Spain; *Taxa*: *Hemorrhois hippocrepis*, Colubridae, reptiles; *Other*: stowaway inside ornamental trees, predation, lizard endemism.

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Since 2003, three snake species were inadvertently introduced in Ibiza island from Southern Iberian Peninsula as stowaways within big olive trees, for ornamental gardening. *Malpolon monspessulanus*, has not been seen since 2010, and it is presumed to have vanished; *Rhinechis scalaris* became naturalized, but 13 years later just maintains a small range and population size. *Hemorrhois hippocrepis*, however, rapidly became invasive, ranging now at least through 26% of the island and threatening endemic island fauna. During 2014-2015 different trapping methods were tested on this invasive snake, wooden boxes with funnels and baited with lab mice, gave the best results. Natural history traits were analyzed on 421 captured specimens. Preliminary results show a rapid phenotypic plasticity, with some introduced individuals overpassing the weight of the heaviest individual in the population of origin by more than a 200%, a maximum rank of body condition (as deduced from abdominal fat body level), and a poorly diversified diet mainly focused on the endemic lizard *Podarcis pityusensis* (57% of the diet in frequency). Here we expose the invasion process of this snake in the island of Ibiza, a phenomenon that repeatedly occurred during the Holocene in many Mediterranean islands, but followed in real time here for the first time. The species has been previously well studied in its native range, permitting accurate comparisons of some of its natural history traits between native and alien populations. This will improve our understanding of the characteristics and processes of successful reptile invaders in Mediterranean islands. Meanwhile, we are engaged in reducing the entrance of these stowaways to the island, by the proposal of limiting tree shipping to the island to summer, the season with the lowest chance of getting hibernating snakes in ornamental trees.

## Biogeographic reconstruction and dispersal dynamics of the carabid beetle *Merizodus soledadinus* invading subantarctic Kerguelen Islands

TIPHAINE OUISSE, D. RENAULT & F. HENDRICKX



Ouisse, T., D. Renault & F. Hendrickx 2016. Biogeographic reconstruction and dispersal dynamics of the carabid beetle *Merizodus soledadinus* invading subantarctic Kerguelen Islands. Pp. 19 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Kerguelen Islands; *Taxa*: *Merizodus soledadinus* (Guerin-Meneville, 1930) (Coleoptera:Carabidae); *Other*: dispersal; population genetics; ecophysiology; insect, sub-Antarctic island.

*Tiphaine Ouisse (e-mail: tiphaine.ouisse@univ-rennes1.fr) and David Renault, University of Rennes 1 & UMR CNRS 6553 Ecobio, Rennes, France; Frederik Hendrickx, Royal Belgian Institute of Natural Science (RBINS), Bruxelles, & Terrestrial Ecology Unit (TEREC), Ghent, Belgium.*

The fast growing populations of alien species, their ecological niche shifts during biological invasions, and their accelerating expanding range in the introduced areas remain under deep investigation. It has been assumed that traits enhancing dispersal may be favoured at the expanding range edges of the alien species, and the assortative mating among the dispersers could further enhance this phenomenon. During the last decades, numerous alien insects were introduced at the subantarctic Kerguelen Islands, of which some of them became invasive. Among them, a flightless predatory ground beetle is of particular interest. *Merizodus soledadinus* (Coleoptera: Carabidae) was uniquely introduced from the Falkland islands 102 years ago at one site, and, since then, colonized a large geographical area. Here, we aimed at decrypting the fingerprint of dispersal evolution using the well-known invasion chronosequence of this ground beetle at the Kerguelen Islands. RAD-sequencing techniques were first used to reconstruct biogeographical relationships among native and introduced areas of this carabid beetle. These techniques were then used to delineate population genetics between formerly and recently established locations at the Kerguelen Islands, and further disentangle natural from human-mediated arrivals into new localities. Finally migratory gene flows among populations at both small and medium geographic scales were highlighted, outlining dispersal dynamics at the invasion front. Finally, physiological experiments (metabolomics) were conducted to identify evolutionary network changes associated with differences in dispersal abilities. We then mapped metabolomics data onto genome-scale metabolic networks so that we could restore the connectivity among identified metabolites. Beetles sampled at the range margins were characterized by distinct physiological strategies as compared with their relatives sampled at the invasion core. Large differences were observed in dispersal behaviour, management of energetic budgets (starvation resistance) and metabolic signatures. Altogether, our data constitute a solid basis for post-introduction expansion modelling and further tests for evolutionary invasion analysis.

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## CONTRIBUTED TALKS

### CT 2. Biodiversity and Macroecology

HOLGER KREFT & LUÍS BORDA-DE-ÁGUA



Sunrise in Pico island (Photo: Paulo A. V. Borges)



## Dissecting global turnover in vascular plants

CHRISTIAN KÖNIG, P. WEIGELT & H. KREFT



König, C., P. Weigelt & H. Kreft 2016. Dissecting global turnover in vascular plants. Pp. 22 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: vascular plants; *Other*: beta diversity, distance decay of similarity, generalized dissimilarity modelling, dispersal filtering, environmental filtering.

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This study aims to provide the first global assessment of species turnover in vascular plants across geographic settings, taxa and functional groups. We analyzed a dataset of 496 vascular plant checklists, containing 420,000 occurrence records for about 98,500 species. We calculated pairwise floristic similarities ( $\beta_{sim}$ ) for subsets based on geographical setting (mainland, islands, different island types), taxonomic group (angiosperms, gymnosperms, pteridophytes), and functional group (trees, shrubs, herbs). For each subset, we analyzed the decay in similarity along geographical distance using generalized linear models and assessed the relative importance of geographic distance vs. environmental conditions using generalized dissimilarity models. Overall, turnover rates were lowest for pteridophytes and herbs, and highest for gymnosperms and shrubs. Environmental variables generally explained a larger amount of compositional variation than geographic distance, but the relative importance differed strongly among subsets. Unexpectedly, turnover among islands was lower than among mainland units and predominantly driven by differences in environmental conditions, whereas mainland turnover was about equally dependent on geographic distance and environmental conditions. This contrast was – in different degrees – consistent across taxonomic and functional groups. We conclude that turnover on global scales is strongly impacted by dispersal and environmental filters imposed by the geographical setting. The strength of filtering processes is directly proportional to the amount of homogenization of realized species assemblages within a given setting. In addition, our results indicate that species groups are differentially successful in passing filters, depending on group-specific characteristics such as dispersal ability or environmental tolerance.

## Mosses and liverworts growing on bark in different archipelagos: A study of alpha and beta diversity patterns

ROSALINA GABRIEL, P.A.V. BORGES, P. CARDOSO, O. FLORES, J.M. GONZÁLEZ-MANCEBO, T.A.J. HEDDERSON, ET AL.



Gabriel, R., P.A.V. Borges, P. Cardoso, O. Flores, J.M. González-Mancebo, T.A.J. Hedderson, S.C. Aranda, M.C.M. Coelho, D.S.G. Henriques, R. Hernandez-Hernandez, L. Marline, N. Wilding & C. Ah-Peng 2016. Mosses and liverworts growing on bark in different archipelagos: A study of alpha and beta diversity patterns. Pp. 23-24 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Azores (Pico, Terceira), Canary Islands (La Palma), Guadeloupe, Madagascar, La Réunion; *Taxa*: Bryophytes: liverworts, mosses; *Other*: alpha diversity, beta diversity, epiphytes, BRYOLAT Protocol, elevation, MOVECLIM project.

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The characterization of the global spatial heterogeneity of diversity is one of the most interesting issues in Ecology; thus, a comparative study across elevational gradients was set up in six islands, using bryophytes. This is a rich, yet neglected, group of plants that, due to their physiological and morphological characteristics are able to occur from the coast to the mountain tops. Data was obtained during the MOVECLIM project, using a stratified protocol (BRYOLAT, adapted), relying on a homogeneous hierarchical sampling strategy. Collection sites were set up in locations with 200 m elevation intervals, following a transect, ideally facing the same orientation and including native vegetation. At each site, two permanent plots (100 m<sup>2</sup>) were established and from each plot, three quadrats (4 m<sup>2</sup>) were randomly selected and thoroughly examined for bryophytes. There, three replicates were collected from six substrates (if present). In this work we selected epiphytic bryophytes since they are diverse both in tropical and temperate ecosystems including indicator and ecologically relevant species. Besides describing gamma and alpha diversity for each island, we



further explored how spatial gradients contribute to the formation of species richness in temperate vs. tropical islands by disentangling beta diversity patterns to spatial turnover and richness components. Results show that the clear hump-shaped gradient observed in species alpha richness is translated to a more complex beta diversity pattern, with the richness differences of beta partition being more important than species replacement in the elevational gradient. Peaks of species replacement occur particularly in the transition between vascular plant communities. As for the distance-decay relationship, a number of patterns were found to be significant, mostly driven by richness differences of species, and stronger for liverworts. Among these species, beta shows consistent higher values between contiguous altitudinal bands, these values being more variable and lower in temperate islands.

## Dispersal ability determines the scaling properties of species abundance distributions

LUÍS BORDA-DE-ÁGUA, H.M. PEREIRA & P.A.V. BORGES



Borda-de-Água, L., H.M. Pereira & P.A.V. Borges 2016. Dispersal ability determines the scaling properties of species abundance distributions. Pp. 25 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: Arthropods; *Other*: dispersal ability, moments, scaling, species abundance distributions.

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We used data on arthropods collected in the Azores to (i) test whether the scaling properties of the moments of their species abundance distributions are similar to those observed for tropical tree species, (ii) test predictions obtained with spatially explicit computer simulations on the rate of change of species abundance distributions as a function of sample size, and (iii) forecast the evolution of the species abundance distribution for sample sizes hitherto not obtained. We concluded that the moments of the species abundance distributions of arthropods have a pattern similar to that observed for tropical tree species, therefore, we conjecture that this is a general pattern in ecology. In agreement with computer simulations, the shape of species abundance distributions of low dispersal ability species reveals a bump for intermediate abundance classes earlier than the distributions of high dispersal ability species. Projections of the distributions for sample sizes for two and four times larger than of those already sampled revealed the same trend but show that considerably more data is required to observe transitions in the shape of the distributions as predicted by simulation models.

## Are reduced dispersal abilities in island floras fact or fiction? Global cross-species relationships between plant traits and dispersal distance offer new insights

FIONA J. THOMSON, T. D. AULD, R. T. KINGSFORD & A.T. MOLES



Thomson, F.J., T.D. Auld, R.T. Kingsford & A.T. Moles 2016. Are reduced dispersal abilities in island floras fact or fiction? Global cross-species relationships between plant traits and dispersal distance offer new insights. Pp. 26 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: >400 plant species; *Other*: dispersal distance, seed mass, dispersal investment, plant height, dispersal structure, plant trait.

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Quantifying global, cross-species relationships between plant traits and dispersal distance can provide new insights into current theories on dispersal. Plants and animals from island environments have long been used as a classic example of selection for reduced dispersal abilities. It has been hypothesised that island floras have diminished dispersal ability to prevent seeds dispersing beyond land. This hypothesis has been built on (i) evidence that island floras have large seeds and low dispersal investment compared to their continental counterparts, and (ii) the assumption that large seeds with low dispersal investment are poor dispersers. However it has never been formally tested, only assumed, that the cross-species relationships between dispersal investment, seed mass and dispersal distance are positive. Here we look at the cross-species relationships between dispersal distance, seed mass, maximum plant height and dispersal investment at a global scale. We ask 1) do small-seeded species disperse further than large-seeded species and 2) do species with greater dispersal investment disperse further than species with lower dispersal investment. We find the opposite expected pattern for seed mass; large-seeded species disperse further than small-seeded species for both mean ( $n = 210$  species) and maximum ( $n = 245$  species) dispersal distances. For dispersal investment preliminary results show no relationship between dispersal investment and mean and maximum dispersal distances ( $n = 120$  species). Interestingly, we find plant height is a better predictor of dispersal distance than seed mass or dispersal investment. These new results challenge the assumptions underpinning the hypothesis that island floras are poor dispersers.

## The niche variation hypothesis and its relationship to lizard population density

MARIA NOVOSOLOV, G.H. RODDA, A. GAINSBURY & S. MEIRI



Novosolov, M., G.H. Roda, A. Gainsbury & S. Meiri 2016. The niche variation hypothesis and its relationship to lizard population density. Pp. 27 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: lizards; *Other*: population density, niche variation hypothesis, lizards, dietary niche, ecology, species richness.

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The niche variation hypothesis predicts that insular species have wide niches due to low species richness. Wider niche are thought to facilitate increased population densities. We hypothesized that insular lizards have wider dietary niche than mainland species and that population density increases with the increase in dietary niche breadth. We collected population density and quantitative diet data for 37 insular and 70 mainland lizard species. We estimated species richness values for the localities where diet data were collected and controlled for phylogenetic non-independence, body mass and the size of the plots over which densities were estimated. Island and mainland species had similar niche breadths. Although islands are species poor, we found no relationship between dietary niche breadth and species richness. However, population density increased with dietary niche breadth across both island and mainland populations. Our results indicate that dietary generalists can more efficiently use resources in their habitat which, in turn, allows them to attain higher densities, however, this is not unique to insular species. Insular and mainland species have similar niche breadths which are not affected by species richness - which implies that low species richness does not stimulate increase in niche width.

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## CONTRIBUTED TALKS

### CT3 – Ecology

DONALD DRAKE & HELENA SERRANO



A small pond in a stream from St. Bárbara in Terceira island (Photo: Paulo A. V. Borges)

## Patterns of flower visitation and nectar feeding in Hawaiian honeycreepers and lobeliads

DONALD R. DRAKE & K.A.P. THOMPSON



Drake, D.R. & K.A.P. Thompson 2016. Patterns of flower visitation and nectar feeding in Hawaiian honeycreepers and lobeliads. Pp. 30 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hawaii; *Taxa*: birds and flowering plants; *Other*: plant-animal interaction, pollination, mutualism, nectar-robbing, invasive species.

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Hawaiian lobeliads (Campanulaceae) and honeycreepers (Drepanidinae) are widely believed to be ecologically interdependent, with the plants providing nectar to the birds in exchange for pollination. With the decline and extinction of many honeycreeper species, it is important to determine whether the remaining native (and alien) birds are likely to be functional pollinators of lobeliads, all of which have protandrous flowers. We spent 116 hours observing flowers and quantifying bird behavior on three Lobeliad species in montane forests on Kaua'i. A different combination of bird species visited each Lobeliad species, and the way each bird species foraged at the flowers differed among Lobeliads. *Cyanea leptostegia* was visited mainly by alien Japanese White-eyes (*Zosterops japonicus*), which inserted their heads in the corollas and likely effected pollination. *Trematolobelia kauaiensis* was visited mainly by the endemic Kaua'i 'Amakihi (*Hemignathus kauaiensis*), which always took nectar from the base of the flower without pollinating, and less frequently by the endemic 'Iiwi (*Vestiaria coccinea*), which always inserted their heads in the corollas and likely effected pollination. *Clermontia fauriei* was visited by five species, most commonly Kaua'i 'Amakihi (always nectar robbing), and White-eyes and 'Iiwi (both sometimes nectar robbing, sometimes pollinating). Although the three Lobeliads offer nectar of similar sugar concentrations (9.6-13.2 % sucrose equivalents, w/w), each is visited by a different set of birds. Whether a particular bird species is a nectar robber, pollinator, or both, depends on the plant species. Until recently, surprisingly little quantitative data existed on honeycreeper-lobeliad interactions, and our observations support other recent observations which suggest that the traditional view of coevolved mutualisms between the two groups does not fully reflect their current relationships.



## Pollination of *Cneorum tricoccon* L. by the opportunistic nectar-feeder lizard *Podarcis lilfordi* (Günther, 1874) in an insular ecosystem

FRANCISCO FUSTER & A. TRAVESET



Fuster, F. & A. Traveset 2016. Pollination of *Cneorum tricoccon* L. by the opportunistic nectar-feeder lizard *Podarcis lilfordi* (Günther, 1874) in an insular ecosystem. Pp. 31 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Balearic Islands; *Taxa*: *Podarcis lilfordi*, *Cneorum tricoccon*, insects; *Other*: vertebrate pollination, double mutualism, nectarivory.

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Due to scarce food resources and to the high densities that vertebrates often reach on islands, typical insect- and seed-eaters expand their feeding niche and interact with a greater fraction of species than their mainland counterparts. Lizards, in particular, mostly with an animal diet in the continent, often include nectar, pollen and fruits in islands, thereby acting as potential pollinators and seed dispersal agents. In this work, we assess the pollination effectiveness of *Podarcis lilfordi*, an endemic lizard of the Balearic Islands, that visits the flowers of *Cneorum tricoccon*, a shrub restricted to the Western Mediterranean area. By means of exclusion experiments, we compared their pollination efficiency with that of insects. Results showed that lizards, mostly females and juveniles, visit flowers at a higher rate than insects, and that seed set is higher when lizards have access to plants than when only insects pollinate flowers. Moreover, lizards tend to select more hermaphrodite flowers, with higher quantities of nectar, than insects. Male lizards, on the other hand, show a higher interest on the fruits of this plant. We further studied germination and seedling emergence success comparing seeds excreted by lizards and control seeds (collected directly from the plants), and found that the former tended to be larger, emerged and grew faster than the latter. We conclude that *P. lilfordi* plays an important role both as pollinator and seed disperser of *C. tricoccon*, thus acting as a double mutualist for this species, with the benefits and drawbacks that this phenomenon may imply for the plant maintenance.



## Seasonal and inter-annual variation in forest flowering and fruiting in a two-decade record from Puerto Rico: Global climate drivers and hurricane effects

JESS K. ZIMMERMAN, J.A. HOGAN, C.J. NYTCH & J. BITHORN



Zimmerman, J.K., J.A. Hogan, C.J. Nytch & J. Bithorn 2016. Seasonal and interannual variation in forest flowering and fruiting in a two-decade record from Puerto Rico: Global climate drivers and hurricane effects. Pp. 32 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. Arquipelago. Life and Marine Sciences. Supplement 9.

Key words: Location: Puerto Rico; Taxa: Angiospermae; Other: El Niño, hurricane, Luquillo, plant reproduction, seasonality, time-series analysis.

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Seasonal and inter-annual fluctuations in global climate are key regulators of reproduction in tropical forests. Global climate phenomena such as El Niño are known to play an important role in regulating inter-annual variation in tropical forest reproduction. We addressed this issue, as well as the long-term influences of severe hurricane disturbances, using trap-based phenology data collected fortnightly from 1993 to 2013 from a hurricane-affected (1989 Hugo, 1998 Georges) subtropical wet forest site in northeastern Puerto Rico. Data were subjected to Seasonal-Trend Decomposition of time series by Loess (STL) and multivariate time series analysis of whole communities and species groups separated by lifeform. STL revealed that flowering and fruiting were seasonal in our ever-wet site. The seasonally de-trended number of species in flower fluctuated over time with no long-term trend while the number of species producing seed varied around a declining trend, one apparently due to the lack of severe hurricane disturbances during the last 15 years of the study. Lagged correlation analyses indicated these patterns were also influenced by Pacific-focused El Niño climate indices as well as Atlantic-oriented indices. Long-term patterns of reproduction in individual lifeforms paralleled the community-wide patterns, with large trees and shrubs exhibiting more sensitivity to hurricane disturbances than small or medium trees. There was no long-term increase in liana or vine reproduction as reported in other neotropical sites. The results confirmed seasonal flowering and fruiting in our ever-wet forest as found in an earlier analysis using only the first 10 years of data. The linkage of inter-annual trends in flowering and fruiting to both Pacific and Atlantic basins, combined with the influence the history of hurricane disturbance, suggests that reproduction in Caribbean mountain forests integrate complex regional and global influences.

## Anticipating effects of climate change in the Hawaiian Islands: Defining plant community and climatic variation across the treeline ecotone

ALISON AINSWORTH & D. R. DRAKE



Ainsworth, A. & D.R. Drake 2016. Anticipating effects of climate change in the Hawaiian Islands: Defining plant community and climatic variation across the treeline ecotone. Pp. 33 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. Arquipélago. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hawaii; *Taxa*: Plants; *Other*: treeline ecotone; climate change; subalpine shrubland; wet forest; Hawaii; plant community.

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Plants within tropical treeline ecotones are theoretically very sensitive to climate variability because this zone represents tree species' altitudinal limits. Mountains on tropical islands may be especially vulnerable to climate change, because tropical high elevation ecosystems are expected to be among the first to experience "novel" climates. Three Hawaiian volcanic mountains support extremely young, isolated, inversion driven treeline ecotones. During the past fifty years, periods of increased temperature and drought associated with more frequent cloud inversion events have occurred, but little is known about how these climatic changes have influenced treeline vegetation. In order to predict future impacts of climate variability on treeline ecotones, we must define the current range of variation within treeline characteristics. Previous studies highlighted an abrupt treeline transition between grasslands and a wet forest on windward Haleakalā, but this unique site does not represent the diversity of treeline ecotones among volcanoes, lava flow ages and types, and regional climatic conditions in Hawaii. We used vegetation data from >100 plots surrounding treelines (1500-2500 m) on Haleakalā, Mauna Loa, and Mauna Kea volcanoes to categorize plant communities. Preliminary analyses suggest that wetter, windward sites have higher elevation, abrupt treeline ecotones between forest and subalpine vegetation compared to drier sites. Treeline indicator species also differ by substrate age and moisture conditions. For example, in the ecotones of drier, older sites on Haleakalā and Mauna Kea, bands of *Sophora chrysophylla* shrubs occur as opposed to the krumholz forms of the islands' dominant forest tree, *Metrosideros polymorpha*, which are found on younger Mauna Loa. Ongoing analyses are identifying habitat specialists at treeline ecotones and testing for additional correlations between environmental drivers (island, climate, soil age, soil type, soil moisture) and treeline structure (basal area, density/abundance, species presence, understory over).

## Peri-urban forest fragments as islands: The response of plants and lichens diversity to habitat fragmentation

LEONARDO ROSATI, G. POTENZA, S. FASCETTI & M. MARIGNANI



Rosati, L., G. Potenza, S. Fascetti & M. Marignani 2016. Peri-urban forest fragments as islands: the response of plants and lichens diversity to habitat fragmentation. Pp. 34 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Italy, Basilicata (Potenza); *Taxa*: vascular plants and lichens; *Other*: multitaxa approach; indicator species; forest management.

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Fragmentation of the natural habitat represents one of the foremost threats to biological diversity. In an archipelago of peri-urban oak woods fragments (*Centaureo-Quercetum pubescentis*), we tested the correlation between richness, diversity and composition of lichens and vascular plants vs size, shape, edge effect and isolation of forest patches. Eleven fragments were randomly sampled using three circular plots of 10 m radius, selected within homogeneous stands for environmental factors (e.g. altitude, aspect, soil) forest structure and management. We collected data on presence and abundance of vascular flora and epiphytic lichens, forest structure and parameters about living and dead wood. Analyses were performed at patch level searching for effects on species richness, life forms, rare and threatened species and community composition. We also investigated which species were the best indicators for habitat fragmentation and evaluated the advantages of conserving several small patches vs few large ones. The correlation between species richness and patch area was positive with a weaker one for vascular plants compared to lichens. In the study area, larger fragments are more isolated, hence the observed isolation effect might be biased. No correlation emerged between species richness and forest structure parameters, whereas we observed a correlation between the presence of stenoecious lichens and basal area and average diameter of the trees; in particular the lichen *Anaptychia ciliaris* was related mainly to the basal area of the plot. Indicator species of the largest fragments are nemoral/stenoecious species (*Lathyrus digitatus*, *Serratula cichoracea*, *Lathyrus jordanii* and *Hypogymnia physodes*, *Degelia plumbea*) while shrub and edge species indicated the smaller ones. Conserve larger patches vs smaller ones is desirable: coherently, the largest fragments host the most abundant remnant populations of *Rhaponticoides centaurium* (Asteraceae) a rare and threatened endemic species of the southern Apennines.

## Cross-taxon and environmental surrogacy of bryophytes and lichens in a natural forest: Implications for conservation

SARA RUAS, A. BERGAMINI, P. CARVALHO, S. FONTINHA, C. LOBO, F. REIS, A. MARTINS & M. SIM-SIM



Ruas, S., A. Bergamini, P. Carvalho, S. Fontinha, C. Lobo, F. Reis, A. Martins & M. Sim-Sim 2016. Cross-taxon and environmental surrogacy of bryophytes and lichens in a natural forest: implications for conservation. Pp. 35-36 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Madeira Island; *Taxa*: bryophytes, lichens; *Other*: cryptogams, hotspots coincidence, environmental surrogacy, species diversity patterns.

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Knowledge on the spatial distribution of biodiversity is essential for its conservation, and even in a small region, biodiversity surrogates are necessary. Here we focused on the diversity patterns of bryophytes and lichens in the laurel forest of Madeira Is. between 300-1300 m a.s.l. We were interested in how far the diversity patterns of these 2 groups overlap and which environmental factors are the main drivers. We surveyed a total of 92 randomly selected plots of 100 m<sup>2</sup>. At each plot, bryophytes and macrolichens were inventoried and environmental variables registered. A total of 197 bryophyte taxa (108 mosses, 89 liverworts) and 104 lichen taxa (68 green-algae lichens, 36 cyanolichens) were identified. Results show that within group surrogates were generally moderately to highly correlated ( $r = 0.62$  for mosses, liverworts,  $r = 0.70$ , lichens with green algae and cyanolichens,  $p < 0.001$  for both), but between group correlations were weaker ( $r = 0.42$  for bryophytes and lichens,  $p < 0.001$ ). Accordingly the coincidence of hotspots was low for bryophyte and lichens. The diversity of all bryophytes and lichens, could be modelled by linear regression considering some variables of which temperature was the most important, the number of threatened bryophyte species was hardly predictable (GLM with Poisson distribution). Niche conservatism may be responsible for the better surrogacy of within-taxon groups than of between-taxon groups. Competitive interactions between lichens and bryophytes may contribute to the weak correlation between the 2 groups. The low predictability of threatened bryophytes may be caused by the high ecological heterogeneity between

the species so that no common species-environment relationships exists and/or by special environmental conditions required by this group, which were not covered by the environmental variables. We conclude that even bryophytes and lichens share a number of characteristics they cannot easily replace each other in biodiversity surveys and act as surrogates.

## Micro-endemism in New Caledonia: Estimating the distribution range of animal species by controlling for sampling effort

MARAM CAESAR, P. GRANDCOLAS & R. PELLENS



Caesar, M., P. Grandcolas & R. Pellens 2016. Micro-endemism in New Caledonia: Estimating the distribution range of animal species by controlling for sampling effort. Pp. 37 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: New Caledonia; *Taxa*: several animals; *Other*: Zoologia Neocaledonica, fauna, sampling effort, distribution area, endemism.

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Islands have always intrigued biologists, due to their remarkable biodiversity. They are considered natural laboratories of evolution and adaptation, because life in isolation has allowed the rise of many innovations. One recurrent particularity of islands is the high number of endemic species. Here we examine this problem in New Caledonia, an island recognized as a biodiversity hotspot with a high level of local microendemism. Our study is aimed at estimating the distribution range of animal species to characterize local microendemism by controlling by differences in sampling effort that could bias this estimation. We based this research on a dataset issued from the series "Zoologia Neocaledonica", a publication from Paris Museum (1988-2014) dedicated to the study of taxonomy of terrestrial and freshwater animals occurring in New Caledonia. We built a database with the geographic occurrences of the 1149 species studied in these publications, and completed the information about their distribution with an exhaustive search in the literature. Then we built minimum convex hulls for each species and calculated the distribution areas. Five potential variables were used to control for the role of sampling effect on the distribution range: sampling date, number of collectors, number of points sampled by the species' collectors, area of the polygon prospected by the species' collectors, and the distance to the nearest road. Species' distribution range varies from near 1 km<sup>2</sup> to around 12.000 km<sup>2</sup>. But more than 80% of the species studied have distribution ranges smaller than 3.000 km<sup>2</sup>, and half of this total were sampled enough to be considered as short-range endemics which means that potentially 80% of animal species are micro-endemics. Roads were considered an important factor biasing the sampling of species distribution within the island, and the lack of samples in areas far from roads are probably impacting the present estimates of distribution range.

## Linking soil biogeochemistry and plant-plant interactions during long-term succession: Evidence from six islands with soils derived from distinct parent material

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Alfaro, F.D., S.R. Abades, H. Villca, F.I. Pugnaire, A. Gaxiola & P.A. Marquet 2016. Linking soil biogeochemistry and plant-plant interactions during long-term succession: Evidence from six islands with soils derived from distinct parent material. Pp. 38-39 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Uyuni salt flat, Central Andean Puna, Bolivia (20°10 S; 67°38 W); *Taxa*: plants; *Other*: facilitation, soil development, ecological interactions, annual plants.

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1. The net effect of plant-plant interactions on plant communities is strongly dependent on resource supply and environmental conditions (e.g. soil pH). In turn, soil biogeochemical gradients of resource availability during long-term succession could affect plant communities by filtering species along the different age stages, or by modifying directly the strength of plant interactions. However, there have been few attempts to assess the relative importance of ecological interactions on plant community structure along biogeochemical gradients during long-term successions. 2. To assess the relative importance of plant-plant interactions on annual plant community structure, we conducted an observational study in six islands located in the Andean Dry Puna of Bolivia. We hypothesized that an enhancement in soil conditions while soil develops, such as increases in soil nitrogen and decline in pH, could reduce the intensity of positive interactions on annual plant diversity and biomass. 3. To assess the effect of intensity of plant-plant interactions on species richness and biomass of annual plants we used the Relative Interaction Index (RII). For this, we recorded the biomass and the diversity of annual plants beneath and surrounding individuals of the two dominant shrub species, *Atriplex imbricata* and *Baccharis* sp., along a soil age gradient. We selected these shrubs because both species accounted for about 50% of total plant cover in the study area. 4. Contrary to our predictions



and to previous studies on plant facilitation, we found that shrub facilitation increased during succession, as soil conditions turned favorable to plant growth. Soil pH declined along the successional gradient and biomass of annual plants beneath shrubs was higher than the biomass in open soils. Moreover, the importance and intensity of facilitation was higher in volcanic islands than in the sedimentary ones. Surprisingly, the RII index of the richness of annual species was close to zero in all stages of succession and in all islands. 5. Our study is the first to show the collapse of facilitation upon small spatial scales, and highlight the importance of soil pH on annual plant productivity during a long-term succession.

## Geochemical islands: Promised Land or unintended refuge?

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Serrano, H.C., M.A. Martins-Loução & C. Branquinho 2016. Geochemical islands: Promised land or unintended refuge?. Pp. 40 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Portugal, SW coast; *Taxa*: *Plantago almogravensis* Franco; *Other*: aluminium, cover, niche, physiology, terrestrial Island.

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Terrestrial ecological islands are habitats separated from contiguous areas, the matrix, not necessarily by water but (e.g.) by geographic or geochemical abnormalities. In these habitats we observe a dramatic shift in plant species composition and/or physiology, which endures in time as long as the character of the "island" is maintained. Are the species found in such islands present due to a preference for the habitat or simply unable to thrive elsewhere?. To answer this question we studied the plant cover and physiology of a rare endemic species from a geochemical island habitat. Within a matrix of sandy podzolic soil erosion and geological processes we have uncovered patches of the soil B-horizon, creating superficial hardpan areas rich in iron and toxic aluminium. These metalliferous areas are identified by permanent gaps within the, otherwise, dense sclerophyllous shrub cover of the soil matrix. The rare endemic *Plantago almogravensis* is a species mostly found on these gaps. To better define the ecological island habitat we measured edaphic variables (e.g. chemical composition, moisture, depth) and biotic variables (e.g. abundance, richness, activity) related to soil microorganisms and plants. We then measured the carbon isotopic composition of *Plantago* sp. leaves as a proxy for the physiological performance of this plant; and its abundance (percentage cover) representing its ecological performance or realized niche. We show that for this *Plantago* sp. abundance is not a synonym of physiological fitness, thus its realized niche could expand outside the geochemical island if other factors were not pushing the species to that niche. The geochemical island is an escape area from competition, for this rare species. We suggest some conservation measures in accordance to our findings.

## Where is iodine? Seeking iodine bioavailability in the Azores

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Garcia, P.V., D.P.S. Linhares, A. Almada, T. Ferreira, G. Queiroz, J.V.C. Cruz & A.S. Rodrigues 2016. Where is iodine? Seeking iodine bioavailability in the Azores. Pp. 41 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: -; *Other*: iodine, environmental availability, human intake, oceanic islands.

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**Background:** Inadequate intake of iodine leads to insufficient production of thyroid hormones, which adversely affects the developing brain resulting in the disease states collectively known as Iodine Deficiency Disorders. Although the association between ocean proximity and iodine environmental availability is well recognized, recent studies have revealed an inadequate iodine intake in the Azorean islands. **Objectives:** We investigated the possible underlying causes of iodine environmental availability in these oceanic islands and its association with iodine intake in schoolchildren. **Methods:** Iodine concentration in soil and grass pasture was measured by INAA and in drinking water by spectrophotometry. Urinary iodine concentration (UIC) in schoolchildren was assessed by ICP-MS in a randomized crosssectional survey with 315 participants from S. Miguel (study group) and Sta. Maria islands (reference group). A validated diet questionnaire assessing sources of iodine was recorded. Data were analyzed with logistic regression models, adjusting for confounding factors (age, residence time, dairy products and meat consumption). **Results:** The iodine concentration in reference soils was significantly higher than in the study group (58.1 ppm vs. 14.5 ppm, respectively;  $p=0.001$ ). Similarly, the schoolchildren with inadequate UIC was significantly higher in the study group than in the reference one (63.0% vs. 37.8%, respectively;  $p<0.001$ ). Chronic exposure to low iodine bioavailability was significantly associated to the exacerbation in iodine deficiency severity, with a 4.9-fold increased risk in the study group. **Conclusions:** The differences observed in the studied islands are related with each island geomorphology (soil properties and orography) and climate, which can promote or inhibit iodine environmental availability, contributing distinctively to iodine bioavailability and human intake.

## The microbiological toolbox: Assessing soil health in metal polluted agricultural volcanic soils

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Parelho, C., A.S. Rodrigues, M.C. Barreto, N.G.C. Ferreira & P.V. Garcia 2016. The microbiological toolbox: Assessing soil health in metal polluted agricultural volcanic soils. Pp. 42-43 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

**Key words:** *Location:* Picos fissural volcanic system, São Miguel Island, Azores; *Taxa:* bacteria; fungi; *Other:* soil enzyme activities, soil microbial activities, andosols, trace metal, integrative biological response.

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The adaptive character of soil microbial communities to metal pollution allows discriminating soil health, since changes in microbial populations and activities may function as excellent indicators of soil metal pollution. Volcanic soils are unique naturally fertile resources, extensively used for agricultural purposes and with particular physicochemical properties that may result in possible accumulation of toxic substances, such as trace metals. The aim of this study is to assess functional diversity of soil microbial communities in volcanic soils under different agricultural land use practices (conventional, traditional and organic), based on a three-tier approach: Tier 1 – assess soil microbial activities [microbial biomass carbon, basal soil respiration, metabolic quotient, enzymatic activities ( $\beta$ -glucosidase, acid phosphatase and dehydrogenase) and RNA to DNA ratio), Tier 2 – link the microbial activity to soil trace metal contamination and, Tier 3 – integrate the microbial activity in an effect-based soil index (Integrative Biological Response) to score soil health status in metal contaminated agricultural soils. Results showed that different agricultural practices in Andosols affected the soil microbial activities by decreasing the abundance of microbial biomass and enzyme activities of microorganisms involved in organic matter decomposition and nutrient cycling, regardless of soil microbial maintenance energy requirements (metabolic quotient) being similar to that of reference soils. The Integrative Biological Response values indicated that soil health was ranked as: organic (4.96) > traditional (12.94) > conventional (17.28) (the higher the value, the worse

the soil health status), highlighting the importance of integrative biomarker-based strategies for the development of the trace metal “footprint” in Andosols. The observed pattern of soil microbial responses reflects the disturbance and stress that agricultural practices cause, as a result of the progressive accumulation of trace metals in soil matrix and the decrease of soil organic matter quantity and quality in the studied farming systems.

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## CONTRIBUTED TALKS

### CT 4. Conservation

DOMINIQUE STRASBERG & MARIA TERESA FERREIRA



*Pyrrhula murina* Godman, 1866, an excellent example of successful conservation in Azores. (Photo: Paulo A. V. Borges)



## Biodiversity conservation in the Socotra Archipelago: Current challenges and future prospects

KAY VAN DAMME, U. ZAJONZ, A. BENSADA & E. ZANDRI



Van Damme, K., U. Zajonz, A. Bensada & E. Zandri 2016. Biodiversity conservation in the Socotra Archipelago: Current challenges and future prospects. Pp. 46 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: Location: Socotra Archipelago, Western Indian Ocean, Yemen; Taxa: all; Other: biodiversity conservation and protected area management, invasive alien species, sustainable land management, knowledge management, traditional management practices.

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The Socotra Archipelago (Yemen) in the Western Indian Ocean, is the only insular UNESCO Natural World Heritage Site in the Arab Region. Socotra is an ancient continental archipelago of Gondwanan origin with a diverse topography, composed of four main islands. It is known for its high biodiversity and endemism in the terrestrial realm and its high biodiversity, biological productivity and unique assemblage compositions in the marine realm. Maintained for centuries through traditional management (pastoralism and fisheries), no extinctions in plants, reptiles, land molluscs or birds have been recorded since the beginning of faunistic and botanical research on Socotra. However, challenges to the biodiversity have increased rapidly during the last decades. Newly arising impacts on the ecosystems include an accelerated erosion of cultural practices and unsustainable development, resulting in habitat fragmentation and -degradation. Recent climatic (cyclones) and political events (war in Yemen) now pose additional challenges to the Socotran ecosystems and biodiversity conservation management. To counter the main triggers of biodiversity and ecosystem decline on Socotra, a new UNEP/GEF project has been designed and approved to strengthen local conservation capacity and to increase the resilience of the unique Socotran ecosystems against arising challenges. Main components of the project include twinned/combined strategic-applied approaches to increase the management of (1) biodiversity and protected areas, (2) invasive alien species, (3) land use and soil erosion, while at the same time (4) building local governance capacities, strengthening cross-sectoral management frameworks, (5) improving knowledge- and data management, (6) revitalizing traditional resource management practices, and (7) establishing sustainable financial mechanisms for conservation. It is our hope that, through this work, the unique ecosystems of Socotra, as well as part of the Socotri culture, have a better chance of surviving current and future threats, thereby remaining an important part of the rich cultural and natural heritage of the Arab Region. The outcomes will be useful for island biodiversity conservation and sustainable development around the globe.

## Effects of climate change on the distribution of indigenous species in oceanic islands (Azores)

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Ferreira, M.T., P. Cardoso, P.A.V. Borges, R. Gabriel, E.B. Azevedo, F. Reis, M.B. Araújo & R.B. Elias 2016. Effects of climate change on the distribution of indigenous species in oceanic islands (Azores). Pp. 47 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: Location: Azores; Taxa: Bryophytes, Vascular Plants, Arthropods; Other: climate change, oceanic islands, ensemble modelling, species distribution.

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Oceanic islands host a high proportion of the world's endemic species. Many such species are at risk of extinction owing to habitat degradation and loss, biological invasions and other threats, but little is known about the effects of climate change on island native biodiversity. The Azorean archipelago provides a unique opportunity to study species-climate-change relationships. We used ensemble forecasting to evaluate the current and future distribution of well-studied endemic and native bryophytes (19 species), endemic vascular plants (59 species) and endemic arthropods (128 species), for two of the largest Azorean Islands, Terceira and São Miguel. Using a Regional Climate Model (CIELO), and assuming the extreme scenario RCP8.5, we examined changes in the potential distributions of the species and possible loss of climate space for them. Models projected that 23 species (11%) could lose all adequate climate on either one or both islands. Five additional species were projected to lose  $\geq 90\%$  of climate space. In total, 90% of the species were projected to lose climate space: 79% of bryophytes, 93% of vascular plants and 91% of arthropods. We also found for vascular plants and arthropods a tendency for upward shift in altitude in their suitable climate space, while for bryophytes the shift was towards the coastal areas. Our results have profound implications for future conservation priorities on islands, such as for the redrawing of conservation borders of current protected areas.

## Connecting pristine forest areas to face climate change effects under high uncertainty: A case study with arthropods in Terceira Island

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Aparício, B.A., J. Cascalho, M.J. Cruz, P.A.V. Borges & F. Ascensão 2016. Connecting pristine forest areas to face climate change effects under high uncertainty: A case study with arthropods in Terceira Island. Pp. 48-49 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Terceira Island, Azores; *Taxa*: Insecta; *Other*: climate change adaptation, connectivity, corridor design, landscape management, individual-based model, island ecology.

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Biodiversity is under unprecedented pressure due to multiple anthropogenic threats worldwide, including habitat loss and fragmentation. Conversely, current conservation efforts generally do not seem to produce the expected outcomes. As a result, we are facing a massive extinction process. Furthermore, climate change is posing an extra and critical pressure in the natural systems, forcing species to adapt or to perish. One adaptation strategy is poleward migration, accompanying the shift of species' optimal climate conditions. However, this range shift can be quite challenging in islands, not only due to the competing interest between humans and nature for the limited available land (e.g., habitat corridor vs. agriculture areas) but also because the optimal conditions may cease to exist within the island area in the near future. Therefore, it is critical to select key corridor areas linking high quality habitat, in order to ensure the migration of organisms while maintaining metapopulation integrity. Nonetheless, the creation of such corridors can be complex and resource consuming. Moreover, there is often an enormous lack of knowledge regarding species' movement preferences, which further increases the uncertainty about where to maintain/restore the functional connectivity to enhance species dispersal capacity. Here, we developed a framework to face such uncertainty using agent-based modelling and applied it in the Terceira Island, Azores, for five endemic ground-dwelling Azorean insect species. Our model framework first feeds on expert knowledge regarding land covers

resistance to movement, and then tries to refine such prior knowledge by testing and comparing the outputs using variations in resistance scores with known occupancy patterns. Using this approach, we were able to identify for the five species crucial areas for species movement, to evaluate the dispersal opportunities given the current land-uses, and evaluate species' vulnerability to climate change effects. Based on our results, we further identified key areas for our focal species.

## Susceptibility to climate change by the laurel forests of Madeira Island: How changes on suitable area might promote floristic adjustments

ALBANO FIGUEIREDO & M.M. SEQUEIRA



Figueiredo A. & M.M. Sequeira 2016. Susceptibility to climate change by the laurel forests of Madeira Island: How changes on suitable area might promote floristic adjustments. Pp. 50 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Madeira Island; *Taxa*: all; *Other*: niche modelling, climatic scenarios, species response, upward shift.

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Two different types of laurel forest are distinguished on Madeira Island: a mediterranean (*Semele androgynae* - *Apollonietum barbujae*), associated to infra to thermomediterranean sub-humid to humid conditions, and a temperate type (*Clethro arboreae* - *Ocoteetum foetentis*), linked to infra to mesotemperate conditions on humid to hyper-humid areas. Since a significant number of services is provided by such forests, this work aims to evaluate how susceptible are current forests to loss of suitable area as a potential impact from climate change, and how species response to such type of environmental change might promote an adjustment on the floristic composition of such forests. The assessment is supported on niche-based modelling of correlative nature for two climatic scenarios (SRES A2 and B2) for the timeline 2070-2099. Occurrence data for calibration/evaluation purposes results from an extensive survey focused on species that are accepted as characteristic or having a structural importance for the community. Predictions for suitable area for the community level result from the weighted combination of models obtained on a first stage for each of the selected species. Models produced for each species are based on ensemble forecasting procedures supported on different modelling techniques and calibration parameters. Considering the potential area of distribution for current climatic conditions, the occupancy area already exhibits a significant contraction. The results also show differences on the magnitude and patterns of change on suitable areas in response to changes on climate conditions by the different species considered. Such result supports the idea that an adjustment on the floristic composition of such forests might occur. Considering the scale of the community, loss of suitable area is projected at lower altitudes, especially under the scenario A2, while an expansion to higher altitudes is expected. But such dynamics might be biased by the availability of habitat - concerning land-use dynamics, or the availability of propagule sources; drivers which influence those are also discussed.

## Conserving native insect communities on islands: Insights from management projects in Hawaii

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Krushelnycky, P.D., K. Kawelo, S. Plentovich, C. King, L. Young & D.R. Drake 2016. Conserving native insect communities on islands: Insights from management projects in Hawaii. Pp. 51 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Hawaii; *Taxa*: insects, arthropods; *Other*: insect conservation, biodiversity, islands.

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It is not always obvious which conservation actions will most effectively maximize the retention or recovery of species diversity in insular insect communities. Insect populations are strongly influenced by both bottom-up and top-down trophic forces, in addition to abiotic constraints. As a result, various management strategies that enhance resources or suppress invasive predators, such as weed control, native plant restoration, and social insect or rodent control, have the potential to benefit large numbers of native insect species. However, the actual or expected benefits of such actions, and the degree to which they vary, is not well characterized. Assessment of six Hawaiian sites invaded by ants suggests that complete eradication of ants may result in widely different degrees of recovery in native insect diversity, from little benefit up to a doubling of mean native species richness. Similarly, intensive rat trapping at two sites resulted in substantial variation in the magnitude of insect richness recovery, both among sites and microhabitats. The magnitude of recovery from rat trapping tended to be lower than that expected to result from the most effective ant eradication scenarios. Monitoring of plant and insect communities in two natural areas also yielded contrasting implications of the potential benefits of plant restoration. At one site, insect richness was strongly positively correlated with native composition of the plant community, and suggested that complete removal of alien plants might result in an approximate doubling of mean native insect richness. This pattern was absent, however, at a second site that supported very low native insect diversity. Together, these examples reveal strong context-dependency in the expected benefits of broad-scale management actions for insect community conservation. Similar monitoring in a wide range of situations is needed to characterize the factors responsible for variation in outcomes, and to develop better predictive capacity for insect community conservation.



## Galapagos giant tortoises and farmers: Coexistence or conflict?

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Camperio-Ciani, G., F. Benitez-Capistros, J. Hugé, F. Dahdouh-Guebas & N. Koedam 2016. Galapagos giant tortoises and farmers: Coexistence or conflict?. Pp. 52 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Santa Cruz Island, Galapagos archipelago, Ecuador; *Taxa*: *Chelonoidis porteri*, *Chelonoidis donfaustoi*, *Homo sapiens*; *Other*: conservation conflicts, participatory rural appraisal, human-wildlife interaction, giant tortoise, human perception, protected areas.

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Human population growth and the consequent land use around protected areas set the scene for human-wildlife interactions. Outside protected boundaries wildlife is forced into human occupied areas (once wildlife habitat), using this space for both shelter and food. As a reaction, humans can take actions to protect their lives and livelihood against the trespassing wildlife. If not properly managed this can lead to a human-wildlife conflict. The Galapagos National Park entirely surrounds human settlements in the inhabited islands of the archipelago. In Santa Cruz Island the migratory routes of giant tortoises cross the National Park border and enter the rural area. In order to study the human-tortoise interactions we gathered information on the perception and the attitudinal factors of the farmers of Santa Cruz (357 censused by the Ecuadorian government), along with the ecological and the environmental factors that are involved in the interaction. We used a combination of semi-structured interviews ( $N = 18$ ) and questionnaires ( $N = 102$ ), framed in a Participatory Rural Appraisal (PRA) approach. This methodology was the base concept to understand farmers' perceptions towards giant tortoise presence in the rural area. Although a negative perception towards giant tortoises was not predominant in the sample population, farmers protected their crops with actions against giant tortoises, the most common being the construction of fences. Fences are predicted to increase with the intended agricultural development. As a consequence, tortoise migratory routes and their undisputable role as ecological keystone species could be further disrupted causing a cascading effect that could jeopardize their ecosystem function in the Island. We suggest that an agricultural implementation in the island should take into account both tortoises migratory routes and farmers perspective, in order to avoid a negative impact of wildlife on the goals of humans and a negative impact of these on wildlife needs.

## First revision of the current status of seahorses (Syngnathidae) and their distribution throughout the Macaronesia (NE Atlantic)

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AZEVEDO, W.V. HOLT & R. HAROUN



Otero-Ferrer, F.J., J.A. González, M. Freitas, R. Araújo, J.M.N. Azevedo, W.V. Holt & R. Haroun 2016. First revision of the current status of seahorses (Syngnathidae) and their distribution throughout the Macaronesia (NE Atlantic). Pp. 53-54 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores, Madeira, Canaries (Macaronesia); *Taxa*: Actinopterygii, Syngnathiformes, Syngnathidae, *Hippocampus* spp.; *Other*: biodiversity management, Macaronesian Islands, marine conservation, morphology, NE Atlantic.

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The seahorse populations have suffered a worldwide progressive declining trend in the last decades. The knowledge about these fishes in the Macaronesian region is scarce and scattered, and most of available information comes from local collections without clear taxonomic accuracy. This study represents the first revision of the current status of seahorses and their distribution in the Macaronesian archipelagos, based on general reports on fish community assemblages, specific assessments and overall data obtained from preserved specimens held in various museums and universities collections along the Macaronesia region. These reports have confirmed the presence of one main species throughout the region, the European short-snouted seahorse *Hippocampus hippocampus*. Occasionally, two other species were also recorded, with one specimen of *H. erectus* caught in the Azores in 2004, and two individuals of *H. algiricus* observed in the Canary Islands in 2009-2010. The latter species are sighted in the Caribbean and West African coasts respectively, and their Macaronesian records may represent, till now, isolated dispersal events related to the particular oceanographic characteristics of this Atlantic area. Additionally, the unique seahorse assessment,



made in Gran Canaria Island, showed that wild populations of *H. hippocampus* occur at low abundances compared to other areas of its geographical distribution, and their structure and demography is conditioned by the environmental conditions of studied site. Nowadays, the information concerning seahorse wild stocks in Macaronesia is insufficient to make an assessment of their risk of extinction based on their distribution and population status. However, some of the main species recorded are heavily traded in nearest African coasts, and therefore its monitoring could guide future conservation actions and would benefit related species sharing their habitats and ecosystems. The study of seahorses could also reflect habitat loss cues, biological invasions, human introductions or global climate change effect all over these islands.

## Movement and activity drivers of an ecosystem engineer: The giant Aldabra tortoise (*Aldabrachelys gigantea*) on Aldabra Atoll

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FLEISCHER-DOGLEY, N. BUNBURY, W. FALCÓN & D.M. HANSEN



Baxter, R., G. Schaepman-Strub, A. Ozgul, E. Postma, L.A. Turnbull, F. Fleischer-Dogley, N. Bunbury, W. Falcón & D.M. Hansen 2016. Movement and activity drivers of an ecosystem engineer: The giant Aldabra tortoise (*Aldabrachelys gigantea*) on Aldabra Atoll. Pp. 55 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Aldabra, Seychelles; *Taxa*: Chelonian, *Aldabrachelys gigantea*; *Other*: movement ecology, habitat, tortoise, home range, climate change, thermoregulation.

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Climate change is changing the shape of landscapes across the globe. How this impacts terrestrial animals, especially ectotherms, will depend on their physiological sensitivity. For animals that act as ecosystem engineers, their response to climate change will have wide-ranging direct and indirect effects on both habitat and ecosystem structure. On islands, tortoises often are ecosystem engineers, and may be especially vulnerable to climate change, as their basic life history traits are strongly related to ambient temperature. Understanding the response of tortoises to ongoing and projected climate change will help inform efficient management policy of the species and its ecosystem. Our study focuses on three ecological research aspects of an ecosystem engineer, the giant Aldabra tortoise (*Aldabrachelys gigantea*) on Aldabra Atoll. We report results of a long-term movement ecology study evaluating the spatial behaviour of these tortoises. Specifically, we examine tortoise home range size, migration, and activity patterns from fine-scale data. Overall, spatial behaviour reflected interactions between internal and external factors. First and foremost, we found unexpectedly large differences in movement patterns between individuals and within individuals between years. Additionally, there were differences between sexes, between dry and wet seasons, and across regions of the atoll. The variation observed across the atoll may be due to spatial and temporal changes in resource availability at the landscape level. Our study provides valuable insight to understand and predict the role of these ecosystem engineers on their native atoll, as well as on other Indian Ocean islands that use these tortoises as functional substitutes in rewilding projects.

## Comparing trace metal content in *Pachygrapsus marmoratus* from sites with different land uses and environmental attributes

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Álvaro, N.V., J.M.N. Azevedo, A.S. Rodrigues & A.I. Neto 2016. Comparing trace metal content in *Pachygrapsus marmoratus* from sites with different land uses and environmental attributes. Pp. 56 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Azores; *Taxa*: Crustacea, Malacostraca, Decapoda; *Other*: heavy metals, volcanic islands, decapods, indicators, coastal areas.

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Volcanically active sites have a different heavy metal footprint from agriculture soils and both differ from urban centres. Different animal species absorb heavy metals differently according to their feeding behaviour and physiology. Therefore, some species have been used in biomonitoring programs for the identification of disturbed areas, based on their capability to accumulate heavy metals. The present study investigates the potential of *Pachygrapsus marmoratus*, a small crab abundant in the Azores intertidal, as an indicator of the presence of heavy metals in Azorean coastal environments, comparing hydrothermal vent locations, urban centres and locations adjacent to agricultural activity. Specimens were collected in the same period and had their hepatopancreas removed, dried and analysed for heavy metals. Results revealed differences in concentration of the studied elements between all sampling sites. Fe, Cu, Mn, Zn and Cd were the metals responsible for separating the various sites. The concentration levels of the heavy metals recorded in the present study reflects their environmental availability. This, associated to the abundance of *P. marmoratus* on the Azores shores and to the fact that these animals are easy to capture and handle, makes this species a potential bioindicator for heavy metal concentration in Azorean coastal areas, both humanized and naturally disturbed.

## Landscape structure influences within-island gene flow in a forest specialist bird species

AURÉLIE KHIMOUN, N. NAVARRO, B. FAIVRE & S. GARNIER



Khimoun, A., N. Navarro, B. Faivre & S. Garnier 2016. Landscape structure influences within-island gene flow in a forest specialist bird species. Pp. 57 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Guadeloupe, Lesser Antilles; *Taxa*: birds, plumbeous warbler *Setophaga plumbea*; *Other*: forest fragmentation, genetic diversity, landscape connectivity, conservation genetics.

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Habitat fragmentation is a severe threat to biodiversity as it may reduce local population size and connectivity, leading to higher genetic drift and decreased gene flow. Reduced within-population genetic diversity and increased genetic structure among previously connected populations are then expected, with ultimate modifications of species evolutionary trajectory and potential local extinctions. Thus, understanding how landscape structure influences individual dispersal and gene flow between populations is a crucial step to infer consequences of fragmentation and ultimately to propose guidelines for land settlement. We used a landscape genetic approach, where patterns of genetic connectivity were correlated with landscape features by building resistance surfaces assigning different resistance-to-movement values to different landscape features. We focused on a forest specialist bird species, the Plumbeous Warbler, which is endemic from the Guadeloupe and Dominica islands. We followed an approach of model optimization to infer how land cover types (*i.e.* forest, urbanized or agricultural surfaces, etc.) may constrain /promote gene flow in Guadeloupe. Landscape functional connectivity was assessed from microsatellite data and two different ecological distances were computed to describe the landscape structural connectivity. Genetic data revealed significant genetic structure both between and within the two parts of the island. Least-cost and resistance distances better described the genetic structure than the Euclidian distance, attesting for the effect of landscape structure on gene flow. Regarding the resistance values of the different land cover classes, both distances provided equivalent results with lowest resistance values attributed to the forest, agriculture and water surfaces, the highest resistance values attributed to pastures and urban areas (open areas) and intermediate resistance values attributed to banana and sugar cane crops. The optimized landscape resistance surface revealed that the Isthmus connecting Basse-Terre and Grande-Terre as well as the surrounding of Pointe-à-Pitre constitute a relatively strong barrier to gene flow in the Plumbeous Warbler.

# Land use and land cover assessment by using high resolution satellite imagery and landscape metrics: The Terceira Island (Azores) case-study

RITA GODINHO, P.A.V. BORGES, H. CALADO & R. B. ELIAS



Godinho, R., P.A.V. Borges, H. Calado & R.B. Elias 2016. Land use and land cover assessment by using high resolution satellite imagery and landscape metrics: The Terceira Island (Azores) case-study. Pp. 58 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Terceira Island, Azores; *Taxa*: plants; *Other*: biodiversity, native vegetation species, alien vegetation species, Rapideye, land use and land cover mapping, spectral signatures.

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The indigenous flora existing in the Archipelago of the Azores (Portugal) composes the base of some very valuable and vulnerable land ecosystems. One example is the Azorean Natural Forest, which also supports an important range of endemic species. The presence of some very aggressive invasive species can cause serious damage on these ecosystems. Their direct competition with native species results in the decline of native species and protected ecosystem degradation. The aim of this paper is to assess the effect of using different land use and land cover (LULC) maps in the calculation of landscape metrics and indexes that present correlation to habitat quality and biodiversity in Terceira Island. Seven landscape metrics and indexes as well as different LULC mapping legends were used and special attention was given to the effects that the different sources of information (thematic maps and high resolution multispectral Rapideye satellite imagery) and the spatial resolutions might have on the use of the LULC maps as monitoring tools for these areas. Simplifications of the thematic maps generated by different classification methods are needed to reduce artefacts generated in the classification, like the salt and pepper effect that can have a great impact in the results. The association of the data generated by the landscape metrics and indexes extracted from the different LULC thematic maps with data related to habitat quality and biodiversity can be a method to define the ideal classification function to be applied to the satellite imagery and the level of simplification to be applied to the resultant LULC map in order to establish the highest possible correlation and to make possible to ensure that the selected LULC map has the specifications needed to constitute the base of a monitoring system.

## Social aspects to successful island conservation: Lessons from the proposed rodent eradication on Lord Howe Island

IAN HUTTON, D. KELLY, C. MURRAY & L. BRICE



Hutton, I., D. Kelly, C. Murray & L. Brice 2016. Social aspects to successful island conservation: Lessons from the proposed rodent eradication on Lord Howe Island. Pp. 59 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Terceira Island, Azores; *Taxa*: plants; *Other*: biodiversity, native vegetation species, alien vegetation species, Rapideye, land use and land cover mapping, spectral signatures.

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Islands support some of the world's most remarkable ecosystems. They are also extremely vulnerable to disturbance from human activities and from introduced plants, animals and disease. Once disturbed, island ecosystems are easily destroyed and may be very difficult to rehabilitate. For these reasons the IUCN has long accorded to islands a high priority for conservation action. Eradication of feral animals from islands began as early as 1925, but accelerated in the 1980's, led by developments in New Zealand to preserve endangered bird species on predator-free offshore island arks. Large animals such as goats, pigs or cats are relatively easy to eradicate from islands because of their size and limited numbers. Rodents are much harder to eradicate, being smaller, nocturnal, numerous, wily and requiring the application of poisons. To 2014 over 400 islands around the world have been successfully treated to remove rodents. This has involved a range of techniques from hand baiting to aerial bait dropping, or a combination of both. However, these target islands have mostly been uninhabited. Where humans have been present they have been scientists, eradication workers, itinerant fishermen or mutton birders, or private tourist resort island staff. Islands with permanent human communities require special consideration when planning conservation programs. Lord Howe Island has a well-established community of around 360, some with a family presence for six generations, and a well developed tourist industry. The delivery of the proposal to eradicate rodents from Lord Howe Island to the community has shown that the social factors are just as important as technical the aspects of an eradication plan if it is to be successful. Here we give the background to why this is so, and a roadmap to include the social factors for success in island eradication programs, or indeed any island conservation program.

Island Biology 2016  
2nd International Conference on Island Evolution, Ecology and Conservation



## CONTRIBUTED TALKS

### CT 5. Biogeography

JOSÉ MARÍA FERNÁNDEZ-PALACIOS & KEVIN BURNS



Pico island seen from Faial island (Azores) (Photo:Paulo A. V. Borges)

## Complex interactions between ecological, evolutionary, and environmental processes explain island biodiversity dynamics

JULIANO SARMENTO CABRAL, K. WIEGAND & H. KREFT



Cabral, J.S., K. Wiegand & H. Kreft 2016. Complex interactions between ecological, evolutionary, and environmental processes explain island biodiversity dynamics. Pp. 62-63 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: hypothetical oceanic islands; *Taxa*: hypothetical plants; *Other*: demography, interspecific competition, island biogeography, metabolic theory, process-based niche model, speciation.

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How biodiversity dynamics occur over spatiotemporal scales is central to ecology and biogeography. However, multiple processes affect biodiversity at different scales and levels of ecological organization. Hence, understanding biodiversity dynamics requires integration of these underlying, interacting processes. Therefore, we present a spatially-explicit, process-based model that integrates key ecological, evolutionary, and environmental processes in a pattern-oriented framework to evaluate the relative roles of these processes on biodiversity dynamics. For this purpose, terrestrial plants and oceanic islands served as ideal model systems. The model is stochastic, grid-based, and integrates ecological (metabolic constraints, demography, and competition), evolutionary (mutation and speciation), and environmental (geo-climatic dynamics) processes. We used the full model to assess emerging patterns across spatiotemporal scales and organizational levels (populations, species, communities, and assemblages), switching off processes to assess their relative importance, hypothesizing that: 1) competition is necessary for realistic population and range dynamics; 2) metabolic constraints are necessary for patterns of endemism and community composition; 3) environmental dynamics, and 4) speciation for biogeographical patterns. The full model generated multiple patterns matching empirical and theoretical expectations. For example, populations were largest on young, species-poor islands. Species, particularly endemics, were better able to fill their potential range on small, species-poor islands. Richness gradients peaked at mid-elevations.

Proportion of endemics was highest on old, large, and isolated environments within the islands. Species and trait richness showed unimodal temporal trends. Switching off processes affected these patterns, supporting most of the hypotheses. The integration of ecological, evolutionary, and environmental processes is essential to simultaneously generate realistic spatiotemporal dynamics at population, species, community, and assemblage-level. Additionally, large-scale biodiversity dynamics emerged directly from biological processes, making mechanistic models valuable ‘virtual field stations’ connecting biogeographical and ecological theories.

## A theory of island biogeography for exotic species

KEVIN C. BURNS



Burns, K.C. 2016. A theory of island biogeography for exotic species. Pp. 64 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: New Zealand; *Taxa*: plants; *Other*: biological invasions, species diversity, turnover.

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The theory of island biogeography has played a pivotal role in the way ecologists view communities. However, it does not account for exotic species explicitly, which limits its use as a conservation tool. Here, I present the results of a long-term study of plant communities inhabiting an archipelago of small islands off the coast of New Zealand and derive a modified version of the theory of island biogeography to predict differences in the turnover and diversity of native and exotic species. Empirical results showed that while species richness of both native and exotic plant species increased with island area, native species consistently outnumbered exotic species. Species turnover increased with species richness in both groups. However, opposite to species-area patterns, turnover increased more rapidly with species richness in exotic species. Empirical results were consistent with the modified version of the theory of island biogeography, which distinguishes exotic species from native species by decoupling extinction rates of exotic species from island area, because they are represented by only small populations at the initial stages of invasion. Overall results illustrate how the theory of island biogeography can be modified to reflect the dynamics of exotic species as they invade archipelagos, expanding its use as a conservation tool.

## More than calibrating the tree: In search of fossils for deciphering the history of New Caledonian biota

PHILIPPE GRANDCOLAS, A. NEL, P. MAURIZOT, N. FOLCHER, D. CLUZEL,  
J. MUNZINGER, P.P. LOWRY ET AL.



Grandcolas, P., A. Nel, P. Maurizot, N. Folcher, D. Cluzel, J. Munzinger, P.P. Lowry, A.B. Leslie, D. Cantrill, H. Jourdan & R. Garrouste 2016. More than calibrating the tree: In search of fossils for deciphering the history of New Caledonian biota. Pp. 65 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: New Caledonia; *Taxa*: plants; *Other*: fossils, biogeography, paleontology, dispersal.

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New Caledonia is the oldest oceanic island in the world. The biogeographic studies on the origin of the island biota recently shifted from an “all-Gondwanan” paradigm toward a more balanced view, taking into account the submergence tectonic events that occurred in Paleocene and Eocene. Many molecular regional studies have now been conducted and they proposed dating for dispersals to New Caledonia and local diversifications. However, to complement these molecular studies, we strongly need paleontological studies to document in parallel the state and the becoming of New Caledonian biota at different periods. Until now, fossil data were very scarce if not totally lacking in New Caledonia and we then extensively sampled different rock beds from Cretaceous to Miocene with the hope to detect informative fossil remains. We succeed in finding rich and easily workable fossils, from before and after the island Eocene submersion. These findings open an avenue for a better understanding of the dynamics of biodiversity evolution on the island. From now, we can already state that the island biota comprise a diversity of flowering plants in the Cretaceous, that is not necessarily expected at such an early time and that the Miocene biota comprise taxa both related and unrelated to the modern ones.

# Islands, Pleistocene climate change, and connectivity help to better understand current plant distributions

HENRY HOOGHIEMSTRA, S. G.A. FLANTUA, R.G. BOGOTÁ-ANGEL, M. H.M. GROOT, Z. GONZÁLEZ-CARRANZA, J.-C. BERRIO, A. BOOM & E. J. DE BOER



Hooghiemstra, H., S.G.A. Flantua, R.G. Bogotá-Angel, M.H.M. Groot, Z. González-Carranza, J.-C. Berrio, A. Boom & E.J. de Boer 2016. Islands, Pleistocene climate change, and connectivity help to better understand current plant distributions. Pp. 66 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

**Key words:** *Location:* northern Andes; *Taxa:* páramo taxa; *Other:* islands-in-the-sky, upper forest line shifts, connectivity, plant distribution patterns, Pleistocene climate change, numerical data analysis.

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In the northern Andes Pleistocene climate change caused altitudinal shifts of the main vegetation associations. Long-scale cycles (precession, obliquity, eccentricity, greenhouse gasses) interfere with millennial-scale cycles (Greenland interstadials), and (multi)annual cycles (climate modi) causing climatic boundary conditions are continuously changing. Site-specific reconstructions are abundant (>1300 in the 2014-update of the Latin American Pollen Database; LAPD) but spatial syntheses are rare, although essential to better understand current distribution patterns of plant taxa, biomes, and biodiversity. Pollen records from ecotone positions have the potential to show short-term changes in climate conditions and plant associations, but the potential to detect rapid changes depends on the temporal resolution of the records. We show that high-resolution pollen records from the northern Andes register previously unknown island dynamics in the northern Andes. After events of rapid upslope forest migration, páramo islands may be temporarily lost. However, if physical connectivity in a mountain area returns, páramo islands may return after some centuries. During the Pleistocene, the northern Andes have shown suites of páramo island archipelagos, of various size, elevational intervals, and periods of persistence. Deep valleys in the Andes (e.g. Huancabamba, northern Peru) represent notorious breaks in connectivity, whereas relatively flat mountain areas (Cocuy, central Colombia) better serve as continuous Pleistocene depositories of genetic variance and biodiversity. High temporal resolution over long intervals of time in single pollen records (LaCocha-1, Fúquene-9C), and high spatial resolution over large areas from multi-site pollen records for selected time-slices (from 2014 updated LAPD) mean that new research questions in the spatial domain requiring multi-site information can be answered. Finally, we compare dynamic islands in the sky with dynamic oceanic islands and we list how drivers and effects have impact on flora and vegetation.

## Evolution, composition and historical biogeography of the flora in the Indian Ocean biodiversity hotspot

JOERI S. STRIJK & T. LE PÉCHON



Strijk, J.S. & T. Le Péchon 2016. Evolution, composition and historical biogeography of the flora in the Indian Ocean biodiversity hotspot. Pp. 67 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Indian Ocean Islands; *Taxa*: plants; *Other*: Indian Ocean Islands, hotspot, palaeogeography, diversification, flora, dispersal.

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The combined flora of the islands in the Indian Ocean region (IOR) is renowned for its exceptional diversity. Geographically dominated by megadiverse Madagascar, the region is largely composed of floras on oceanic and coralline islands which vary widely in origin, age and structure. Its geological complexity and the high levels of endemism in the flora make the Indian Ocean region particularly interesting and challenging for studies on patterns and processes of evolution in isolation. However, in comparison to many other island systems, the IOR continues to remain understudied, both in taxon coverage and overall understanding. Typically, studies focus on Madagascar and only include a sparse sampling from the distinctly unique island systems, thereby neglecting important floristic components and historical connections. These issues refrain us from gaining a more comprehensive understanding of the importance of the immense palaeogeographical changes in the region. Furthermore, timing of dispersal, colonization and their combined effects on patterns of biotic assembly and opportunities for plant diversification on islands remain poorly understood at the biodiversity hotspot scale. Here we present the findings of our comparative study of plant diversification at the hotspot scale in the Indian Ocean region. We take into account plant lineage characteristics, evolutionary origins /connections, ecological placements and timing of diversification to discuss how geological changes and plant dispersal have combined into forming unique and highly species rich sets of habitats on isolated islands.



## Isolation effects on island plant diversity: Testing theoretical predictions with a biogeographical eco-evolutionary model

JULIANO S. CABRAL, R. J. WHITTAKER, K. WIEGAND & H. KREFT



Cabral, J.S., R.J. Whittaker, K. Wiegand & H. Kreft 2016. Isolation effects on island plant diversity: Testing theoretical predictions with a biogeographical eco-evolutionary model. Pp. 68-69 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hypothetical oceanic islands; *Taxa*: Hypothetical plants; *Other*: general dynamic model, isolation effects, metabolic theory, oceanic islands, process-based models, species richness.

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By considering the interplay between biogeographical level processes, such as colonization, extinction, and speciation, over the geological life-span of oceanic islands, the General Dynamics Model of island biogeography (GDM) predicts how biogeographical rates as well as resultant patterns of species richness and endemism vary depending on island age, area, and isolation. Here, we used a recently developed spatially-explicit, niche-based, mechanistic model to test core GDM predictions. Constrained by metabolic rates and driven by island dynamics, our model simulated plant demography, dispersal, competition, mutation, and speciation at the individual and population levels over geological time-scales. We ran simulation experiments with different degrees of island isolation by varying distance to mainland and dispersal abilities of mainland species pools and examined temporal patterns of species richness and endemism as well as colonization, speciation, and extinction rates. We obtained humped-shaped temporal trends in richness, endemism, and biogeographical rates, which confirmed temporal predictions of the GDM. Higher isolation caused lower colonization, lower species richness, a higher rate of cladogenesis, and thus more cladogenetic endemics, radiating lineages, and species per radiating lineage. Divergences from GDM predictions included interactions between temporal and isolation effects on species per radiating lineage. These results largely

confirmed how temporal trends vary in amplitude depending on isolation. In a more generalized context, isolation affects biodiversity by decreasing richness, but increasing endemism, particularly cladogenesis. Here, the model properties of simulating individual- and population-level processes in a hierarchical ecological framework demonstrate that predicted biographical patterns can emerge from low level processes and that detected divergences from biogeography theory provide insights into the eco-evolutionary dynamics of oceanic islands. Such insights thus indicate the advantages of considering population-level processes and their interactions under a spatially-explicit, niche-based framework.

## Quantifying island isolation and its effect on insular fauna

YUVAL ITESCU, J. FOUFOPOULOS, P. PAFILIS & S. MEIRI



Itescu, Y., J. Foufopoulos, P. Pafilis & S. Meiri 2016. Quantifying island isolation and its effect on insular fauna. Pp. 70 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Aegean Sea, Greece; *Taxa*: reptiles, *Mediodactylus kotschy*; *Other*: spatial isolation, temporal isolation, species richness, body size.

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Isolation is a key factor in island biology. The most commonly used measure of isolation is the distance from the nearest mainland, since it is unambiguous and easy to calculate. Many studies using this index, however, have failed to detect an effect of isolation on the phenomena examined. Spatial and temporal isolation can be defined in several ways, with relation to the mainland and to other islands in an archipelago. Which isolation index (if any) is most relevant for different biological traits has never been thoroughly studied for animals. Here we defined and quantified 15 isolation indices (8 temporal and 7 spatial) and examined which of them best predicts the species richness of snakes, lizards and all reptiles, and the body size (snout-vent length) of a gecko (*Mediodactylus kotschy*) across 94, mostly continental-shelf, islands in the Aegean Sea, Greece. The isolation index that best predicted these patterns differed across taxa. For all reptiles it was a spatial index - the distance from the closest mainland harboring a similar fauna. For snakes and lizards separately, the best predictor was a temporal index (time since last isolation of the island and time since separation from a predator-richer island, respectively). In all three groups, accounting for area, islands become poorer as isolation grows. Geckos became significantly smaller as temporal isolation indices increased (except for time since separation from the nearest mainland). Most spatial isolation indices failed to significantly predict gecko size. Distance from the closest reptile-richer island, and distance from the closest predator-richer island were also inversely correlated with gecko body size. The most commonly used isolation index - distance from the nearest mainland, regardless of its fauna - was not significantly correlated with either richness or body size. Our findings suggest that isolation should be much more carefully considered when studying insular faunas.

## Tarsier tales: How the evolution of tiny primates portrays Sulawesi's turbulent past

STEFAN MERKER, Y. BOHR, C. DRILLER & D. PERWITASARI-FARAJALLAH



Merker, S., Y. Bohr, C. Driller & D. Perwitasari-Farajallah 2016. Tarsier tales: How the evolution of tiny primates portrays Sulawesi's turbulent past. Pp. 71 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Sulawesi, Indonesia; *Taxa*: tarsiers; *Other*: colonization, Indonesia, phylogeography, primates, Wallacea.

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Due to its location in the transition zone between Asia and Oceania, its complex geologic history and its long isolation from other major landmasses, the Indonesian island of Sulawesi hosts a high diversity of endemic vertebrates. Among these, the enigmatic, nocturnal tarsiers are known as “old endemics” or “early colonizers” of the island and thus, as an excellent indicator taxon for microplate-tectonic shifts and sea-level fluctuations. In our presentation, we interpret phylogenetic relationships among tarsiers in view of plate-tectonic reconstructions and evidence of land and sea. How did these little primates colonize Sulawesi and when? How did they disperse across the island? What happened when young taxa came into secondary contact? We integrate biological data on an old Sulawesi endemic lineage with geologists' notions on the evolution of landmasses in the region to further understanding of how the islands of the Malay Archipelago were colonized.

## Turnover dynamics of breeding landbirds on islands: 'True but trivial' over decadal time-scales?

DUNCAN MCCOLLIN



McCollin, D. 2016. Turnover dynamics of breeding landbirds on islands: 'True but trivial' over decadal time-scales?. Pp. 72 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Skokholm, Wales; *Taxa*: Aves; *Other*: island biogeography, turnover, immigration, extinction, birds.

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The theory of island biogeography has stimulated much debate over the past 49 years. One major criticism of the theory is that it is 'true but trivial'. Based on analyses of annual turnovers of bird species on Skokholm and elsewhere it has been posited that turnover mainly comprises rare species 'flickering' and which thus contribute little to community dynamics. Here, I present an analysis of turnover of breeding landbirds on Skokholm, Wales using an updated long-term dataset. I show that over short time-scales, as expected, but even over longer time-scales (up to 12 years), much of the turnover involves rare species 'flickering' and comprise the bulk of the turnovers. However, analyses of turnover over long time-scales ( $\geq 6$  years) emphasize that turnover can involve both the establishment of sizeable populations and/or the extirpation of formerly abundant species. This suggests that whilst turnover may indeed be largely 'true but trivial' when short-term censuses are considered, a longer-term view suggests that turnover involves an increasingly greater proportion of species which are of ecological interest.

## Proper taxonomy improves the biogeographic signal of austral rove beetles (Coleoptera: Staphylinidae: Staphylinini)

JOSH JENKINS SHAW & A. SOLODOVNIKOV



Shaw, J.J. & A. Solodovnikov 2016. Proper taxonomy improves the biogeographic signal of austral rove beetles (Coleoptera: Staphylinidae: Staphylinini). Pp. 73 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Lord Howe Island, Australasia; *Taxa*: Coleoptera: Staphylinidae; *Other*: taxonomy, phylogenetics.

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The rove beetle subtribe Amblyopinina is the signature group of terrestrial Staphylinidae in the south temperate region e.g. Australia, New Zealand, and southern South America. Recent phylogenetic studies have found the subtribe to be monophyletic and much larger in composition than previously thought. Taxonomic changes in the subtribe Amblyopinina necessitated by new phylogenetic evidence begin to reveal the otherwise concealed, strong biogeographic pattern exhibited by this group, especially for the island-rich SW Pacific. For example, proper taxonomy of Amblyopinina of Lord Howe Island strongly changes our perception of biogeography of that unique island. Two new species in two genera are described from LHI. Three LHI species that were thought to be of the globally distributed genus *Heterothops* are moved to *Cheilocolpus* (two species) and *Ctenandropus* (one species), respectively. As a result, LHI appeared as having Australia-derived south temperate faunal element of Amblyopinina including island endemics. A large amount of taxonomic acts (new genera to describe, hundreds of new combinations) are still to be implemented within the subtribe Amblyopinina. For example, many species from Australia described in the genus *Quedius* (subtribe Quediina) are actually hypothesized to be congeneric with species of Amblyopinina from New Zealand and southern South America. Our planned molecular phylogeny of Amblyopinina will navigate those taxonomic changes and further emphasize the potential of this group for biogeographic studies. We plan to use at least the same set of 6 genes as in earlier phylogenetic work on Staphylinini, both nuclear and mitochondrial for ca. 40-50 taxa representative of a broad sample of Amblyopinina, from areas that support the highest diversity of the subtribe (Australia, New Guinea, New Zealand, South America and also LHI). New systematics will be a baseline for biogeographic studies of Lord Howe and other small or big Island systems in the Southern Hemisphere.

## Rove beetles (Coleoptera: Staphylinidae) as a model group for describing biogeography of the Aegean archipelago

LINE KRÆMER, A. SOLODOVNIKOV & A. BRUNKE



Kræmer, L., A. Solodovnikov & A. Brunke 2016. Rove beetles (Coleoptera: Staphylinidae) as a model group for describing biogeography of the Aegean archipelago. Pp. 74 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Aegean archipelago; *Taxa*: Coleoptera, Staphylinidae; *Other*: biogeography, endemism, taxonomy.

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With more than 9,800 islands the Aegean archipelago is one of the world largest continental island systems, located in the Aegean Sea, with two distinct mainland regions in proximity (Greek peninsula to the west and north and Anatolian coast to the east). It consists of numerous continental-shelf islands of varying sizes that used to be part of a greater mainland region until the Middle Miocene and since have been shaped under the combined effects of tectonic activity and sea-level changes. Both its location and geological history makes the Aegean archipelago a particularly interesting system for biogeographical studies. Here, we present the results of taxonomic and faunistic studies conducted on the Skyros Island, one of the relatively small and isolated islands of the archipelago. Our study group was the rove beetles (Insecta: Coleoptera: Staphylinidae) the largest, and globally distributed beetle family. Due to high taxonomic and ecological diversity, rove beetles are a potential good model group for the evolutionary and biogeographic studies. We made an inventory of the rove beetle fauna of Skyros based on a nine days collecting trip in April 2015, compared this fauna to other Greek islands with available data, and hypothesized possible factors that led to the observed faunal composition of Skyros. Finally, we assessed the observed rove beetle fauna in the palaeogeographic context from available scattered literature regarding the origin of Skyros. The collecting yielded mostly widespread species, well adapted to arid and disturbed habitats. However, one interesting finding of a specialized genus of dry habitats showed potential of being an endemic species to Skyros. It is a wingless species and could support the hypothesis that the Aegean archipelago was already dry when Skyros isolated 4.5 mya.



## CONTRIBUTED TALKS

### CT 6. EVOLUTION AND GENETICS

ROSEMARY G. GILLESPIE & BEN WARREN



Photo: Paulo A.V. Borges

## Diversification and species assembly among Hawaiian arthropods: The play of adaptive radiation in four acts

ROSEMARY G. GILLESPIE



Gillespie, R.G. 2016. Diversification and species assembly among Hawaiian arthropods: The play of adaptive radiation in four acts. Pp. 76 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hawaii; *Taxa*: arthropods; *Other*: chronosequence, progression, spider, insect, ecological speciation.

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Archipelagoes with a known geological chronology provide an opportunity to study the early stages of differentiation across an age-structured landscape. The Hawaiian Islands are particularly useful for examining the ecological-evolutionary nexus because they display an age chronology that allows analysis of communities that are just starting to establish, to more mature, allowing insights into how early ecological processes give way to longer term processes of adaptation and species diversification. Here, I use arthropods in the Hawaiian archipelago to highlight insights into the early stages of adaptive diversification and community assembly from the youngest islands. I focus in particular on (a) the relative importance of geographic isolation and ecological shifts in the early stages of species differentiation and the interplay between ecological and genetic differentiation; and (b) the frequent concordance between island age and lineage age in a species radiation and what this tells us about overall patterns of species accumulation. I use genetic and genomic tools to understand microevolutionary change, coupling these data with ecological metrics across the chronosequence to uncover community dynamics. This work highlights the interplay between rates of ecological and genetic differentiation in shaping biodiversity.

## Integrating island assembly models and comparative population genetics

ISAAC OVERCAST & M. J. HICKERSON



Overcast, I. & M.J Hickerson 2016. Integrating island assembly models and comparative population genetics. Pp. 77 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: La Palma, Canary Islands; *Taxa*: arthropods; *Other*: comparative population genetics, island community assembly.

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Collecting abundance data is hard, yet species abundance distributions and species area relationships are fundamental for understanding how communities assemble in island systems. Capitalizing on the exponential increase in availability of sequence data for non-model organisms, we have developed a way to bridge coalescent-based models of population genomics with models of island community assembly. Briefly, we forward-time simulate community assembly in island systems under various models, and then use the simulated abundance distributions and colonization times, and in situ speciation times to parameterize a hierarchical multi-taxa coalescent model to simulate population genomic data backwards in time. These simulated genetic data provide a way to jointly infer parameters under the linked island assembly and comparative population demographic models as well as a way to fit an array of competing island community assembly models without the necessity of collecting abundance data. We validate the power of the method with simulations, and apply the method to study community assembly of arthropods on La Palma, Canary Islands. This joint framework bridges tools and perspectives from community ecology with those of comparative phylogeography and population genetics to better understand the underlying dynamics of island community diversity patterns in the context of heterogeneous and changing environments.

## A new "evolutionary scandal": Asexual ladybirds (Coccinellidae: Coleoptera) in Macaronesia and the Mascarene Islands

ALEXANDRA MAGRO, B. DUTRILLAUX, A. O. SOARES, E. LECOMPTE, J. MURIENNE, A.M. DUTRILLAUX, H. FÜRSCH & J.L. HEMPTINNE



Magro, A., B. Dutrillaux, A.O. Soares, E. Lecompte, J. Murienne, A.-M. Dutrillaux, H. Fürsch & J.-L. Hemptinne 2016. A new "evolutionary scandal": Asexual ladybirds (Coccinellidae: Coleoptera) in Macaronesia and the Mascarene Islands. Pp. 78 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Macaronesia and Mascarene; *Taxa*: Coccinellidae: Coleoptera; *Other*: geographic parthenogenesis, asexuality, robertsonian translocations.

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All-female populations of predatory ladybirds were found in two distant regions, the Azores archipelago (St Maria Island) and the Mascarenes archipelago (La Réunion Island). Both populations have a similar phenotype and were identified as *Nephus voeltzkowi*, a bisexual species widely spread in sub-Saharan Africa. However, laboratory rearing shows individuals from St Maria and La Réunion only reproduce by parthenogenesis, a mode of reproduction as yet unknown in the Coccinellidae family and a new "evolutionary scandal" (Maynard Smith, J. 1986. Contemplating life without sex. *Nature* 324: 300-301). DNA sequencing confirms the asexual populations are very closely related: the mitochondrial genome (~17.000 bp) and the nuclear ribosomal cluster (~6.500 bp) display a 99.8% and 96.6% similarity, respectively. The estimated divergence time between the two asexual populations is about 4500-5000 years. In contrast with their genome similarity, their karyotypes are different, with 14 chromosomes for the St Maria and 17 for La Réunion, some being unmatched. We conclude that they belong to a single chromosomally polymorphic species undergoing simple Robertsonian changes, of no consequence to their phenotype. Following a parthenogenesis event, descendants of *N. voeltzkowi* disseminated overseas. On each colonised island, parthenotes independently accumulated a few DNA alterations, including those leading to chromosome rearrangements. We propose that parthenogenetic individuals of *N. voeltzkowi* from the South-Western Indian Ocean coast or islands reached Macaronesia by the hand of man.

## Eco-evolutionary feedbacks in fish-zooplankton communities on the Scottish island of North Uist

TALIB CHITHEER & A. MACCOLL



Chittheer, T. & A. MacColl 2016. Eco-evolutionary feedbacks in fish-zooplankton communities on the Scottish island of North Uist. Pp. 79 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Scottish island of North Uist; *Taxa*: Gasterosteidae, Three-spined sticklebacks; *Other*: eco-evolutionary feedback, zooplankton.

*Talib Chittheer (e-mail: plxtm2@nottingham.ac.uk) and Jean Andrew MacColl, University of Nottingham, School of Life Sciences, Nottingham, UK.*

Eco-evolutionary feedbacks occur when evolution of organismal traits causes environmental change that drives further evolution. Predator and prey interactions provide good examples of eco-evolutionary feedback. Here we examine the potential for eco-evolutionary feedbacks between three-spined sticklebacks and their zooplankton prey in lochs on the Scottish island of North Uist. Many lochs on the island were colonised by sticklebacks after the last glaciation, 16,000 years ago. Previous work has shown that sticklebacks in different lochs have diverged greatly from each other in response to local environments. We show that they have also diversified greatly in functional foraging traits that determine the efficiency of capturing different prey items. This could strongly affect total primary production and the structure of prey communities. We also examine the effect of predation on prey life-history, by comparing reproductive traits of the zooplankton communities in lochs with and without sticklebacks. The results showed that ancestral sticklebacks populations have adapted according to the habitat type they colonised. Fish feed on benthic prey in shallow lochs, requiring greater effort for a successful foraging strategy, compared with fish that feed on pelagic zooplankton. In turn, zooplankton in lochs with fish have more rapid reproductive cycles and higher fecundity parameters, probably in response to the increased threat of predation. Our results suggest a strong possibility of eco-evolutionary feedbacks in these simple ecosystems.

## Understanding phylogenetic patterns of extinction in island settings

BEN H. WARREN



Warren, B.H. 2016. Understanding phylogenetic patterns of extinction in island settings. Pp. 80 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Indian Ocean islands; *Taxa*: birds; *Other*: phylogeny, extinction, threatened species, branch lengths.

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Molecular phylogenetic data from Indian Ocean island birds show that IUCN threatened species occur on longer branches than non-threatened species. These results complement genetic data and taxonomic distinctiveness from birds and other taxa in archipelagos worldwide. However, the processes underlying this pattern are little explored. It could be that older species (those having diverged less recently) are at higher risk of extinction than younger ones. This could be consistent with the taxon cycle hypothesis, in which lineages go through sequential phases of expansion and contraction of ranges, commonly entailing extinction of late stage taxa. However, an alternative explanation for the data is that threatened (or restricted-range) species are no older than non-threatened, but occur on long branches as an artefact of the extinction of their close relatives. Phylogenetic clustering in extinction as a result of a shift in the probability of extinction might be particularly likely to yield this pattern. Here I explore these possibilities using phylogenetic simulations.

## Repeated evolution of large seeds on islands

PATRICK KAVANAGH & K. C. BURNS



Kavanagh, P. & K.C. Burns 2016. Repeated evolution of large seeds on islands. Pp. 81 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: South Pacific; *Taxa*: plants; *Other*: insular evolution, island, New Zealand, plants, seed.

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Several plant traits are known to evolve in predictable ways on islands. For example, herbaceous species often evolve to become woody and species frequently evolve larger leaves, regardless of growth form. However, our understanding of how seed sizes might evolve on islands lags far behind other plant traits. Here, we conduct the first test for macroevolutionary patterns of seed size on islands. We tested for differences in seed size between 40 island–mainland taxonomic pairings from four island groups surrounding New Zealand. Seed size data were collected in the field and then augmented by published seed descriptions to produce a more comprehensive dataset. Seed sizes of insular plants were consistently larger than mainland relatives, even after accounting for differences in growth form, dispersal mode and evolutionary history. Selection may favour seed size increases on islands to reduce dispersibility, as long-distance dispersal may result in propagule mortality at sea. Alternatively, larger seeds tend to generate larger seedlings, which are more likely to establish and outcompete neighbours. Our results indicate there is a general tendency for the evolution of large seeds on islands, but the mechanisms responsible for this evolutionary pathway have yet to be fully resolved.



## Is insular woodiness in the genus *Argyranthemum* (Asteraceae) driven by drought?

LARISSA CHACON DÓRIA, M. DEL ARCO, S. DELZON & F. LENS



Chacon Dória, L., M. del Arco, S. Delzon & F. Lens 2016. Is insular woodiness in the genus *Argyranthemum* (Asteraceae) driven by drought?. Pp. 82 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Tenerife, Canary Islands; *Taxa*: *Argyranthemum*; *Other*: insular woodiness, drought resistance.

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Many island floras are characterized by plant groups which tend to be woodier than their mainland counterparts. This process is called insular woodiness, and whether it is a derived or primitive feature has long been debated. However, there is considerable molecular evidence showing that many woody island species have evolved from herbaceous continental ancestors. One interesting aspect is that the shift from herbaceous towards insular woodiness occurred much more on continents than on islands, especially in dry continental regions facing at least a number of consecutive dry months per year. Moreover, in Canary Islands, ca. 65% of the insular woody species grow in markedly dry regions. These sources of evidence suggest a link between increased woodiness and increased drought resistance. In order to test this hypothesis we first selected the insular woody daisy group *Argyranthemum*, one of the largest insular woody groups native to Macaronesia, and their herbaceous relatives growing on mainland Europe. We performed hydraulic measurements using the centrifugation technique to estimate the stem pressure at which plants lose 50% of their hydraulic conductivity ( $P_{50}$ ) due to the formation of air bubbles (embolism) in their xylem conduits. This  $P_{50}$  value is considered to be a good proxy for drought stress resistance, and hydraulic failure in woody plants has been linked to forest mortality on a number of occasions. In addition to our hydraulic work, we are performing light microscope, scanning electron microscope and transmission electron microscope observations in the stems of insular woody *Argyranthemum* and their herbaceous relatives to investigate the anatomical characters underlying differences in embolism resistance. Our preliminary results showed that the *Argyranthemum* species studied are more embolism resistant (more negative  $P_{50}$  values) than their mainland herbaceous relatives, supporting our hypothesis that the island woody species are more drought resistant than their mainland herbaceous relatives.

## Using phylogenomic approaches to study maintenance of morphologically identical species in *Micromeria* (Lamiaceae) from the Canary Islands

MANUEL CURTO, P. PUPPO & H. MEIMBERG



Curto, M., P. Puppo & H. Meimberg 2016. Using phylogenomic approaches to study maintenance of morphologically identical species in *Micromeria* (Lamiaceae) from the Canary Islands. Pp. 83 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Canary Islands; *Taxa*: *Micromeria* Benth. (Lamiaceae); *Other*: morphological species, gene-flow, phylogenomics, RAD-seq.

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Geneflow is the major force preventing differentiation and homogenizing genetic structure. In island systems, since hybridization is frequent, this effect might be more pronounced. In groups where hybridization is common this may lead to high genetic similarity of morphologically differentiated species within one island or of high genetic differences in morphologically similar species between islands. In *Micromeria* from the Canary Islands we find one of these examples: morphologically similar individuals are distributed over the whole archipelago, formerly regarded as one species, *M. varia*. However, using molecular markers this form was arranged into multiple species. *Micromeria varia* might therefore constitute a group of morphologically similar species with several independent origins and convergent evolution. Nevertheless, the finding of high inter-specific gene-flow within each island for neutral markers led to the hypothesis that this form might have evolved only once and genetic differences today result from hybridization with other species on their respective islands. Consequently the divergences observed possibly represent genetic differentiations between islands in neutral markers and the species complex could constitute a morphospecies, a morphologically similar group of individuals despite genetic differences. We are investigating the processes involved in maintaining this phenotype in multiple islands using genomic methods for genotyping and whole genome comparisons. So far we have used variation in RADs and identified 1211 loci across 52 individuals of the '*M. varia* complex' from all islands. We reconstructed the major phylogeny, which was congruent with the separation of *M. varia*. Additionally, we found several incongruent loci through the ABBA/BABA method. These incongruent loci may constitute genes under selection that are responsible for the maintenance of this particular form. This is currently being tested by comparing their function and phylogenetic signal, in both RADs and whole genome data, with *M. varia* ecological features.

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## WORKSHOPS

### WS 1. IUCN – Strategies for the conservation biodiversity

CHAIR: THOMAS BROOKS



Pico Gaspar in Terceira (Azores) home of a small isolated fragment of native forest  
(Photo: Paulo A. V. Borges)

## Strategies for the conservation of island biodiversity

MICHAEL HOFFMAN & T. BROOKS



Hoffman, M. & Brooks, T. 2016. Strategies for the conservation of island biodiversity. Pp. 86 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: islands, threatened species, conservation priorities, conservation success, IUCN.

*Michael Hoffman and Thomas Brooks (e-mail: t.brooks@iucn.org), International Union for Conservation of Nature (IUCN), 28 rue Mauverney, 1196 Gland, Switzerland.*

Islands are important priorities for biodiversity conservation. Covering ~5 of the earth's land surface, islands hold more than one-fifth of the world's plant species and about one-quarter of the world's threatened mammals and one-third of the world's threatened birds. Sadly, the majority of recorded species extinctions since 1500 have occurred on islands, with invasive alien species playing a major role. More than 70 of recorded extinctions in five animal groups (tetrapods and molluscs) were island species. For this reason, islands figure prominently in the prioritization plans of many international conservation organizations. To name just one example, 40 of highly threatened species known from single sites identified by the Alliance for Zero Extinction, a partnership of more than 100 Non-Governmental Organizations, are on islands, many of them unprotected. Indeed, islands present tremendous opportunities for conservation successes: many of the most remarkable species recoveries have taken place on islands, and island nations such as the Cook Islands, Mauritius and Seychelles, have achieved net improvements in status of their biodiversity. This session will begin with an evaluation of our current state of knowledge of island biodiversity, threats and conservation actions, a primer on the role that the Specialist Groups of the IUCN's Species Survival Commission have played both in improving our understanding of the state of island biodiversity and responding to threats, and an open discussion on how delegates can get more involved.

## Species Conservation Profile (SCP): A streamlined workflow for collaborative authoring, peer-review and scholarly publication serving the IUCN Red Data List

LYUBOMIR PENEV, P. STOEV, T. GEORGIEV, V. SENDEROV & P. CARDOSO



Penev, L., P. Stoev, T. Georgiev, V. Senderov & P. Cardoso 2016. Species Conservation Profile (SCP): A streamlined workflow for collaborative authoring, peer-review and scholarly publication serving the IUCN Red Data List. Pp. 87 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: IUCN, species conservation, species profiles, scholarly publication.

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Species Conservation Profiles (SCP) are concise treatments of species of conservation importance based on an IUCN-approved template and controlled vocabularies for some of the species characteristics. The Biodiversity Data Journal in collaboration with IUCN SSC members created a workflow that allows for user-friendly authoring, peer-review and publication of SCP via a specially designed template in its authoring platform, the ARPHA Writing Tool (ARPHA). Apart from the rich editing interface, the tool provides additional functionalities including commenting, replying to comments, importing data from online resources (for example, literature references from CrossRef, PubMed, Mendeley, and occurrence records in Darwin Core format from GBIF, BOLD and iDigBio), versioning, reviewing by external parties during the authoring process, linguistic and copyediting, building image plates and multimedia, automated technical checking, and others. At the end, the author can submit the profile to either the Biodiversity Data Journal just with a click of a button, pass peer-review, and publish it as an open access citable scholarly article within days after acceptance. The publication will be available in semantically enhanced HTML, PDF and machine-readable XML, all archived in PubMedCentral and ZENODO. The workflow is expected to play a significant role in experts' engagement and creates additional incentives for researchers to contribute to the IUCN Red Data Lists by publishing new, or updating existing species profiles that can be cited and re-used as any other scholarly article. Once published, the information on alien species can be directly imported into the SIS and IUCN Red List with no further work for assessors and reviewers.

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## WORKSHOPS

### WS 2. iDigBio – DIGITIZED NATURAL HISTORY COLLECTIONS

CHAIR: SHELLEY A. JAMES



A collection of mushrooms (Photo: Paulo A. V. Borges)

## Integrated Digitized Biocollections (iDigBio): Mobilizing natural history collections for understanding island biodiversity

SHELLEY A. JAMES, D. L. PAUL, M. J. COLLINS & G. NELSON



James, S.A., D.L. Paul, M.J. Collins & G. Nelson 2016. Integrated Digitized Biocollections (iDigBio): mobilizing natural history collections for understanding island biodiversity. Pp. 90 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: digitization, biodiversity, data mobilization, natural history collections, biogeography.

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Advancements in digital technologies are rapidly improving efficiency in the aggregation, use, and sharing of natural history collections and biodiversity specimen data. Researchers now have access to ever increasing herbarium data sets for visualization, analysis, and modeling to assist with taxonomic research and conservation assessments. iDigBio ([www.idigbio.org](http://www.idigbio.org)), the national resource for the U.S. National Science Foundation's Advancing Digitization of Biodiversity Collections (ADBC) program, is mobilizing data and images for millions of biodiversity specimens. Voucher specimen data, both neontological and paleontological, from island communities across the globe is available in electronic format through the iDigBio web-based graphical interface ([www.idigbio.org/portal/](http://www.idigbio.org/portal/)) and APIs. It provides a wealth of information for the research community, government agencies, students, educators, and the general public, including baseline data for biodiversity assessments and non-native or invasive species distribution, providing data and images for new species discovery, and assisting with efficient location of voucher specimen collections for further research. This presentation will highlight ADBC activities, data gaps the Island Biology community may be able to help narrow, and potential research uses of the data as they pertain to expanding the understanding of the biodiversity and biogeography of island flora and fauna and the communities they comprise.

## Biological Collections Data: Best practices and trends for standards, digitization, and biodiversity informatics literacy for research use of collections data

DEBORAH L. PAUL & K. C. SELTMANN



Paul, D.L., K.C. & Seltmann 2016. Biological Collections Data: Best practices and trends for standards, digitization, and biodiversity informatics literacy for research use of collections data. Pp. 91 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: iDigBio, digitization, data standards, identifiers, biodiversity informatics skills, data gap analysis.

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For biological collections data to have the longest life possible, and be usable for as many audiences as possible, we need high-quality, georeferenced, standardized data. The latest standards being used for sharing (mobilizing) collections data include but are not limited to ABCD, Darwin Core, Global Genomic GGBN, Audubon Core, and Ecological Metadata Language (EML). Transcription of data from existing specimens, imaging specimens and documents, collecting specimens, and using biological collections data requires identifiers. These unique strings make it possible to study and keep track of relationships between objects both physical and digital. Some collections currently rely more and more on researchers' requests for deciding what to digitize; this trend is referred to as "digitization on demand." At the same time, collections and aggregators like iDigBio (<http://idigbio.org>), GBIF (<http://gbif.org>), and VertNet (<http://vertnet.org/>) are providing data quality information and attempting to analyze specimen data looking for missing data. For example, these data gaps may be taxonomic, geographic, or habitat-based. This data gap analysis (DGA) can help collections to prioritize digitization, and also inform researchers about where to focus collecting and sampling efforts. Accurate georeferencing of specimen locality data using appropriate standards is critical as it facilitates better, faster research. Scientists are urged to please contribute their georeferencing expertise and gazetteers. With ever more data available, scientists find they need to update their data skills. Some groups like Data Carpentry, Software Carpentry, and Reproducible Science Curriculum, now offer easy-to-access training, designed specifically for the beginner or intermediate-level, and tailored to specific communities as well.

## Collecting experiences in Melanesia: Best practices for efficient digitization

SHELLEY A. JAMES



James, S.A. 2016. Collecting experiences in Melanesia: Best practices for efficient digitization. Pp. 92 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Melanesia; *Taxa*: all; *Other*: iDigBio, biodiversity data, specimen collection, digitization, data mobilization.

*Shelley A. James (e-mail: sjames@flmnh.ufl.edu), iDigBio, Florida Museum of Natural History, Gainesville, FL, USA.*

The processes of field collection of natural history specimens, keeping track of the physical specimens through the curation and distribution process, and converting data from field notebook into digital format and delivery to data aggregator, can be complex. Legacy collections are expensive and time consuming to digitize, and error corrections are often complicated to resolve. As such, developing best practices for new field collections for efficient digitization and data sharing is critical for avoiding the often repeated efforts of digitization within multiple natural history collections and propagation errors that can result. Understanding the data life cycle for natural history collections, from collection methodologies to dissemination and data sharing, requires knowledge of the appropriate use of identifiers, and understanding data standards such as Darwin and Audubon Core. Gathering data fit-for-research-use at the time of collection, including essential data fields and supplementary information such as trait or environmental data, results in reproducible research and rapidly discoverable data. This presentation will highlight these concepts as they apply to island biology and biodiversity research, with lessons learned from experiences of fieldwork in the tropical islands of Melanesia.

## Accessing digital collections data sources for research: A tour of iDigBio data services

MATTHEW J. COLLINS & D. L. PAUL



Collins, M.J. & D.L. Paul 2016. Accessing digital collections data sources for research: A tour of iDigBio data services. Pp. 93 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: iDigBio, biodiversity informatics, data use, aggregator.

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Digitized collection objects are an important resource for research analyses such as ecological niche modeling, morphological studies, and data gaps. National and international initiatives have resulted in an enormous number of standardized data records, hundreds of millions, becoming aggregated and made available for research use in the last few years. Some aggregators also offer tens of millions of images of museum specimens. Aggregators like the Global Biodiversity Information Facility (GBIF) internationally, and the Integrated Digitized Biocollections (iDigBio) in the United States, provide several interfaces to their data sets: web based portals, application programming interfaces (APIs), and data processing services. This talk will provide an overview of what kinds of use cases these interfaces can serve, the trade-offs they make and how to get started using them. As a concrete example, the iDigBio portal's features will be demonstrated. The programming API will be described and examples of its use from the R programming language will be shown. iDigBio's data processing service, Global Unified Open Data Access (GUODA), which provides a high-performance method for analyzing entire biodiversity data sets, will be described as well.

## The Guam ecosystem Collaboratorium's biorepository project

TERRY J. DONALDSON, D. P. LINDSTROM, J. A. PETERSON & J. S. BIGGS



Donaldson, T.J., D.P. Lindstrom, J.A. Peterson & J.S. Biggs 2016. The Guam ecosystem Collaboratorium's biorepository project. Pp. 94 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Micronesia; *Taxa*: marine animals, corals; *Other*: marine biodiversity; biorepository.

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The University of Guam, with major support from the U.S. National Science Foundation, is establishing a biorepository inventory system to store and catalog biological specimens from the region. This biorepository will utilize new digitization procedures, especially those promoted by the iDigBio Program, to capture and store various forms of data that may be accessed by researchers globally for scientific research. Data will include collection metadata, whole organism data, genetic data (i.e., genomes and proteomes), organismal data (i.e., otoliths, gonads, etc.), and behavioral, ecological and oceanographic data. These data will be cross-referenced in a virtual library of high-resolution digital photographs, videos, biometric specimen data, and habitat characteristics. The initial focus will be upon marine biodiversity, and will allow for the identification of key biotic and abiotic drivers that act upon population structure. These data may be used also to identify new forms of biodiversity, characterize genotypic-specific responses that promote survival in extreme environments (i.e. ocean warming, turbidity and ocean acidification), and identify and describe environmental conditions that put species at risk. Initially, the biorepository will make it possible to investigate current levels of genetic diversity within two target species of corals and allow for the identification of source and sink populations. This information may be used to better inform resource management of areas that if protected can serve as sources for natural repopulation. The Biorepository will increase local capacity for scientific research, promote the unique biodiversity of the region, and create a gateway for advancing science focused on Micronesia.

## Digitizing the Azorean bryophyte, vascular plant and arthropod' collections: The Azores Bioportal initiative

ROSALINA GABRIEL, E. MENDONÇA, R.B. ELIAS, I.R. AMORIM, F. PEREIRA & P.A.V. BORGES



Gabriel, R., E. Mendonça, R.B. Elias, I.R. Amorim, F. Pereira & P.A.V. Borges 2016. Digitizing the Azorean bryophyte, vascular plant and arthropod' collections: The Azores Bioportal initiative. Pp.95 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Azores; *Taxa*: bryophytes, vascular plants, arthropods; *Other*: databases, grey literature, PORBIOTA, LifeWatch, GBIF – Portugal, Azores bioportal.

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The Azorean Biodiversity Portal (ABP) is an e-infrastructure which aims to make available the best information regarding biodiversity and distribution of Azorean *taxa*. The ABP is a key e-infrastructure for the integrated management of biodiversity data, providing a large number of specialized services that support research, policy and education. This was the first Biodiversity Portal based in Portugal, starting in 2008, and the only one which provides easy access to island biodiversity data. ABP is currently recognized as a valuable outreach, management and conservation tool for all who work in science and protection of biodiversity. The ABP is currently associated with the Portuguese PORBIOTA, LifeWatch Europe and GBIF–Portugal initiatives. The digitization of the collections held in the University of the Azores (bryophytes, vascular plants and arthropods) was set as a priority by the organizing team and its operationalization started with the creation of preliminary databases in 2004-2006. The main ABP action lines for the period 2015-2020 related with bryophytes, vascular plants and arthropods are to: a) improve the informatics system of the e-infrastructure to allow complex queries and improve user-friendliness; b) guarantee a rigorous classification of every species, providing updated and comprehensive checklists, ensuring accuracy on the compilation of biogeographical information; and c) provide innovative biodiversity analytical tools for online identification of species using species trait data. The new portal, Azores Bioportal, <http://azoresbioportal.uac.pt>, will have new pages dedicated to the collections of Herbarium of the University of the Azores (AZU) for bryophytes and vascular plants and “Dalberto Teixeira Pombo” Collection for arthropods. We aim to have all the data for each specimen available online for experts and the public by 2020.



## HOLOS: Integrating biological and environmental data to assess ecological and evolutionary response to change

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Gillespie, R.G., A. Hiller, M. Koo, M. Kelly, K. Koy, C.M. Marshall & G. Rapacciuolo 2016. HOLOS: Integrating biological and environmental data to assess ecological and evolutionary response to change. Pp. 96 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: California, Hawaii; *Taxa*: all; *Other*: ecoinformatics, climate change, checklists, field notes, vegetation mapping.

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Understanding biotic responses to environmental changes, both past and present, necessitates a holistic understanding of the complex interactions and feedbacks among organisms, climate, and their physical and biotic environments across space and time. The newly launched Berkeley Ecoinformatics Engine ([ecoengine.berkeley.edu](http://ecoengine.berkeley.edu)) addresses this challenge by creating web-based building blocks that access and integrate data from established biological and environmental data repositories as well as newly digitized historical data sets rescued from orphaned or remote labs. These datasets include specimens from natural history collections, field surveys and observations, photographs, environmental sensor networks, GIS baselayers of past, present, and future climate scenarios and more. This unique combination of features and data makes the Ecoengine an invaluable tool for biodiversity and global change research. Users can access Ecoengine through their pathway of choice from directly tapping the Application Programming Interface (API), to R (via rOpenSci's Ecoengine package), to using Holos ([holos.berkeley.edu](http://holos.berkeley.edu)) our newly launched exploratory mapping interface. Case studies are illustrated from the Hawaiian Islands, making use of the island age chronology to show how different groups of arthropods have responded to abiotic environmental parameters. The results highlight the importance of rainfall in both constraining and facilitating diversification, and underscore the combined importance of abiotic niche conservatism and lability over the course of adaptive radiation.

## An insight about species turnover from bat species records on Siberut Islands, Indonesia

SABHRINA G. ANINTA, S. NOERFAHMY, S. WIANTORO & D. T. ISKANDAR



Aninta, S.G., S. Noerfahmy, S. Wiantoro & D.T. Iskandar 2016. An insight about species turnover from bat species records on Siberut Islands, Indonesia. Pp. 97 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Siberut Island, Indonesia; *Taxa*: Chiroptera; *Other*: species turnover, species records, biodiversity, biogeography, island bats.

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Due to their limited space and vulnerability to both immigration and extinction, islands have a unique species assemblage. The species number of an island over a period of time thus may provide important insights on processes affecting biodiversity. In our study, we collected bat species records from Siberut Island from the early 20<sup>th</sup> century to 2013 to see the pattern of bat diversity over time. We found that bat species assemblage is not consistent over time with a cumulative number of 22 species. However, this number is unlikely to be a fixed point for Siberut bat species richness. Overestimation is possible due to the possibility of species turnover. We assumed that species turnover is the cause of different yearly species assemblages as the number of new records found per year does not vary much (average species richness = 4.33 species/year, standard deviation = 1.84 species/year). This was corroborated by the consistent proportion of functional groups throughout the year with different species assemblages for each sampling year in both functional groups. Furthermore, we may infer turnover possibility from the similarity of bat species composition between Siberut and the Sundaland islands (Sumatra, Borneo, Java, and Malaya Peninsular) that confirmed the tendency of bats to be opportunistic dispersers. Underestimation is nevertheless possible due to the unavailability of standardized species presence data from the museum and the lack of systematic long term monitoring. Despite its homogenous nature, Siberut ecosystems consists of five major ecosystem types with a variety of microhabitat which are worth to consider to record additional bat species. Hence, our study has demonstrated the importance of species records completeness for assessing the pattern of species richness of a tropical island and long term monitoring for perceiving biodiversity in a broader sense.

## The role of niche differentiation and conservatism in the diversification of island plant clades

JUN YING LIM



Aninta, S.G., S. Noerfahmy, S. Wiantoro & D.T. Iskandar 2016. The role of niche differentiation and conservatism in the diversification of island plant clades. Pp. 98 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hawaii; *Taxa*: plants; *Other*: niche conservatism, ecological speciation, dispersal, Hawaiian archipelago, island plants.

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Understanding how the interplay of niche evolution and dispersal influences the geographical distribution of clades remains a central goal in island biogeography. Due to the strong physical barriers conferred by an insular setting, speciation on islands or island-like environments have been hypothesized to be predominantly associated with in-situ ecological divergence and subsequent utilization of different habitats. However, niche conservatism may also be imposing environmental constraints on the dispersal patterns of lineages, promoting the formation of closely related species that share similar environmental preferences. Both processes are likely to be important in the diversification of island clades, but their relative contribution of niche conservatism and differentiation in shaping island species distributions is still not fully understood. Here, I use plant natural history collection locality data from Hawaii to determine the geographic distribution and climatic niches of species for several endemic plant clades. By integrating these data with published phylogenetic data into models of correlated discrete trait evolution, I explore the role of niche differentiation in the geography of speciation of these clades. Finally, I also evaluate how intrinsic clade-level differences may influence the relative contribution of in-situ niche divergence versus synclimatic dispersal on the diversification of these clades.

## Documenting and digitizing specimens from a weird and scenic landscape: Utilizing and enhancing collections to understand patterns of biodiversity

KATIE L. PETERSON & C. E. PARENT



Peterson, K.L. & C.E. Parent 2016. Documenting and digitizing specimens from a weird and scenic landscape: Utilizing and enhancing collections to understand patterns of biodiversity. Pp. 99 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Craters of the Moon National Monument and Preserve, Idaho; *Taxa*: Salticidae, Thomisidae, plants; *Other*: biodiversity, digitization, vouchers, community phylogenetics.

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My research focuses on island biogeography within a continental context and understanding biodiversity patterns related to biogeographical features of lava flows and kipukas at Craters of the Moon National Monument and Preserve (CRMO, Idaho, USA). Collections made during two field seasons at CRMO will contribute to two current collections at the University of Idaho. Spiders collected will be added to the William F. Barr Entomological Museum that currently houses more than 1 million specimens. This collection has voucher specimens from original insect surveys conducted at CRMO; however, that survey did not include spiders, so my collections will significantly increase our knowledge of the current biodiversity of Salticidae and Thomisidae spiders. Digitization efforts in the Barr Museum are already underway to document the Lepidopteran collection, and as sample processing and identification progresses, my spiders will also be digitized. Plant specimens will be added to the Stillinger Herbarium- a collection of more than 200,000 specimens. The entire vascular plant collection has been digitized and is publicly accessible through the Consortium of Pacific Northwest Herbaria data portal, which includes collections from a total of 36 herbaria ([www.pnwherbaria.org](http://www.pnwherbaria.org)). I am utilizing this data portal as a resource to determine appropriate species pools for community phylogenetic analyses. Museum collections are essential for my research, and I am thankful to be able to contribute to existing collections in the process so others are able to learn and appreciate the amazing diversity of an interesting landscape online, even if they are unable to see it firsthand.

## Harnessing biocollections data with hierarchical models to understand homogenization of island biotas

ANDREW J. ROMINGER



Rominger, A.J. 2016. Harnessing biocollections data with hierarchical models to understand homogenization of island biotas. Pp. 100 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: global; *Taxa*: arthropods and plants; *Other*: Beta diversity, biogeography, Bayesian hierarchical model, biocollections.

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Integrated information across scales of space, time and biological organization is critical to advancing our understanding of the processes that generate and maintain biodiversity. This is challenging because most organismal data collection is itself limited and fragmentary, and not easily re-integrated even in cases where linkage is possible (e.g. biocollections records--such as those housed in natural history museums--linked back to phylogenies). With massive biocollections digitization efforts producing digital vouchers that include spatiotemporal and often trait information, these limitations are easing. However, getting full use of museum specimen records to test key ecological questions still requires new theoretical advances and tools to assess sampling effort and coverage, and to broadly link these data more effectively. I am developing and applying statistical solutions to account for the sampling biases inherent in non-standardized biocollections data by harnessing the power of hierarchical models. In particular, the work here uses digitized biocollections data to evaluate how beta diversity has changed through time, i.e. have biotas become more or less homogeneous due to anthropogenic pressures. This issue is particularly relevant for island systems that face intense pressure from invasive species, which while not always responsible for extinctions, may indeed play a heavy role in homogenizing the unique evolutionary history of island biotas.

## The role of herbaria in research on Pacific Island floras

JONATHAN P. PRICE



Price, J.P. 2016. The role of herbaria in research on Pacific Island floras. Pp. 101 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hawaii, Society Islands, Marquesas Islands; *Taxa*: flowering plants; *Other*: herbarium specimens, biogeography, conservation, phenology.

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Herbaria have long served as critical repositories for taxonomic and systematic research. Many forms of data from herbarium specimens are now available in digital form. Three herbaria (Bishop Museum, National Tropical Botanic Garden, and the US National Herbarium) represent key opportunities for research in three key areas: 1) biogeography, 2) ecology, and 3) conservation. Collection locations have long been used to assess the geographic and ecological distributions. Whereas traditionally biogeographers have used location data, modern databases make locations readily viewable thanks to data fields representing geographic coordinates (latitude and longitude). Nonetheless, adjunct data about the collection locality can offer critical clues about where species have occurred. Together, these data inform useful reconstructions of the natural distributions of virtually all Hawaiian plant species, with multiple applications. Herbarium specimen data have also informed ecological studies, for example, by indicating flowering times for species whose phenology is poorly known or by describing the surrounding community for species whose habitats have been badly degraded by invasive species. Together, these data can be used to target the locations, habitat, and months in which species can be found and most reliably identified. They also provide important templates for habitat restoration. As more data become available additional research avenues may be possible, including comparative bioclimatology across different archipelagos, shifting phenology resulting from climate change, and detailed accounting of invasive species expansions.

## Herbarium data mining to assess invasion risks and trace invasion histories of nuisance algae in Tropical Pacific Islands

TOM SCHILS, C. BOEDEKER, A. SIMEON & F. LELIAERT



Schils, T., C. Boedeker, A. Simeon & F. Leliaert 2016. Herbarium data mining to assess invasion risks and trace invasion histories of nuisance algae in Tropical Pacific Islands. Pp. 102 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Tropical Pacific Islands; *Taxa*: marine macroalgae; *Other*: algae, biogeography, digitized collections, invasive species, marine, risk assessment.

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The macroalgal diversity of tropical Pacific islands and the risk of alien introductions to these islands are assessed using complete morphospecies accounts derived from herbarium records and published checklists. Marine biodiversity assessments, however, are in a state of flux as genetic diversity analyses reveal that traditional taxonomic methods greatly underestimate diversity at various spatial scales. As positive relationships between biodiversity and ecosystem functioning are well-established, accurate estimates of species diversity and objective tools to measure this diversity are essential to support marine monitoring and conservation programs. Therefore, the macroalgal diversity and risk assessment based on morphospecies inventories are compared to the floristic relationships between Pacific islands using a DNA barcoding approach focused on a family of red algae that is omnipresent on tropical reefs and contains nuisance taxa. The last example that demonstrates the value of digitized herbarium data to understand unusual biological phenomena is a case-study on a recent but persistent green algal bloom in Guam, Mariana Islands.



## WORKSHOPS

### WS 3. Biological invasions

CHAIRS: ANTÓNIO ONOFRE SOARES & HELEN ROY



Caldeira Funda in Flores (Azores) is being invaded by *Hedychium gardnerianum* Sheppard ex Ker-Gawl, one of the most difficult species to control in the archipelago. (Photo: Paulo A. V. Borges)

## Biological invasions: The importance of collaborations and communication

HELEN E. ROY & COST ACTION TD1209 ALIEN CHALLENGE



H. Roy & COST Action TD1209 ALIEN Challenge 2016. Biological invasions: The importance of collaborations and communication. Pp. 104 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: alien species, information exchange, policy, pathways, impacts.

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The number of new species arriving across Europe is increasing rapidly. There are more than 14 000 alien species in Europe and a proportion of these species threaten biodiversity, the economy and/or society and are termed invasive alien species (IAS). There are a number of international agreements which recognise the negative effects of IAS and reflect widespread concerns. Indeed recently the European Union (EU) Regulation 1143/2014 on IAS establishes an EU-wide framework for action to prevent, minimise and mitigate the adverse impacts of IAS on biodiversity. Communication and cross-boundary collaborations, ensuring knowledge on IAS is shared between countries, are essential to ensure successful implementation of IAS legislation and strategy. The COST Action ALIEN Challenge aims to facilitate enhanced knowledge gathering and sharing through a network of experts, providing support to a European IAS information system which will enable effective and informed decision-making in relation to IAS. Here I provide an overview of ALIEN Challenge highlighting the importance of collaborations and communication in advancing understanding of invasion biology. ALIEN Challenge involves people from 34 European countries alongside additional countries around the world. I highlight the invaluable contributions of the network in addressing key questions in relation to information on IAS particularly compiling inventories, unravelling impacts and exploring pathways. Networks established through collaborative initiatives such as COST Actions have a bright future with benefits for people, science, and nature.

## *Harmonia axyridis* did not establish in the Azores: The role of species richness, intraguild interactions and resource availability

ANTÓNIO O. SOARES, A. HONĚK, Z. MARTINKOVA, J. SKUHROVEC, P. CARDOSO  
& I. BORGES



Soares, A.O., A. Honěk, Z. Martinkova, J. Skuhrovec, P. Cardoso & I. Borges 2016. *Harmonia axyridis* did not establish in the Azores: The role of species richness, intraguild interactions and resource availability. Pp. 105 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Azores; *Taxa*: Arthropods; *Other*: Elton's diversity-invasibility hypothesis, Darwin's naturalization hypothesis, resource availability hypothesis Coccinellidae, body mass, inter-specific interactions.

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Elton's diversity-invasibility, Darwin's naturalization and resource availability hypotheses were used to explain why *Harmonia axyridis* Pallas (Coleoptera: Coccinellidae) did not establish in the Azores. We compare ladybird adult communities of three similar habitats of the Azores and Czech Republic as well the communities of tree habitats along a north-south latitudinal transect on mainland Europe. Communities were characterized in terms of biodiversity, average difference in body mass between *H. axyridis* from other coccinellid species and the total body mass of all individuals in the rarefied sample as a surrogate for aphid abundance and availability. The lack of success in the Azores, as well as its low success in Southern Europe, can be explained by a combination of resource availability and inter-specific competition. We conclude that a mix of resource availability (main) and Darwin's naturalization hypothesis (secondary) seem to be determinant to the success of the invasive alien species.

## Do gut symbionts play a role in the invasion strategies of subterranean termites?

SÓNIA DUARTE, T. NOBRE, P.A.V. BORGES & L. NUNES



Duarte, S., T. Nobre, P.A.V. Borges & L. Nunes 2016. Do gut symbionts play a role in the invasion strategies of subterranean termites?. Pp. 106 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Faial Island, Azores and mainland, Portugal; *Taxa*: Blattodea, Isoptera, Rhinotermitidae, *Reticulitermes grassei*; Phylum Parabasalia, Order Oxymonadida, Phylum Preaxostyla; *Other*: subterranean termites, gut symbionts, flagellate protists, invasive population, unicoloniality.

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Despite the importance of termites within diverse ecosystems, they can also be forestry and urban pests. Subterranean termites may cause severe damage in urban areas. These termites harbour flagellate protists and bacteria in the dilated portion of their hindgut: host and symbionts work together as a tripartite lignocellulolytic system. *Reticulitermes grassei* Clément is an invasive alien species in the Faial Island (Azores). As a consequence of a possible founder effect, we hypothesized that the flagellate protist community of the invasive population of *R. grassei* would differ from the mainland autochthonous termite populations' symbionts. Termites were captured in Portugal mainland, and in Faial Island, and their gut contents analysed morphologically. The results showed 12 different morphotypes of flagellate protists in the two invasive populations against 6 to 12 on the fourteen mainland populations. Diversity indices were calculated for each location. A core group of flagellate protists was identified as occurring in all termite populations studied. Additionally, aggression tests were performed and invasive alien termite populations did not display aggressive behaviour towards each other, contrasting with the behaviour of mainland autochthonous termite populations. As an invasive alien social insect, they are likely to suffer a change in the social structure as a response to the invasion event: single colonies boundaries breakdown, resulting in a population-wide cooperation unicolonial system. This strategy is advantageous for the maintenance of the flagellate protist communities as it promotes horizontal transfer of symbionts beyond the boundaries of a single colony, increasing the pool of flagellate protists species. This therefore contributes to a strategy of quick dominance of the ecological niches available in the invaded range. The role of symbionts within the invasion process is usually overlooked; however, this should be further investigated, as each symbiont carries its own genome, with the potential to affect host invasiveness and ecology.

## The macroecology and biogeography of invasions on islands: Recent progress and gaps in knowledge

FRANZ ESSL, C. CAPINHA, B. LENZNER, H. SEEBENS & GLONAF CORE TEAM



Essl, F., C. Capinha, B. Lenzner, H. Seebens & GloNAF core team 2016. The macroecology and biogeography of invasions on islands: Recent progress and gaps in knowledge. Pp. 107 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: amphibians, birds, bryophytes, mammals, molluscs, reptiles, vascular plants; *Other*: alien species, biogeography, diversity, introduction effort, isolation, macroecology.

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Islands are hotspots of species diversity – of native species, but even more so, many islands have become heavily invaded by alien species. The consequences of the unprecedented influx of alien species on the long-term conservation of native and endemic island biota are dramatic, which makes a better understanding of the factors shaping invasions on islands a priority for conservation. In the last years, the substantial increase in global distribution data on alien species of several taxonomic groups has for the first time allowed to compile databases which provide accurate and exhaustive information on the global richness, flows between regions, taxonomic composition and temporal accumulation of alien species. In addition, data on anthropogenic pressures, on the exchange routes of goods and people, and on a large range of environmental factors have increasingly become available for islands. Combined, this data allow for robust analyses of the patterns and processes of island invasions worldwide. In this talk, we will present key insights that have emerged recently from these global databases. Further, we will highlight the likely future consequences of biological invasions for island biota, and identify gaps in knowledge which have to be addressed as a priority.



## A European early warning and rapid response system of invasive alien species

ANA CRISTINA CARDOSO, K. TSIAMIS, E. GERVASINI, F. D'AMICO & I. DERIU



Cardoso, A.C., K. Tsiamis, E. Gervasini, F. D'Amico & I. Deriu 2016. A European early warning and rapid response system of invasive alien species. Pp. 108 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: Europe, IAS - Invasive Alien Species, information system, early warning, notification system.

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Invasive alien species (IAS) contribute substantially to species decline and extinction, in particular on islands. The risk exposure to IAS is likely to grow due to increased global trade, transport, tourism and climate change. The most desirable environment and cost-effective approach to tackle IAS is prevention. This entails: a) listing of IAS not yet present in a given territory or at an early stage of invasion with the most adverse impact; b) the establishment of surveillance systems for early detection; c) establishment of a body responsible for prompt eradication and, d) appropriately resourced contingency plans. Recognizing the need for robust action to control and mitigate IAS, the European Commission (EC) adopted the EU Regulation 1143/2014 on the prevention and management of IAS. A list of IAS of Union concern, based on risk assessments will be published soon. For these species, the Member States (MS) must take action to prevent further introductions and spreading to neighbouring countries, in case cost-effective management measures are not available, and to promptly detect and eradicate them in parts of the MS where newly arrived. The European Alien Species Information Network (EASIN; <http://easin.jrc.ec.europa.eu>) has been developed by the EC as the information support system for the implementation of the IAS Regulation. EASIN aggregates data and information indifferent information systems and databases worldwide, harmonizing synonyms, common names, occurrence, biology, origin, year of first introduction, impact and introduction pathways, following international standards. EASIN offers flexible online search and mapping services for the retrieval of tailored information. In addition, an Early Warning Notification System (NOTSYS) is being developed within EASIN, to be used by EU MS for notifying the EC and all MS for new detection of IAS, and for reporting management actions as well as their effectiveness. New populations of IAS must be monitored against a geographic distribution baseline validated by MS.

## *Harmonia axyridis* (Pallas) (Coleoptera: Coccinellidae) did not invade the Azores (Portugal): Is invasibility to blame?

ISABEL BORGES, A. MAGRO, A. GIL & A. O. SOARES



Borges, I., A. Magro, A. Gil & A.O. Soares 2016. *Harmonia axyridis* (Pallas) (Coleoptera: Coccinellidae) did not invade the Azores (Portugal): Is invasibility to blame?. Pp. 109 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: Coleoptera (Coccinellidae); *Other*: ladybirds, *Harmonia axyridis*, invasibility, invasiveness, food requirements, community structure.

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Despite several attempts to introduce *H. axyridis* in the Azores, the ladybird apparently did not establish. The invasiveness of this large sized species is well studied but not much is known about the relationship between life-history traits related to the ability to invade and the environment invasibility. Ladybird communities in the Azores are nowadays dominated by the minute species of the *Scymnus* genus. The largest ladybird species present is the medium sized *Coccinella undecimpunctata* L. whereas the large *C. septempunctata* L. is no longer found in the archipelago. We hypothesize that the actual surface and fragmentation of suitable habitats and consequently the availability of food resources along with ladybird life-history traits related to reproduction and development, determine the current ladybird community structure. To test this hypothesis we characterized the habitat in terms of the quantity of prey and evaluated suitable habitat surface and fragmentation. Furthermore, reproductive and developmental traits were estimated for small, medium and large ladybirds. Our results showed that suitable ladybird habitats in the Azores are highly fragmented, and cover less than 10 % of the island surface. Resource levels required for ladybird species to develop and reproduce seem to be suitable therefore for medium and small species but not for large sized species. Indeed, we found that *C. undecimpunctata* and *Scymnus* spp required for development, respectively, 30% and less than 10% of the prey biomass consumed by *C. septempunctata*. Also fat investment in gonads was significantly higher for the large ladybird than for the medium and small sized species. Habitat invasibility assessed by resource availability along with predator particular life-history traits seem to be determinant key factors for community structure and for the outcome of invasion by ladybirds in particular.



# Alien Species Profile (ASP): A streamlined workflow for collaborative authoring, peer-review and scholarly publication of information on invasive species

LYUBOMIR PENEV, P. STOEV, T. GEORGIEV, V. SENDEROV & P. CARDOSO



Penev, L., P. Stoev, T. Georgiev, V. Senderov & P. Cardoso 2016. Alien Species Profile (ASP): a streamlined workflow for collaborative authoring, peer-review and scholarly publication of information on invasive species. Pp. 110 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: alien species, invasive alien species, invasive biology, scholarly publication.

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Alien Species Profiles (ASP) are concise treatments of invasive alien species (IAS) that originate from internationally recognized standard templates, respectively from NOBANIS, CABI and ISSG species pages/factsheets. The species profiles are elaborated for the Biodiversity Data Journal in collaboration with invasion biologists and are available as templates in the ARPHA Writing Tool (AWT) where they can be worked on collaboratively and then directly submitted to the journal for peer-review, publication and dissemination. Apart from the user-friendly and rich editing environment, the tool provides additional functionalities including commenting, replying to comments, importing data from online resources (for example, literature references from CrossRef, PubMed, Mendeley and occurrence records in Darwin Core format from GBIF, BOLD, iDigBio), versioning, reviewing by external parties during the authoring process, linguistic and copyediting, automated mapping, building image plates and multimedia, automated technical check, and others. At the end, the author can submit the profile to the Biodiversity Data Journal or One Ecosystem journal, with just a click of a button, pass peer-review, and publish it as an open access citable article within days after acceptance by the editors. The publication will be available in semantically enhanced HTML, PDF and machine-readable XML, all archived in PubMedCentral and ZENODO. The workflow is suitable for interest groups formed either on regional basis or by taxa of interest and will provide a collaborative working and peer-review platform to the group members, as well as publications in contextually linked online collections. The ASP published as academic articles are expected to incentivize invasion biologists to publish citable up-to-date species information and create additional motivation for researchers to contribute to international data aggregators on alien species. Once published, the information on alien species can be directly imported into data platform dealing with invasive species with no further work for assessors and reviewers.

## The impact of invasive plant species on native communities in UK Overseas Territories

COLIN CLUBBE



Clubbe, C. 2016. The impact of invasive plant species on native communities in UK Overseas Territories. Pp. 111 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: UK Overseas Territories, St Helena, Falkland Islands; *Taxa*: plants; *Other*: GSPC, *ex situ* conservation, invasive plants.

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Invasive alien species (IAS) present a current and continuing challenge for island communities around the world. Invaders have significant negative impacts on native communities and the resources required to map and control them put extra strains on already over-stretched environmental budgets. Kew's UK Overseas Territories (UKOTs) team are working with partners in several UKOTs to document plant diversity, assess non-nativeness and develop strategies for dealing with invasive alien plants. Key activities and interventions comprise: (i) identifying, documenting and prioritising invasive alien species of plant; (ii) developing *ex situ* approaches to conserve native species, including seed collecting and establishing native species nurseries; (iii) *in situ* control measures; (iv) promoting better biosecurity and quarantine measures; (v) directly linking these activities to key policy initiatives, including the Global Strategy for Plant Conservation (GSPC), that the territories have committed to in order to demonstrate the role that invasive species control is playing in delivering policy objectives. This talk will draw on case studies from several UK Overseas Territories, including the Falkland Islands and St Helena to illustrate the diversity of approaches underway and assess their effectiveness and long-term sustainability.

## Eradication of island invasives: Major incremental improvements and dramatic new possibilities

DANIEL SIMBERLOFF



Simberloff, D. 2016. Eradication of island invasives: Major incremental improvements and dramatic new possibilities. Pp. 112 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: RNA-guided gene drives, eradication efforts, seed banks, public health.

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Continuing, substantial incremental progress characterizes efforts to eradicate nonnative vertebrates from islands, with at least 31 mammal and 8 bird species eradicated from over 600 islands worldwide. Success rates have increased, as have areas of target islands, number of projects targeting multiple invasive species, and number of projects undertaken on inhabited islands. Considerable payoffs to conservation are demonstrable and often rapid. Island plant eradication efforts have also increased, with clear successes despite pessimism engendered by soil seed banks. Insect eradications are possible – even on large islands – but costs are often so substantial that only public health or agricultural concerns, rather than conservation, can lead to adequate funding. The various advances to date have entailed many new technologies and improved techniques, but these have essentially been embellishments, often dramatic ones, of existing strategies. Several new strategies based on genetic advances – most recently RNA-guided gene drives –are under rapid development and offer great promise, particularly for island invasive species.

## Invasions facilitation: Novel mutualisms between alien plants and native insects

MARIA ROSA PAIVA & M. ALMEIDA



Paiva, M.R. & M. Almeida 2016. Invasions facilitation: Novel mutualisms between alien plants and native insects. Pp. 113 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: Acacia, Coleoptera, Diptera, Hymenoptera; *Other*: insect-plant mutualisms, seed dispersal, pollination, native ants, alien ants.

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Evolutionary outcomes at community level are largely determined by species interactions, among which mutualisms, i.e. interactions that improve the fitness of the organisms of all species involved. Although mutualisms have been operating over millions of years, in invaded habitats novel interactions can quickly evolve between alien species and either native or alien ones, resulting in enhanced invasions. In southern Europe, Australian acacias presently constitute a growing threat to the integrity of ecosystems. Two types of studies, A and B, were conducted in Portugal, both in areas invaded by *Acacia longifolia* and *Acacia dealbata* and in areas bearing natural vegetation. In study A, ant communities were compared, ant mutualisms identified and characterized and the type of services provided by ants in the dispersal of acacias seeds assessed. Two native species, the scavenger *Cataglyphis iberica* and the granivorous *Messor barbarus* proved to be efficient dispersers, transporting seeds to distances larger than previously observed and showing a diet switch type of response to the abundance of acacia seeds. By contrast, the invasive *Linepithema humile* did not transport acacia seeds and consumed the elaiosomes in situ, thus reducing the probability of their removal by other ants. In study B, mutualisms between *A. longifolia* and insect pollinators were identified. It was concluded that native species of Hymenoptera, Diptera and Coleoptera which fly early in the season, in synchrony with the acacias flowering period, contribute to the pollination of the invasive plants. Results provide evidence of the importance of recent evolutionary processes, namely the establishment of novel mutualisms, in the facilitation of invasions. Although several studies indicate that connectance values of food chains incorporating invasive alien species do not differ from those of non-invaded networks, as the invasion progresses the whole network typology will be modified. Integrated research at community and ecosystem level is urgently needed.

## Effectiveness of seed dispersal of fleshy fruits by *Turdus* and wind on Robinson Crusoe Island, Chile

CECILIA SMITH-RAMÍREZ & V. ZAPATA



Smith-Ramírez, C. & V. Zapata 2016. Effectiveness of seed dispersal of fleshy fruits by *Turdus* and wind on Robinson Crusoe Island, Chile. Pp.114 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Robinson Crusoe Island, South Pacific; *Taxa*: *Turdus falcklandii*, *Aristotelia chilensis*, *Rubus ulmifolius*, *Ugni molinae*; *Other*: anemochory, barochory, endozoochory, invasive species, invasive species management.

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Fleshy fruits are dispersed mainly by animals and gravity. Since strong winds occur on Robinson Crusoe Island, we believe that some fleshy fruits might be dispersed by this vector. We evaluated the seed dispersal of fleshy fruits by wind and *Turdus* in a management area where fleshy-fruits-invasive species had been removed, and compared the effectiveness of *Turdus* and wind seed-dispersal. The only disperser bird on this island is *Turdus falcklandii*. Three hundred and sixty seed collectors of 30 cm diameter were installed during 18 months, along two fruiting seasons, in a forest management area surrounded by invasive shrublands. We placed the seed collectors inside the forest and in 62 forest gaps where invader plants had been removed. Others were placed at the border of the forest with gaps and inside invasive scrublands. Every month the seeds and fruits of each seed collector were quantified and identified. We assumed that fruits fallen in traps that were in the middle of gaps (without vegetation cover) were dispersed by wind and the seeds in feces were dispersed by *Turdus*. We assumed that fruits dispersed in forest, border and invader scrubland that were not of the same species than the vegetation covering the collector, were dispersed by wind. In addition, we evaluated seedling emergence in the field, of the seeds of the main species dispersed, which were three invasive ones. We found that 21.9% of *Aristotelia chilensis*, 16% of *Rubus ulmifolius*, 48.4% of *Nothomyrcia fernandeziana*, 23% of *Drimys winteri*, 9% of *Rhaphithamnus venustus* and 5% of *Ugni molinae* seed rain in collectors were dispersed by wind. We also found that wind is an effective seed disperser of *Aristotelia*, less effective in the case of *Rubus*, but not in the case of *Ugni*.

## Final stage of the mongoose-eradication project on Amami-Oshima Island, Japan

YUYA WATARI, K. FUKASAWA, T. HASHIMOTO, T. MOROSAWA, H. KOMINE, F. YAMADA, C. IWAMOTO & S. ABE



Watari, Y., K. Fukasawa, T. Hashimoto, T. Morosawa, H. Komine, F. Yamada, C. Iwamoto & S. Abe 2016. Final stage of the mongoose-eradication project on Amami-Oshima Island, Japan. Pp. 115 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Amami-Oshima Island, Japan; *Taxa*: mammals, frogs; *Other*: invasive predators, detection dogs, eradication, impact, restoration, recovery of native species.

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Biological invasion is one of the main factors devastating biodiversity and ecological services. Therefore, conservation actions give a high priority to invasive alien species (IAS) management. Recently, the successful eradication of IAS has been increasingly reported, although the studies have been limited mainly to small islands or relatively simple ecosystems, where the IAS could be eradicated quickly using relatively basic methods. Here, we explore the challenges of the final stage of a long-term (15 years) eradication project on a big island (712 km<sup>2</sup>). The small Indian mongoose, *Herpestes auropunctatus*, was introduced to Amami-Oshima Island, Japan, in around 1979, and expanded its range to forested areas inhabited by many endangered species, decreasing their populations. The Ministry of the Environment began the eradication project in 2000, and through an intense trapping effort (>2 million trap nights per year), the estimated mongoose population declined markedly from about 6,000 in 2000 to <100 in 2015. The recoveries of six island endemic vertebrates have been confirmed: the Amami rabbit, *Pentalagus furnessi*; Amami spiny rat, *Tokudaia osimensis*; Ryukyu long-furred rat, *Diplothrix legata*; Amami Ishikawa's frog, *Odorrana splendida*; Amami tip-nosed frog, *Odorrana amamiensis*; and Otton frog, *Babina subaspera*. Currently, the project is entering the final stage, which involves a lower trapping rate of the mongoose and a focus on detecting and eliminating survivors. In this presentation, we explore new techniques to deal with this situation, such as spatial allocation of the trapping effort, the use of detection dogs, and a reduction of the by-catch of recovered native species, and discuss the feasibility of mongoose eradication.



## Listen to the crickets: An innovative approach to improving tropical island biodiversity monitoring in context of invasive spread and biodiversity crisis. Insights from the New Caledonian biodiversity hotspot

JÉRÉMY ANSO, L. DESUTTER-GRANDCOLAS, E. BOURGUET & H. JOURDAN



Anso, J., L. Desutter-Grandcolas, E. Bourguet & H. Jourdan 2016. Listen to the crickets: An innovative approach to improving tropical island biodiversity monitoring in context of invasive spread and biodiversity crisis. Insights from the New Caledonian biodiversity hotspot. Pp.116-117 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: New Caledonia, South west Pacific; *Taxa*: Orthoptera Grylloidea; *Other*: biodiversity monitoring, cricket communities, bioacoustic, ecological succession, invasive species.

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Among Orthoptera, crickets appear to be the “poor relatives” in the context of ecosystem monitoring, compared to katydids and grasshoppers. However, in insular tropical forests, crickets exhibit higher diversity than other orthopterans, and are among the most abundant insects on forest floor, contributing to phytophagy and litter degradation, and key resources for higher trophic levels. They also exhibit acoustic activity that can be recorded and monitored. These properties could be highly relevant to develop efficient indicators of environmental health, especially on islands, which, though they make up less than 5% of land surface, shelter nearly 50% of all critically endangered species, accompanied with high levels of habitat destruction and invasive species spread. Thus, we propose an innovative biodiversity monitoring tool based on cricket fauna and their songs. In the New Caledonian biodiversity hotspot, which has a rich and highly endemic cricket fauna (>180 taxa, >90% endemism), we characterized cricket communities through a standardized taxonomic and acoustic census effort. We considered an ecological gradient from shrubland to forest (3 stages), in the context of the spread of a major invasive ant (*Wasmannia auropunctata*). We monitored 48 plots (16 per ecological stage: 8 invaded and 8 uninvaded plots). We found that each stage is characterized by a specific cricket community, with a complete species turnover from shrubland to forest. Cricket communities also respond to invasive ant spread. Furthermore, passive recording at night showed a high contribution of



crickets to the ambient sound, and that changes in cricket sound revealed the underlying community changes in response to habitat gradient and invasion status. These results highlight an exciting possibility for a fast and non-invasive method of monitoring rich insect fauna. As crickets are present in virtually every island ecosystem, they could be widely assessed as a potential bioindicator to improve management of tropical island ecosystems.

## Harmonization and integration of databases: Linking impact and pathways

JAN PERGL



Pergl, J. 2016. Harmonization and integration of databases: Linking impact and pathways. Pp.118 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Europe; *Taxa*: all; *Other*: data management, online sources, databases, pathways, impact.

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In the presentation I will focus on two issues; online sources for invasive alien species (IAS) and the interactions between pathway of introduction and impact. Several IAS online sources are used by researchers, policymakers and managers. By means of an online questionnaire we identified which databases are used and for what. In our survey we also looked at data information gaps for individual data sources. Our aim was particularly to identify the aspects related to pathways of introduction, impact and distribution data. By exploring whether established alien species with known ecological impacts (IAS) are associated with particular introduction pathways, the second part of the presentation will be focused on addressing the relationship between impact of alien species and pathways of biological invasions. The CBD and EU legislation confirm that policies focus on the prioritization of pathways in order to prevent the introduction of IAS. To make pathway management work efficiently, it is clear that it has to be built on rigorous data on the impacts of alien species, and how these interact with individual pathways. We found that some pathways and taxonomic groups contribute disproportionately more to the overall risk from alien species with documented impacts, and these should receive increased attention.

## Analysis of the impacts of invasive alien species in an island context: Implications for management

ANGELIKI F. MARTINOU



Martinou, A.F. 2016. Analysis of the impacts of invasive alien species in an island context: Implications for management. Pp. 119 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: global *Taxa*: all; *Other*: mosquitoes, public health, ecosystem services.

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Islands differ in size, characteristics and distance from the shore. As a result they support unique life assemblages with high levels of endemism and offer valuable ecosystem services contributing to human well-being. Globalization and human activities have brought even the most remote of these island landscapes closer than ever to the mainland and invasive alien species are widely accepted as a leading threat to island biodiversity with large ecological and socio-economic impacts. An overview of the impacts of invasive alien species on biodiversity and ecosystem services from islands with different characteristics will be presented based on the most up to date research advances but also from the knowledge gained through collaborative work that takes place during the COST TD1209 Action. Examples will be drawn based on current experience with particular reference to invasive species of medical or public health importance. Implications for decision making and management of IAS species will be discussed.

## When invasive ants are more efficient than natives ones to disperse seeds: Implications for restoration of highly disturbed shrublands in New Caledonian biodiversity hotspot

MAUREEN CATEINE, I. GAYRAL, O. BLIGHT, E. PROVOST & H. JOURDAN



Cateine, M., I. Gayral, O. Blight, E. Provost & H. Jourdan 2016. When invasive ants are more efficient than natives ones to disperse seeds: Implications for restoration of highly disturbed shrublands in New Caledonian biodiversity hotspot. Pp. 120-121 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: New Caledonia; *Taxa*: Formicidae, *Polyrhachis guerini*, *Solenopsis geminata*; *Other*: invasive ants, seed dispersal, myrmecochory, ecosystem processes.

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Island communities are often renowned for their assemblage distortion, so called "island disharmony", in comparison with similar areas on mainland. So we observe atypical niche filling or vacant niches that newcomers, such as invasive alien species (IAS), could monopolise easily. Ants are an interesting model in this context, especially considering their involvement in various ecosystem processes, such as seed dispersal. Ants may be involved in seed dispersion whether passively by granivory (predation) or actively by myrmecochory (adaptation of seeds). At world scale, Australia has been regarded as a major diversification hotspot for evolution of myrmecochory. Yet, despite strong affinities with Australia, this ecosystem service provided by ants has never been evaluated in New Caledonia. How native ants' communities return this ecosystem service and what is the impact of invasive ants on this service? We address these questions in open shrubland on ultramafic soils in New Caledonia, which is considered as a high challenge for vegetation restoration, in a context of increasing perturbation regime by both fire and nickel mining activities. The native ant communities are dominated by the endemic ant *Polyrhachis guerini*. But these open habitats may also be colonized by major invasive alien ants, such as *Solenopsis geminata*, a granivorous fire ant. We selected two conditions (invaded

vs uninvaded by fire ants) where we have tested 6 native seeds against ant dispersal (with variation in size and occurrence of elaiosomes). We performed experiments about seed preference (choice test) and seed dispersal (distributed depots). Our results are unexpected: if the dominant native ants (*P. guerini*) illustrate some ability for seed dispersal, it was highly outcompeted by the invasive one (*S. geminata*), which seems more efficient to disperse local seeds. Our results are preliminary and require further studies, but it illustrates potential important functional role for invasive ants in heavily disturbed ecosystem conditions.

## Marine invasions in offshore islands: A perspective from the Macaronesia region

JOÃO CANNING-CLODE, P. CHAINHO, T. MARQUES, R. HAROUN, P. FOFONOFF, L. MCCANN, J. T. CARLTON ET AL.



Canning-Clode, J., P. Chainho, T. Marques, R. Haroun, P. Fofonoff, L. McCann, J.T. Carlton, G. Ruiz & R.S. Santos 2016. Marine invasions in offshore islands: A perspective from the Macaronesia region. Pp. 122-123 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Macaronesia; *Taxa*: benthic communities; *Other*: biological invasions, non-indigenous species, fouling; island ecosystems.

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While terrestrial introductions have been well documented on many island ecosystems and continue to be the focus of extensive work in invasion biology, studies on marine invasions on most of the world's islands have been poorly explored. Three island systems in the Pacific Ocean (New Zealand, Hawaiian Islands and Guam) and one in the Atlantic Ocean (Azores) are exceptions. Although the ability to compare and evaluate the extent of invasions between island and mainland systems is accompanied by a number of restraints, some studies predict that impacts of marine non-indigenous species (NIS) on biodiversity, as for terrestrial systems, will be greatest on islands. In contrast, other studies found no evidence that native marine biotas of islands are more severely affected by invasions compared to continental biotas. These contrasting hypotheses thus await more rigorous examination as more data become available. To expand our understanding of the scale and diversity of fouling marine bioinvasions on insular systems, we examine here the marine bioinvasions of benthic organisms of Macaronesia, consisting of four archipelagos: Azores, Madeira, Canary Islands and Cape Verde. We performed the first extensive literature review of records of fouling NIS in Macaronesia and have complemented this search with data from ongoing field surveys in some of the islands. We recognize 108 NIS in the region and relate these numbers with critical spatial and temporal variables, including latitude, ship traffic, distance to mainland ports and the nature of modern day vectors that continue to

bring non-native species to these island systems. The number of NIS was higher in Azores followed by Madeira, Canary Islands and Cape Verde. Finally, closer island systems share more NIS probably due to a closer shipping history.



## Marine protected areas as biotic resistance hot-spots against non-indigenous species invasions

IGNACIO GESTOSO, P. RAMALHOSA, P. OLIVEIRA & J. CANNING-CLODE



Gestoso, I., P. Ramalhosa, P. Oliveira & J. Canning-Clode 2016. Marine protected areas as biotic resistance hot-spots against non-indigenous species invasions. Pp. 124 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Madeira island; *Taxa*: Form Marine fouling organisms (e.g. sponges, hydroids, tube worms, barnacles, bryozoans, ascidians, and algae); *Other*: non-indigenous species, fouling communities, MPA, marina, biotic resistance.

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Biological invasions are a major threat to both world's biota and human society, and together with habitat destruction are considered major causes of biodiversity loss worldwide. Consequently, world marine policy is recognising the need for more marine protected areas (MPAs) as a major tool for protection and conservation of marine biodiversity. Particularly in small islands, MPAs are central assets of the local economy and society, and key to increasing the community and ecosystem stability in the face of human impacts, such as bioinvasions. Located in the Northeast Atlantic, the offshore Madeira island suffers, however, an intense human activity along its coastal environment (i.e. ship trade, aquaculture production, recreation, transportation). In this context, the number of alien species in Madeiran waters has been found to be increasing in recent years due to ongoing monitoring surveys of harbours and marinas. The arrival and/or expansion of alien species from these already invaded areas (i.e. marinas and ports) to other coastal areas and, especially to MPAs, can potentially cause unpredictable changes in the biotic structure and composition of ecological communities of the archipelago. This study reports a pilot experiment conducted to evaluate how MPA communities will be affected by settlement and/or expansion of alien species. After an initial 6-month colonization period at the Garajau MPA (SW Madeira), 10 PVC settling plates were transferred to Funchal marina to be exposed to high levels of alien species propagule pressure for an additional 3 months. Fouling communities from the MPA, Funchal marina and bare plates were then combined in four different PVC plate treatments. Results indicate structure and composition of fouling communities from the MPAs differed from those collected in the marina. Interestingly, MPA communities tended to show lower percentages of alien species cover, suggesting some degree of biotic resistance against colonization and/or expansion by alien species.

## The role of plant fidelity and habitat disturbance on the species richness of indigenous and exotic canopy spiders on an oceanic island

MARGARITA FLORENCIO, F. RIGAL, P.A.V. BORGES, P. CARDOSO, A. M.C. SANTOS  
& J.M. LOBO



Florencio, M., F. Rigal, P.A.V. Borges, P. Cardoso, A.M.C. Santos & J.M. Lobo 2016. The role of plant fidelity and habitat disturbance on the species richness of indigenous and exotic canopy spiders on an oceanic island. Pp. 125-126 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Terceira Island, Azores; *Taxa*: Canopy spiders; *Other*: arthropods, biotic resistance to invasions, oceanic island, plant architecture, species richness.

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Oceanic islands are isolated portions of earth of volcanic origin offering a wide spectrum of “vacant” niches for species colonization. The large distance from islands to the mainland and the wide opportunities for colonizers usually favor the assembly of non-saturated communities in which the role of competitive interactions should be low. However, these particular conditions can also facilitate the human-mediated introduction of alien species. Oceanic islands can thus act as real experiments to examine the influence of biological invasions and to understand the processes that lead to successful invasions. We analyzed the role of habitat disturbance (both at local and at regional scale) and plant features on the species richness of local canopy spiders of both native and alien potentially invasive alien species on the Azorean island of Terceira. Canopy spiders could be affected by habitat disturbance, the biogeographical origin of plant (native vs. alien), and the complexity of vegetation structure. We detected that, at local scale, habitat and plant origin are able to explain the variation in the species richness of native spiders, whereas habitat and plant structure poorly explained the alien spider richness. The surrounding landscape matrix substantially affected native spiders, but did not affect alien spiders, with the exception of the negative effect exerted by native forests on the richness

of alien species. We suggest that the local effects of habitat type, plant origin and plant structure are able to explain the species richness variation observed at a regional scale. Plant fidelity and plant structure are key factors for native and alien species respectively, suggesting that native forests may act as physical barriers to the colonization of alien spiders. Our findings shed light on the mechanistic processes behind invasions but also establish guidelines for the land-use management in the study island in order to minimize the effects of anthropic alterations on biodiversity.

## Ancient DNA and microfossil analysis of ancient rat faeces reveals new insights into the impact of the introduced Pacific rat (*Rattus exulans*) on the prehistoric New Zealand biota

JANET M. WILMSHURST, J.R. WOOD & T.C. COLE



Wilmshurst, J.M., J.R. Wood & T.C. Cole 2016. Ancient DNA and microfossil analysis of ancient rat faeces reveals new insights into the impact of the introduced Pacific rat (*Rattus exulans*) on the prehistoric New Zealand biota. Pp. 127 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: New Zealand; *Taxa*: Pacific rat, *Rattus exulans*; *Other*: coprolites, rat, predation, invasion, ecological interactions, aDNA.

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Rats have been dispersed with prehistoric humans to thousands of islands around the world, where they have had devastating effects on indigenous biotas and ecosystems. However, a complete understanding of the ecological consequences of rat invasions has remained elusive. This is because contemporary studies on rat impacts are based on ecosystems heavily modified during prehistoric times, and prehistoric evidence for direct rat predation is mostly circumstantial e.g., a short temporal overlap of bones of rats with extinct birds. In this talk I will show how ancient DNA and microfossil analyses of dated ancient rat dung found in rock crevices can directly reveal the impacts of the Pacific rat (*Rattus exulans*) on intact New Zealand ecosystems, from the start of their invasion when they were introduced with the first human settlers in the 13th century. Reconstructing past ecological interactions between an invasive rat and island biota helps to resolve questions about how invasive rats transform vulnerable island ecosystems, and to advance our thinking about the legacy of rat impacts on current ecosystem processes and function.

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## SPECIALIZED SYMPOSIA – BIODIVERSITY



The Azorean native spider species *Macaroeris cata* (Blackwall, 1867) (Photo: Paulo A. V. Borges)

Island Biology 2016  
2nd International Conference on Island Evolution, Ecology and Conservation

## Specialized Symposium 20

### (Bd1) Biodiversity in the Gulf of Guinea Islands

CHAIRS: MARTIM MELO, RICARDO LIMA, ROBERT C. DREWES & LUÍS M.P. CERÍACO



## Endemism unsung: The California Academy of Sciences Gulf of Guinea expeditions

ROBERT C. DREWES



Drewes, R.C. 2016. Endemism unsung: The California Academy of Sciences Gulf of Guinea expeditions. Pp. 131 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Gulf of Guinea; *Taxa*: fauna and flora; *Other*: biogeography, colonization, divergence times, museum collections, oceanic islands.

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The Gulf of Guinea archipelago includes a continental (land-bridge) island, Bioko, along with three oceanic Islands - Príncipe, São Tomé, and Annobón. Since initial Victorian-era expeditions in the late 19<sup>th</sup> Century, the biodiversity of the islands has remained rather poorly sampled, in spite of their fairly close proximity to Europe. Following an earlier survey of Bioko, the lone “continental” member of the archipelago, the first of nine multidisciplinary terrestrial expeditions and two marine expeditions to São Tomé and Príncipe was initiated by the California Academy of Sciences In 2000. To date, these modern expeditions have consisted of 46 different scientists, graduate students, photographers and educators from eleven institutions. In an ongoing effort to document the macrobiota of the islands, a wide variety of organisms ranging from bryophytes to flat worms and millipedes to amphibians has been sampled; over 60 publications based directly or in part on these collections have yielded numerous new species and distribution records, and a continual refinement of estimates of endemism. Tissue samples and corresponding voucher specimens have been collected in all groups; these are available to the scientific community, enabling molecular testing of relationships between taxa, estimates of time divergence, dispersal patterns and the testing of biogeographic hypotheses such as distance and area effects, dynamic equilibrium, etc. The Government of the Republic of São Tomé and Príncipe is supportive of this work.

## Bird speciation in the Gulf of Guinea

MARTIM MELO & P. JONES



Melo, M. & P. Jones 2016. Bird speciation in the Gulf of Guinea. Pp. 132 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Gulf of Guinea; *Taxa*: birds; *Other*: allopatry, endemism, in-situ diversification, introgression, radiation, sympatry.

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The Gulf of Guinea islands constitute a remarkable center of endemism. Nowhere is this more evident than for the birds of Príncipe and São Tomé. These two islands hold a concentration of endemic birds with no parallel worldwide: 28 species in an area barely reaching 1000 km<sup>2</sup>. This high number of endemic bird species was the result of speciation events rather than the accumulation of relict species extinct on the mainland. The main reason for such high levels of in-situ diversification stems from the particular geographical situation of the islands. From a bird's perspective, the islands: i) are located at a distance from the mainland that is both close enough to make colonisation events probable and far enough to make maintenance of connections with the mainland unlikely; and ii) are surrounded in the north and east by one of the richest centres of biodiversity in the world, providing a large pool of potential colonisers. As a result, the islands were colonised by species from a diverse array of families that, by occupying a variety of different niches, reduced the possibilities of radiations within the archipelago. Nevertheless, two cases of archipelago radiation have been demonstrated for five white-eyes (Zosteropidae) and for two seedeater species (Fringillidae). The seedeater case is of particular interest in that it shows the dynamics between gene flow and natural selection during speciation in sympatry (see talk by Martin Stervander, Symposium Ev-2). In general, species that diverged the most in phenotype were those that speciated after establishing sympatry with related populations, providing strong evidence for the importance of ecological interactions in promoting phenotypic diversification and speciation.

## Príncipe Island UNESCO Biosphere Reserve: A living lab to promote sustainability, awareness and conservation

ESTRELA MATILDE & A. ABREU



Matilde, E. & A. Abreu 2016. Príncipe Island UNESCO Biosphere Reserve: A living lab to promote sustainability, awareness and conservation. Pp. 133 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. Arquipelago. Life and Marine Sciences.

Key words: *Location*: Príncipe Island, São Tomé & Príncipe; *Taxa*: multiple; *Other*: biodiversity, sustainable development, community engagement, integrated conservation.

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'Science for Sustainability support sites', UNESCO Biosphere Reserves are special places for testing interdisciplinary approaches to understand and manage changes and interactions between social and ecological systems, including conflict prevention and management of biodiversity. Príncipe Island was recognised as a UNESCO World Biosphere Reserve in 2012 in a process driven by the President of the Regional Government and with a strong integration of the 8000 inhabitants of the island. The President envisages a development model for the island that follows the standards of Biosphere Reserves, promoting solutions to reconcile the conservation of biodiversity with its sustainable use. Príncipe Island Biosphere Reserve (PBR) has a management unit that works as a platform to promote collaborations and projects on the island, but is also developing a strategy and Action Plan, covering three main areas of work: Conservation & Research; Awareness & Communication; and Social & Economic Development of the Island. The PBR strategy and Action Plan goal is to develop the island in a sustainable way, raising awareness regarding the responsible use of the resources and the conservation of species and habitats, changing the local mind-set, and creating opportunities promoting the sustainable development of communities. Today, Príncipe is known as one of the most active Biosphere Reserves of the world, is a member of the African Biosphere Network bureau, and was chosen to represent the African continent on the World Biosphere Reserves Congress, demonstrating that this small special island is setting a very positive example to the world.

## Reed frog diversification in the Gulf of Guinea: Land-bridges, overseas dispersal, and in situ speciation

RAYNA C. BELL



Bell, R.C. 2016. Reed frog diversification in the Gulf of Guinea: Land-bridges, overseas dispersal, and in situ speciation. Pp. 134 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Gulf of Guinea Islands; *Taxa*: African reed frogs (genus *Hyperolius*); *Other*: hybridization, population genomics, long distance dispersal, oceanic island, land-bridge island.

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Island faunas have inspired evolutionary biologists for centuries and I am especially captivated by the enigmatic history of African reed frogs in the Gulf of Guinea archipelago. Within the archipelago, amphibians are distributed on the land-bridge island Bioko, which has periodically been connected to the adjacent African continent, and two oceanic islands (Príncipe and São Tomé) that have never been connected to the mainland. Cycles of rising and retreating sea levels due to global glacial cycles in the Pliocene and Pleistocene resulted in several periods of isolation and connectivity between amphibian populations on Bioko Island and the adjacent continent. To investigate how these cycles shaped population divergence in co-distributed reed frog species, I combine phylogeography and paleoclimatic modeling techniques. In contrast to land-bridge islands, oceanic islands accumulate endemic species via two key mechanisms: colonization by continental or adjacent island species that subsequently diverge from source populations or *in situ* diversification of resident island species. To characterize the roles of dispersal and *in situ* speciation in reed frog diversification on the oceanic islands of the Gulf of Guinea, I combine phylogeography and population genomics. Through this work I identified a hybrid zone between sister species on São Tomé Island and I am currently extending this work to investigate ecological drivers of speciation and phenotypic divergence in this case of *in situ* speciation.

## The population genetics of a *Drosophila* hybrid zone

DANIEL R. MATUTE



Matute, D.R. 2016. The population genetics of a *Drosophila* hybrid zone. Pp.135 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: São Tomé Island, Gulf of Guinea; *Taxa*: *Drosophila*; *Other*: genomics, hybridization, introgression.

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Until recently, hybrid zones in *Drosophila* were either unknown or not studied. The human commensal *D. yakuba* can be collected widely throughout sub-Saharan Africa and on the islands of Bioko and São Tomé in West Africa. *D. yakuba*'s sister species, *D. santomea*, is endemic to the volcanic island São Tomé. On São Tomé, *D. yakuba* is more common at low elevations (below 1,450 m) and *D. santomea* is more common in higher altitude mist forests (between 1,153 m and 1,800 m). The two species hybridize in a stable area of contact in the midlands of São Tomé. We collected hybrids across longitudinal transects of São Tomé to determine the precise geographic range of *D. yakuba*, *D. santomea* and their hybrids. From genome-wide data we probabilistically inferred ancestry of each site in the genome of over 50 individuals. We found that *D. yakuba* individuals from the São Tomé hybrid zone have a mostly *D. yakuba* genome (as expected) but some lines show small regions with *D. santomea* origin. We also identified which of these introgressions had phenotypic effects.

## Biodiversity conservation in São Tomé and Príncipe: An overview

RICARDO FAUSTINO DE LIMA



Lima, R.F. 2016. Biodiversity conservation in São Tomé and Príncipe: An overview. Pp.136 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: São Tomé and Príncipe, Gulf of Guinea, central Africa; *Taxa*: multiple; *Other*: endemics, ecosystems, forest, tropics, central Africa.

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The Democratic Republic of São Tomé and Príncipe (Gulf of Guinea, central Africa) is a small island nation with a remarkable biodiversity. It is often identified as a key global priority for conservation, due to a high number of endemic and threatened species. It holds over 60 endemic vertebrates and 100 endemic plants. The conservation status of ecosystems is difficult to assess because most have not yet been well defined, mapped or extensively surveyed. Nevertheless, there are clear signs that natural areas are fast being converted to human use and that land use of anthropogenic landscapes is being intensified. Almost 100 of its species are classified as threatened by the International Union for Conservation of Nature. These numbers will surely continue growing in the foreseeable future, as new species are still being described and assessed, and human pressure on São Tomé and Príncipe's natural resources is increasing fast. Habitat loss, overexploitation and invasive species have been identified as key drivers of biodiversity loss on the islands, associated to a fast growing economy and human population. I will provide examples of how these threats are affecting biodiversity, by identifying knowledge gaps and by providing specific socio-economic contexts. Several conservation initiatives have taken place in the country in the last 25 years, from the Gulf of Guinea Conservation Group and ECOFAC to the more recent RedeBio and Príncipe's Man and Biosphere Reserve. In 2006 conservation efforts have culminated in the creation of two natural parks, which currently cover nearly one third of the country. I will assess the successes and shortcomings of these initiatives, and propose new directions to ensure the long-term conservation of São Tomé and Príncipe's unique natural heritage.

## BIRD CONSERVATION IN SÃO TOMÉ AND PRÍNCIPE: ISLANDS FOR BIODIVERSITY AND PEOPLE

LUÍS T. COSTA, H. SAMPAIO, G.M. BUCHANAN, R.F. DE LIMA & A. WARD-FRANCIS



Costa, L.T., H. Sampaio, G.M. Buchanan, R.F. Lima & A. Ward-Francis 2016. Bird conservation in São Tomé and Príncipe: Islands for biodiversity and people. Pp. 137 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: São Tomé and Príncipe, Gulf of Guinea, Africa; *Taxa*: birds; *Other*: endemism, threatened species, BirdLife International, partnership, sustainability, threats.

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The avifauna of São Tomé and Príncipe is remarkable. It holds 28 endemic species in just 1001 km<sup>2</sup> and 13 of its birds are globally threatened. Despite being consistently identified as a key area for the conservation of biodiversity, threats such as habitat loss, overexploitation and introduced species are mounting, and conservation measures have been scarce and largely ineffective. BirdLife International has had a presence in the country since 2006, aiming to improve the conservation status of its birds, for the benefit of biodiversity and people. This initiative has invested in research, capacity building and environmental awareness, always in partnership with local authorities. Our work has greatly improved knowledge on the ecology and threats to Santomean birds and ecosystems, as well as on socio-economic contexts. We surveyed large extents of forest, collecting data on the distribution and habitat associations of threatened taxa, as well as information on threats and their socio-economic drivers. We have organized several training courses, as well as provided opportunities for local agents to be engaged in multiple research and monitoring activities. In the medium-term it is also a goal to facilitate the creation of an independent local non-governmental organization to continue working on bird conservation and other environmental matters in São Tomé and Príncipe. Finally, we have also worked to improve environmental knowledge and awareness of local stakeholders, namely the government, civil society and private sector. To such end we have had regular meetings, provided scientific evidence to support decision making and developed several public awareness campaigns. This experience has made clear that the future of humans and biodiversity is intertwined, and that these islands and their birds can provide a model system to study solutions for global sustainability.



## Studying cetaceans in a small archipelago: Challenges and perspectives in the conservation of highly mobile top predators on São Tomé and Príncipe

INÊS CARVALHO, A. PEREIRA, C. PICANÇO, B. LOLOUM & C. BRITO



Carvalho, I., A. Pereira, C. Picanço, B. Loloum & C. Brito 2016. Studying cetaceans in a small archipelago: Challenges and perspectives in the conservation of highly mobile top predators on São Tomé and Príncipe. Pp. 138 -139 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: São Tomé and Príncipe; *Taxa*: Cetacea, *Megaptera novaeangliae*, *Tursiops truncatus*, *Stenella attenuata*; *Other*: cetaceans, conservation, photo-identification, human impacts.

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West African waters have a diverse cetacean fauna but they are also one of the most poorly studied areas worldwide. São Tomé and Príncipe seem to be an important area for cetaceans, probably due to large concentrations of prey, as well as the existence of several small bays and shallow water that constitute important rest areas. In comparison to other areas of the world, little is known about the spatial and temporal patterns of distribution and abundance of cetaceans around this archipelago. Only a few references are available and go back to the 19th and 20th century whaling periods, when the Gulf of Guinea was an important whaling ground. Since 2002, an effort has been made in order to study the occurrence and distribution of cetaceans in São Tomé waters and identify possible threats. Synergies between research teams, local NGOs and international collaborations has allowed producing and sharing data, resulting in a better understanding of local and regional cetaceans' occurrence, movements and migration patterns across the Gulf of Guinea region. We found a regular presence of some species in the archipelago like *Tursiops truncatus* and *Stenella attenuata*; we highlighted the importance of the waters of São Tomé as a calving and nursing area for *Megaptera*

*novaeangliae*; and we identified hotspots for cetacean occurrence around the Island and relate them with anthropogenic pressures (e.g. bycatch, direct hunting and competition). Negative interactions between humans and cetaceans must be quantified, as they may represent a conservation issue. The scarce national legislation on marine conservation and the reduced local capacity to monitor and supervise these negative activities may bring some challenges in terms of future conservation.

## Ecology and distribution of endemic pigeons in São Tomé: Potential implications of hunting

JORGE M. PALMEIRIM, M. CARVALHO, R.F. DE LIMA & J.E. FA



Palmeirim, J.M., M. Carvalho, R.F. Lima & J.E. Fa 2016. Ecology and distribution of endemic pigeons in São Tomé: Potential implications of hunting. Pp. 140 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: São Tomé and Príncipe, Gulf of Guinea; *Taxa*: birds; *Other*: pigeons, island endemics, harvesting, hunting, exotic species.

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Knowledge of the determinants of habitat use and abundance is critical to manage threatened species, especially when they are harvested. Sampling environmental variables and pigeons along 35 km of transects we identified these determinants for four species of endemic pigeons in the Island of São Tomé. In addition, we evaluated the potential impact of the ongoing harvesting on their populations. Maroon Pigeon *Columba thomensis* was the least abundant and most localized species, followed by São Tomé Green Pigeon *Treron sanctithomae*. They were both associated to old-growth forest. Bronze-naped Pigeon *C. malherbii* and Lemon Dove *C. simplex* were more abundant and used a broader range of habitats. Determinants of distribution and abundance varied among species, and included habitat type, fruit availability and potential hunting pressure. Three of the four pigeon species are hunted quite intensively; *T. sanctithomae* and especially *C. thomensis* are significantly affected by this activity. Hunters also harvest substantial numbers of exotic mammals, such as feral pigs, monkeys and civets, which are likely to have a major impact on the valuable biodiversity of the island. Hunting activities should thus be diverted from pigeons to these species, which actually have a greater potential for providing protein. The harvest of such exotic species is likely to be beneficial for the maintenance of local ecosystems and species, a situation that is probably shared with that of many other oceanic islands with a valuable endemic biodiversity.

## SEA TURTLE RESEARCH AND CONSERVATION AT PRÍNCIPE ISLAND, WEST AFRICA

ROGÉRIO L. FERREIRA, T. C. BORGES & A.B. BOLTEN



Ferreira, R.L., T.C. Borges & A.B. Bolten 2016. Sea turtle research and conservation at Príncipe Island, West Africa. Pp. 141 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Príncipe Island (1° 37' N; 7° 23' E), São Tomé and Príncipe, Gulf of Guinea; *Taxa*: *Chelonia mydas*, *Eretmochelys imbricata*, *Dermochelys coriacea*; *Other*: nesting, in-water, stable isotopes.

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Sea turtles are of paramount importance to healthy coastal ecosystems, and their populations are known to be declining worldwide. Príncipe Island (1° 37' N; 7° 23' E) possesses one of the last sea turtle aggregations in West Africa, especially for the critical endangered hawksbill sea turtle (*Eretmochelys imbricata*) but also for green sea turtle (*Chelonia mydas*). Despite its high conservation value, local and regional information on their numbers and habitats remains scarce. Here we present results from research centered at Príncipe Island, with the overall goal to contribute to the conservation of the marine and coastal environment of the region. Using nesting census, in-water surveys and stable isotope analyses we improved the understanding on the ecology and spatial distribution of the sea turtles in and around Príncipe, including their connectivity with foraging and breeding areas. Social integration and cultural sensitivity is fundamental to achieve true community-based conservation; thus we have followed an ethnographic approach to the field and conducted the research based on those principles.

## Adopting an integrated approach to island-wide conservation and sustainable development in the Island of Príncipe, São Tomé & Príncipe

FELIPE A. SPINA, A. BOLLEN, A.M. GARRO, R. ALVES & E. MATILDE



Spina, F.A., A. Bollen, A.M. Garro, R. Alves & E. Matilde 2016. Adopting an integrated approach to island-wide conservation and sustainable development in the Island of Príncipe, São Tomé & Príncipe. Pp.142 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Príncipe Island, São Tomé and Príncipe, Gulf of Guinea; *Taxa*: multiple; *Other*: Biosphere Reserve, livelihoods, governance, biodiversity, empowerment.

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The Island of Príncipe, São Tomé & Príncipe was designated as a Biosphere Reserve in 2012. It is the oldest oceanic volcanic island in the Gulf of Guinea, and has a notable terrestrial and marine biodiversity, particularly due to the high levels of endemism. The Príncipe Trust Foundation (PTF) was formally established in 2015, but some of its projects already have a four-year history. PTF supports the Government in managing and promoting the Biosphere-Reserve. PTF focuses its work in three areas: Conservation & Research; Education, Outreach & Awareness Building; Human & Economic Development. PTF has been particularly interested in exploring participatory approaches based on community empowerment linking conservation with livelihoods. For example, three years ago, a team of 20 local rangers was trained to record nesting and hatching data of threatened sea turtles, conduct patrols on beaches and at sea to tackle illegal poaching, guide tourists during nocturnal visits, and raise awareness on sea turtles. The revenue generated by sea turtle watching goes to a local community fund that benefits the entire community. This approach and close collaboration with the coast guard has already resulted in a significant decrease of poaching. In 2015/2016 we recorded the highest monitored number of Green sea turtle nests, 1621, as well as 80 of Hawksbill and 22 of Leatherback sea turtles. PTF has been working on the conservation of pollinators by mapping wild bee colonies (+20 mapped) in order to promote sustainable beekeeping. In Roça Sundry PTF is engaging with a group of young women building their capacity to organise guided visits around the historical site and promoting the development of traditional handcrafts. The Biosphere team has been implementing projects such the Water & Recycle challenge that collected 316000 plastic bottles in exchange for 6000 reusable bottles while raising awareness about waste management.

## Inferring the migratory connectivity and habitat use of the sea turtles occurring in São Tomé Island using genetics and stable isotopes

JOANA HANCOCK, R. REBELO, S. VIEIRA & N. FERRAND



Hancock, J., R. Rebelo, S. Vieira & N. Ferrand 2016. Inferring the migratory connectivity and habitat use of the sea turtles occurring in São Tomé Island using genetics and stable isotopes. Pp. 143 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: São Tomé Island, São Tomé and Príncipe, West Africa; *Taxa*: Chelonioidae, sea turtles; *Other*: conservation, gene flow, genetics, isotopes, migration.

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Understanding migratory connectivity is central to conservation biology, as the exchange of genes between populations determines the relative effects of selection and genetic drift, while introducing genetic variability and thus increasing local effective population size. Genetic markers have been widely used to assess migratory connectivity in sea turtles, and implications on the populations' dynamics, genetic diversity and population resilience. Three species were targeted for this study: *Lepidochelys olivacea*, *Eretmochelys imbricata* and *Chelonia mydas*. Adult female, a sub-sample of their offspring, adult male and juvenile sea turtles were sampled at several locations on São Tomé and Príncipe archipelago and genotyped at several microsatellite loci to assess levels of multiple paternity, genetic variation and whether individual levels of homozygosity are associated with reproductive success. Additionally, migratory connectivity and habitat use was assessed using mitochondrial DNA and stable isotope analysis of epidermal tissue.

## Improving marine biodiversity and livelihoods of coastal communities in Príncipe

ANA NUNO, K. METCALFE, B.J. GODLEY & A.C. BRODERICK



Nuno, A., K. Metcalfe, B.J. Godley & A.C. Broderick 2016. Improving marine biodiversity and livelihoods of coastal communities in Príncipe. Pp. 144 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Príncipe, São Tomé and Príncipe, Gulf of Guinea Islands; *Taxa*: multiple; *Other*: artisanal fisheries; bycatch; coastal communities; island conservation; natural resource management; social-ecological systems.

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People and nature are inextricably linked; an integrated social-ecological perspective provides a better understanding of systems involving people and natural resources than focusing only on the effect of people on the environment or the effect of interventions on people. For example, to address the sustainability of the world's fisheries, biological aspects of fish stocks need to be taken into account together with the livelihoods of coastal communities and the management of other protein sources. Enhanced and widespread social-ecological approaches will ultimately improve the robustness of natural resource management decisions, with implications for the resilience of social-ecological systems, affecting both biodiversity and human wellbeing. Using artisanal fisheries and the conservation of marine ecosystems in the island of Príncipe (São Tomé and Príncipe, Gulf of Guinea Islands) as a case study, we will explore trade-offs between fisheries and conservation interventions, and potential implications for protected species (e.g. sea turtles, sharks and rays) and local livelihoods. Our project will focus on interventions aimed at improved food security, increased gender equality and poverty reduction in fisheries dependent coastal communities in the island of Príncipe through a participatory social-ecological approach to enhance marine biodiversity and resource management. We will briefly present our research project, with a focus on introducing key research goals and tasks, and discussing opportunities for collaboration and future initiatives.



## Specialized Symposium 12

### (Bd2) Island Forests: Present status and future challenges

CHAIRS: LUÍS SILVA & RUI BENTO ELIAS

## Island forests, an overview

LUÍS SILVA



Silva, L. 2016. Island forests, an overview. Pp.146 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: islands; *Taxa*: forests; *Other*: biodiversity, conservation, economy, forests, islands; management.

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Forests have an important contribution for the maintenance of ecosystem services and of economic activity world-wide: as carbon sinks, reservoirs of biodiversity, sources of food, fiber, medicine, timber, and fuel. The integration of the various services provided by forests, the economic evaluation of ecosystem services, and the sustainable management of forest resources are still unattained but intended objectives. Tourism and recreation are part of a wider set of cultural forest services, including use and non-use values, which being quasi-public assets, are not valued through the normal market mechanisms. Forest management is frequently linked with protected areas, and the implementation of strategies to mitigate climate change. The European Strategy focus on a multifunctional forest, serving economic, social and environmental purposes. Within this framework, the very diverse situation of forests in several archipelagos is discussed. In the Azores, about 10% of the natural forest was estimated to remain while exotic woodland expanded. In Madeira, the forest has a very prominent role in biodiversity conservation but also in tourism, being considered as World Heritage. In several islands, projects aim to recreate the previously lost natural forest, while in others a large forest cover is still present, but only in part corresponding to a mature forest. In several cases, changes in forest affected other biodiversity values and sustainability. Island forests in temperate or colder climates have also been reduced and changed. The scientific investment and the management structure devoted to forests vary considerably, linked to socio-economic and development issues. Although much outside knowledge can be acquired, the implementation of forest management is often hampered due to local politico-economical issues. Therefore, community based approaches are being followed. This symposium aims to discuss the future of island forests within a global framework where the importance of planted forest is increasing as natural forests continue to decline.

## Natural forests of the Azores: Conservation status, threats and guidelines for the future

RUI B. ELIAS



Elias, R.B. 2016. Natural forests of the Azores: Conservation status, threats and guidelines for the future. Pp.147 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Azores; *Taxa*: vascular plants; *Other*: climate change, ecological restoration, forest conservation, laurel forests, montane cloud forests, natural parks.

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Presently, it is possible to define five forest vegetation belts in the Azores: *Erica-Morella* Coastal Woodlands, *Picconia-Morella* Lowland Forests, *Laurus* Submontane Forests, *Juniperus-Ilex* Montane Forests and *Juniperus* Montane Woodlands. The remaining coastal woodlands, where present, are mostly disturbed. Laurel forests (lowland and submontane forests) are the potential dominant vegetation in the Azores since they could cover up to 75% of the land. However, as a consequence of centuries of landscape transformation due to human action, these communities are now in critical danger and reduced to a few, often highly invaded, patches. *Juniperus-Ilex* Forests and *Juniperus* Woodlands (both montane cloud forests) still occupy relatively large areas, mainly in Terceira, Flores and Pico islands. Even so, these surviving native pristine forests, have suffered extensive losses in São Miguel, Pico, São Jorge and Faial. In the last 20 years, the scientific knowledge of Azorean native forests has increased significantly. Biology and ecology of individual species as well as the ecology of forest communities are better understood than ever. Montane cloud forests are especially well studied and many conservation measures were directed to the remaining areas of these communities. Most remaining natural and semi-natural areas are now protected under national and European laws. However, the conservation of natural forests has been most times passive and little attention has been given to coastal woodlands, lowland and submontane forests. Furthermore, recent studies have showed that most tree species may have their potential distribution reduced due to the effects of climate change. There is a clear need for a more comprehensive approach to forest conservation, with emphasis on the restoration of the ecological integrity in and around protected areas, taking into account the possible effects of climate change on species distribution and on the efficiency of current Island Natural Parks.

## Management of exotic woodland resources in the Azores: Biomass availability from *Pittosporum undulatum* stands

LURDES BORGES SILVA, A.I.C. TEIXEIRA, E.B. DE AZEVEDO, M. ALVES, R.B. ELIAS &  
L. SILVA



Silva, L.B., A.I.C. Teixeira, E.B. Azevedo, M. Alves, R.B. Elias & L. Silva 2016. Management of exotic woodland resources in the Azores: Biomass availability from *Pittosporum undulatum* stands. Pp.148-149 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: São Miguel, Terceira and Graciosa islands (Azores); *Taxa*: *Pittosporum undulatum* Ventenat (Pittosporaceae); *Other*: biomass assessment, invasive species, management, modeling.

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A considerable forest area in the Azores (30%) is dominated by non-productive exotic woodland, mostly dominated by *Pittosporum undulatum* and other invasive species. The importance of this invasion is such that the implementation of management actions to stop *P. undulatum* spread should be a priority. An alternative could be the sustainable use or local reforestation of the vast areas occupied by the invader. Our work aims to evaluate the existing woody biomass of *P. undulatum*, in order to assess its availability for energetic use. Previous work was devoted to (i) establish allometric equations to estimate tree biomass from other dendrometric traits (e.g. tree height, diameter at breast height); and (ii) select a reliable but practical method to estimate tree density at *P. undulatum* stands (e.g. T-square sampling). In the present research we applied those methods to a total of 115 randomly selected stands dominated by *P. undulatum* in Graciosa (20 stands), São Miguel (75 stands) and Terceira (20 stands) islands, in order to estimate available biomass. A total of 672 trees were used to select the best allometric models for biomass estimation from dendrometric traits, and 5870 trees were sampled in total for stand biomass estimation. The total quantity of existing biomass was estimated for the *P. undulatum* stands, including confidence intervals, and calculations were made to assess the available annual biomass yield. We then used forest stand traits, topographic and climatic variables to model the spatial distribution of *P. undulatum* biomass. This research allowed refining the biomass

estimates obtained in previous projects and the establishment of a standard methodology for the evaluation of *P. undulatum* stands. Using *P. undulatum* biomass for energetic production, following sustainable principles of forest management, could stimulate its long term containment or eventual replacement at biodiversity sensible areas, while allowing economic and environmental benefits.

## Restoration of the Azorean laurel forest in S. Miguel Island, home of the Azores bullfinch: Lessons learned

RUI BOTELHO, R.H. HELENO, J.A. RAMOS, F. FIGUEIREDO, L. PEÑIL, A. SALVADOR, C. SILVA ET AL.



Botelho, R., R. Heleno, J.A. Ramos, F. Figueiredo, L. Peñil, A. Salvador, C. Silva, R. Coelho, A. Cruz, J. Teodósio & L. Costa 2016. Restoration of the Azorean laurel forest in S. Miguel Island, home of the Azores bullfinch: Lessons learned. Pp.150 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: São Miguel Island, Azores; *Taxa*: vascular plants; *Other*: Macaronesian laurel forests, *Pyrrhula murina*, endemic species, Island Habitat Restoration, IAS control.

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Since 2003 SPEA and several partner institutions have been working in the restoration of natural habitats seriously threatened by invasive alien species (IAS), in São Miguel island, Azores. Those actions have recovered 500 hectares of Azorean Laurel Forest and contributed to reduce the extinction risk of the Azores Bullfinch (*Pyrrhula murina*), an endangered endemic bird. A monitoring scheme was implemented to evaluate the restoration success, which also allowed a better understanding of native and exotic species distribution patterns in this habitat and of their interactions and dynamics. The data collected showed that those Laurel Forests, despite being confined to less than 5 km<sup>2</sup>, present great diversity in terms of composition and structure. While at high altitude plant communities exhibit characteristics of a Humid Laurel Forest, at lower elevation Mesic Laurel Forests are found. Moreover, the two main invasive trees species show distinct distribution patterns: *Clethra arborea* shows highest densities at high altitudes, while *Pittosporum undulatum* is more abundant at low altitude. As for native communities, Humid Forests were found to be the most diverse, whereas in Mesic Forests several species that were expected to exist were not found. Our data also allowed comparison of habitat evolution in invaded areas with or without IAS control. Invaded communities showed a positive evolution after IAS removal, with a positive correlation of native species densities with time after intervention. However, time after IAS removal was also correlated with re-appearance of IAS seedlings. Therefore, a better understanding of the dynamics of invaded and non-invaded Laurel Forests is essential to guarantee long term success of ecological restoration actions.

## Madeira natural forests: Current status and future prospects

MIGUEL MENEZES DE SEQUEIRA, R. JARDIM, J.H. CAPELO,  
C.A.GÓIS-MARQUES, A. FIGUEIREDO & A. PUPO-CORREIA



Sequeira, M.M., R. Jardim, J.H. Capelo, C.A.Góis-Marques, A. Figueiredo & A. Pupo-Correia 2016. Madeira natural forests: Current status and future prospects. Pp. 151-152 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Madeira Island, Portugal; *Taxa*: vascular plants; *Other*: laurel forests, conservation.

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Madeira Island pre-scientific description portrays it as a luxurious forest from sea level to the mountaintop. However, these native forests suffered degradation and loss of occupancy area since the Portuguese settlement of Madeira Island in 1425. Since early times numerous attempts were made to halt the process. In Madeira island five vegetation belts were recognized with climatophilous microforests and mesoforests. Lower altitudes (up to 200 m) of the southern face are associated to a microforest dominated by madeiran oleaster tree, replaced by a microforest of marmulano on the wetter and cooler northern face (up to 80 m). Recently, several localities with these types of forests were proposed to be included in Natura 2000 network. Above these microforests appear the laurel forests, the barbusano-tree forest and the stink-laurel temperate forest. Recent works of rephotography, combined with dendrochronology and phytosociological data, showed that some second-growth forest remained in this state due to severe disruptions (grazing, fire and wood cutting), also the main factors that explain current restricted area of the high altitude tree-heath forests, where expected species such as Madeira juniper and Madeira rowan, are rare. Now-a-days recovery of Madeira vegetation is jeopardised by habitat fragmentation, urban pressure, and niche occupation by exotic plants. Despite the resilience of such forest, patent on the survival to environmental changes in the past, such threats might represent an enormous challenge to conservation, namely because of the



projected upward shift on vegetation belts under future climate change scenarios, which might be blocked by land use or invasion by exotic species. The brand image of *Madeira* as a tourist destination is strongly associated with nature. Thus, the study and preservation of the native forests is a crucial step forward to valorise its multifunctional use, ensuring the equilibrium of the island at multiple levels.

## Abandoned agricultural terraces in Madeira Island: A glimmer of hope for passive restoration?

AIDA PUPO-CORREIA, M.M. SEQUEIRA & J.T. ARANHA



Pupo-Correia, A., M.M. Sequeira & J.T. Aranha 2016. Abandoned agricultural terraces in Madeira Island: A glimmer of hope for passive restoration?. Pp. 153 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Madeira Island, Portugal; *Taxa*: vascular plants; *Other*: historical landscape repeat photography, landscape restoration, abandoned agricultural fields, passive recovery, native vegetation.

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Since the Portuguese settlement of Madeira Island, in 1425, agriculture had played an important role in the early replacement of natural vegetation. This communication describes changes that occurred in areas cultivated in the late 19<sup>th</sup> and early 20<sup>th</sup>, which are currently abandoned. Diverse “retrospective techniques”, such as landscape repeat photography and research of historical records, were used, combined with vegetation *relevés*. There was a clear dispersal of exotic plants over abandoned terraces, more conspicuously in southern coastal areas. Recovery of native vegetation also occurred, although, in much lesser extent. The recovery process was heavily dependent on several factors such as: time when land-clearing started, length of cultivation period, the crop type that was cultivated, time when abandonment occurred, and anthropogenic disturbances that are taking place. Despite all these factors, and regardless of the location, it was the vicinity to native vegetation that determined self-recovery. Plant communities that developed over abandoned agricultural fields are in accordance with previously defined vegetation models. However, the newly formed communities tend to have more exotic and less endemic taxa than similar vegetation types in surrounding areas which acted as sources of the propagules. Passive restoration can be a suitable approach if adjacent diaspore sources exist and there is no time limit. Yet, in view of the foregoing, achieving full balance can demand the removal of exotic species as well as the reintroduction of missing native plants to improve diversity and to restore natural landscapes.

## Invaded indigenous forests remnants of Mauritius: What lessons for island forest conservation?

CLAUDIA BAIDER & F.B.V. FLORENS



Baider, C. & F.B.V. Florens 2016. Invaded indigenous forests remnants of Mauritius: What lessons for island forest conservation?. Pp. 154 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Mascarenes, Indian Ocean; *Taxa*: all; *Other*: alien species control, invasive species, restoration, recovery.

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The indigenous forests remnants of Mauritius, an eight million years old volcanic oceanic island, are broadly characterised by a relatively high tree species richness and a high tree density for an oceanic island. They are also among the forests that have sustained some of the most extreme degree of destruction by humans – only 5% remains – and some of the most severe invasion rates by alien plants worldwide. This confers on Mauritian forests a flavor of what wet forests elsewhere might increasingly come to look like as habitat destruction and alien plant invasion progresses. Concurrently, Mauritius has a network of forest areas, where there has been control of invasive alien plants, sometimes since decades, providing a largely unique opportunity for comparative studies probing the influence of alien plants and of their removal from such forests. We studied the impact of invasive alien species (plants and selected animals) on different guilds of plants and on certain faunal groups through a comparative approach of controlled and adjacent non-controlled forests. We found that even the most well preserved areas of forests are in fact dominated by invasive alien woody plants. The removal of alien plants has profound positive effects. It reduces native tree mortality, increases tree growth rates and reproductive outputs which in turns lead to an increase in regeneration, tree density and species richness, and even to the reappearance of plant species hitherto believed extinct. Non woody plants such as orchids and ferns also recover strongly, sometimes through a cascading effect, and faunal groups such as butterflies and birds recover too. Although a number of species appear to still require additional specific attention, we found that, for the overwhelming majority of native populations, merely removing alien invasive plants brought strong benefits and should therefore be considered, by far, as the top priority in conserving island forests.

## Population structure of *Juniperus brevifolia* forests along an altitudinal gradient at the Special Protection Area of Pico da Vara - Ribeira do Guilherme, São Miguel, Azores

LOURDES PEÑIL, V. GOMEZ-SANZ, S. MERINO-DE-MIGUEL, R. BOTELHO & J. TEODÓSIO



Peñil, L., V. Gomez-Sanz, S. Merino-de-Miguel, R. Botelho & J. Teodósio 2016. Population structure of *Juniperus brevifolia* forests along an altitudinal gradient at the Special Protection Area of Pico da Vara - Ribeira do Guilherme, São Miguel, Azores. Pp. 155 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: São Miguel Island, Azores; *Taxa*: *Juniperus brevifolia*; *Other*: protected area, mapping, GIS - Geographic Information System, population structure.

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*Juniperus brevifolia* (Seub.) Antonie is an Azorean endemic gymnosperm, dominating several types of forests and woodlands that are presently more extensive in Terceira, Pico and Flores islands, particularly above 500 m.a.s.l. In São Miguel Island, the most populated island of the archipelago, changes in land use, namely the replacement of natural forest by production forest for timber production and by intensive pastureland, the main factors responsible of the decline in the extension of natural forests. In this study we examined the population structure of *J. brevifolia* by using dasometric parameters, in the eastern part of São Miguel Island, specifically in the Special Protection Area (SPA) of Pico da Vara - Ribeira do Guilherme. This study began with the mapping distribution of the species, as well as the biophysical characterization of the target area, using climate, topographic, hydrologic and vegetation variables with Geographic Information Systems (GIS). Based on these variables, the study area was divided into five potential sampling units in which a survey using 10 x 10 meters plots has been carried out inside of the SPA. The biophysical characterization was done by photointerpretation and field surveys, permitting the selection areas of *J. brevifolia*. The sample size was 11 plots and the ratio of plots was directly proportional to the area of the samples units. The population structure of the *J. brevifolia* forest was studied at altitudes from 650 to 1100 meters. The analysis of the collected data show that *J. brevifolia* forests present four different types of structure along this altitudinal gradient based on the results of dasometric variables. At higher altitudes, we found that the major continuous stands are represented mainly by individuals with low stature. The results on this study contribute to the knowledge and protection of these species, which is essential to create conservation strategies.

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## Specialized Symposium 13

### (Bd4) Subterranean Biology on Islands

CHAIRS: ISABEL R. AMORIM & ANA SOFIA P.S. REBOLEIRA

## A review of the subterranean biology research performed in the Azores

ISABEL R. AMORIM, F. PEREIRA, R. GABRIEL & P.A.V. BORGES



Amorim, I.R., F. Pereira, R. Gabriel & P.A.V. Borges 2016. A review of the subterranean biology research performed in the Azores. Pp. 158 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: arthropods, plants, microorganisms; *Other*: volcanic cavities, MSS, biospeleology, biodiversity, new taxa, conservation.

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The Azores, located in the North Atlantic roughly halfway between the Iberian Peninsula and Newfoundland, is a young volcanic archipelago composed by nine islands with geological ages ranging from 8.12 (S. Maria) to 0.25 Myr (Pico). The volcanic activity in the Azores, mostly the result of tectonic movements as the archipelago is located at the junction of 3 tectonic plates, has led to the formation of many volcanic cavities since the islands have emerged. These underground formations, including volcanic pits and lava tubes, and the "creatures" that they may host have ignited the curiosity of the archipelago's inhabitants since the islands were discovered by Portuguese navigators in the 15th century. However, the first record of an expedition to an Azorean cave is from 1879, when Prince Albert of Monaco, explored Furna do Enxofre in Graciosa Island and the first biospeleological expeditions occurred only in the late 80's of the 20th century. Since then, many studies have been undertaken in the subterranean habitats (e.g., caves, deep fissures, Milieu Souterrain Superficiel-MSS, anchialine water bodies) of the Azores, namely concerning: i) inventory of plants (cave entrance), arthropods, microorganisms, and living and extinct vertebrates; ii) phylogeography and phylogeny of subterranean inhabiting taxa; iii) ecology of cave arthropods and iv) biotechnological interest of cave microorganisms. An extensive review of the subterranean biology studies developed in the Azores and of its main results will be presented. In conclusion, the research performed so far in the underground habitats of the Azores has led to the discovery of new taxa, the production of many scientific and outreach publications, the generation of useful information relevant for cave conservation policies, and, last but not least, has been crucial to foster further studies.



## Cave-adapted faunas in volcanic islands vs. continental areas

ANA SOFIA P.S. REBOLEIRA & P. OROMÍ



Reboleira, A.S.P.S. & P. Oromí 2016. Cave-adapted faunas in volcanic islands vs. continental areas. Pp. 159 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: Arthropoda; *Other*: subterranean faunas, island disharmonies, ecological shifts, local radiations.

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Islands, like caves, are considered laboratories of ecology and evolution – models to understand what governs the colonisation processes and modulates biodiversity patterns. Thus, the study of cave animals in islands provides unique opportunities for biological research. Continuous discoveries of cave-adapted animals in a wide variety of subterranean habitats on oceanic Islands, have led to reconsider the classic interpretations of subterranean colonization processes as mainly influenced by Pleistocene climatic changes. The perception of cave species as climatic relicts and caves as isolated refuges has changed. Animals colonise subterranean ecosystems for different reasons, including survival, opportunism or to escape from competitive pressures in surface habitats. The transition from the surface to the aphotic environment establishes an ecological filter, which determines communities characteristics: i) low number of lineages; ii) high level of endemism, as result of habitat isolation and fragmentation; iii) high proportion of relict taxa, due to environmental stability over long geological periods; and 4) truncated food webs, imposed by the scarce nutrient input, which favours omnivores. Cave animals generally respond in the same way to similar environmental pressures across many evolutionary lineages. In particular, the highly diverse arthropods display many cases of independent and convergent adaptation to subterranean life. However, consistent differences are observed in insular versus continental cave-adapted faunas. We have compiled data of subterranean species from the archipelagos of Macaronesia, Hawaii, Rapa Nui, Galapagos, Réunion, Samoa and Guadalupe to establish the major ecological, climatological, historical and geological factors responsible for the main differences between insular and continental cave-adapted faunas. Island cave communities tend to present: 1) faunistic disharmony compared to continental cave faunas, due to the potential absence of surface ancestors; 2) concomitant spectacular subterranean radiations of certain genera; and 3) “rare” zoological groups exhibiting troglomorphy, that are occupying empty niches left by the lack of “classic” cave colonizers.

# Fossil birds from Graciosa island (Central Azores): A preliminary list

JOSEP ANTONI ALCOVER, F. PEREIRA, H. PIEPER & J.C. RANDO



Alcover, J.A., F. Pereira, H. Pieper & J.C. Rando 2016. Fossil birds from Graciosa island (Central Azores): A preliminary list. Pp. 160 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Graciosa Island, Azores, North Atlantic Ocean; *Taxa*: Aves, Rallidae, Scolopacidae, Phasianidae, Fringillidae, Troglodytidae, Corvidae, Muscicapidae, Procellariidae, Hydrobatidae; *Other*: fossil birds, new species, rails, bullfinch, chaffinch, wren.

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Caves are especially important to study the patterns and processes of life adaptation to the subterranean environments. They are also primordial places to find fossils of extinct species of vertebrates and to record their evolution. The paleontological survey of the caves from Graciosa island (Central Azores) allowed us to obtain a few thousands of bones, currently in study. Here we present a preliminary list of the fossil birds from Graciosa. Most of the material has been obtained in two caves, Furna do Lavar and mainly Furna do Calcinhas, a small cave situated inside the Caldeira. The identified fauna includes a rail (*Rallus* sp.), a quail (*Coturnix* sp.), a bullfinch (*Pyrrhula* sp.) one or two chatfinches (*Fringilla* sp.), a goldcrest (*Regulus* sp.), a blackbird/thrush (*Turdus* sp.), a starling (*Sturnus vulgaris*), a raven (*Corvus* sp.), a snipe (*Gallinago* sp.), a wren (Troglodytidae, new genus), pigeons (*Columba* sp.), a duck (*Anas* sp.) petrels (*Pterodroma* spp.), shearwaters (*Puffinus* spp.), and storm-petrels (*Oceanodroma* spp.). Compared with the extant bird fauna, this fauna presents some relevant characteristics. First, the degree of endemicity is very high, containing at least 3 new species plus, very probably, a new passerine genus, which will be the first endemic genus of bird from all the Macaronesia. Otherwise, some of the terrestrial birds currently inhabiting Graciosa, like *Motacilla cinerea*, *Erithacus rubecula*, *Oenanthe oenanthe*, *Sylvia atricapilla*, *Passer domesticus*, *Serinus canaria* and *Carduelis carduelis*, are absent in the fossil record. The distributional ranges of a lot of species have been markedly modified after the European arrival. Our study provides knowledge on the original diversity and distribution of the bird fauna of Graciosa and it can be helpful for restoration goals.

# An unexpected vertebrate fossil assemblage on Mallorca (Balearic Islands, Western Mediterranean Sea)

ENRIQUE TORRES ROIG, J.A. ALCOVER, P. BOVER, S. BAILON, J. AGUSTÍ & J. ROFES



Torres Roig, E., J.A. Alcover, P. Bover, S. Bailon, J. Agustí & J. Rofes 2016. An unexpected vertebrate fossil assemblage on Mallorca (Balearic Islands, Western Mediterranean Sea). Pp. 161 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Mallorca, Balearic Islands, Western Mediterranean Sea; *Taxa*: Anuran, Squamata, Soricinae, Cricetinae, Muridae, Gliridae, Leporidae, Bovidae; *Other*: fossil vertebrates, Messinian Salinity Crisis, Pliocene, Na Burguesa-1, island colonization, extinction.

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Cave sediments occasionally incorporate the remains of vertebrates than can fossilize, becoming important sources for the knowledge of past faunas. The fossil breccia can even survive the caves where originated and provide information about faunas dated to million years ago. The discovery of Na Burguesa-1 site in Mallorca (Balearic Islands) has provided an unexpected vertebrate fossil assemblage. It corresponds to ancient cave sediments. Nowadays the primordial cavity has been totally eroded and only is preserved the infill sediment. This karstic sediment is composed by sharp pebbles of limestone embedded in a matrix of red-brown silts strongly cemented by calcite. Inside it appear layers with abundant microvertebrate remains, bioaccumulated by raptor birds. Through a long and slow preparation with acetic acid has been possible to recover thousands of disarticulated bones. Terrestrial mammals are the best-represented group, which includes Soricinae, Cricetinae, Muridae, Gliridae, Leporidae and Bovidae specimens. There is also a good herpetological record (4 Anura and 13 Squamata), mainly identifiable to the family level. Instead, birds are the worst represented group. Some of these taxa represent the ancestors of the early Pliocene fauna from Caló den Rafelino (Mallorca). Some others may be related with their late Miocene mainland relatives. The paleontological site of Na Burguesa-1 is attributed to a basal Pliocene, supporting the hypothesis of colonization during the Messinian Salinity Crisis (MSC) due to the great drawdown of the Mediterranean Sea level. After the subsequent flooding of the Mediterranean basin, this paleocommunity remained isolated, evolving in insularity conditions along 5.35 My. Some extinction episodes took place during the Pliocene and only a few species of terrestrial vertebrates (*Alytes muletensis*, *Podarcis lilfordi*, *Nesiotites hidalgoi*, *Hypnomys morpheus* and *Myotragus balearicus*) survived on Mallorca until the arrival of the first humans sometime before 4160 BP. Only *A. muletensis* and *P. lilfordi* survived until the present.

## The pyroclast deposits, an important subsurface habitat for troglobionts on recent volcanic islands

ANTONIO J. PÉREZ, H. LÓPEZ & P. OROMÍ



Pérez, A.J., H. López & P. Oromí 2016. The pyroclast deposits, an important subsurface habitat for troglobionts on recent volcanic islands. Pp. 162 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Canary Islands; *Taxa*: Arthropoda; *Other*: pyroclast deposits, subsurface habitats, troglobionts.

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Many subsurface habitats different than caves have been described as suitable for adapted subterranean life. Most of them are more or less climatically isolated from the surface environments thanks to the soil lying upon and the vegetation. Some others like epikarst and scree lack this protection but can be suitable if the climate is wet or the layer is deep enough to maintain underground humidity. However, an exposed, unusually shallow subsurface habitat rather common on recent volcanic islands has demonstrated to hold an abundant hypogean fauna even in arid island environments. This is the case of the lapilli fields occurring on high altitudes of Tenerife, Canary Islands, which have been sampled every three months along 2014. The sampling method consisted of baited pitfall traps set at the bottom inside 60 to 90 cm deep pvc pipes stuck vertically into the lapillis. This was the first time this environment had been sampled for adapted subterranean fauna except an isolated case that had been reported decades ago for Ascension Island. Our results have demonstrated that pyroclast deposits can hold a fauna almost as varied in troglobitic species, and even more abundant in individuals, as the caves found in the same area, suggesting that this environment is much richer than expected and really relevant for within island dispersion of troglobionts.

## Sardinia, a hotspot of diversity for subterranean terrestrial isopods (Crustacea, Oniscidea)

STEFANO TAITI, P. MARCIA, M. CASU & R. ARGANO



Taiti, S., P. Marcia, M. Casu & R. Argano 2016. Sardinia, a hotspot of diversity for subterranean terrestrial isopods (Crustacea, Oniscidea). Pp. 163 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Sardinia, Italy; *Taxa*: Crustacea, Isopoda, Oniscidea; *Other*: troglobionts, stygobionts, endogean.

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Sardinia is a western Mediterranean island with a very large number of terrestrial isopods. Investigations in recent years have increased the number of Oniscidea known from the island to 115. Many of these species (40, of which 39 are endemic and 19 new to science) occur in subterranean environments, either in caves or in endogean habitats. They belong to the families Trichoniscidae (25 spp., 11 spp. nov.), Styloniscidae (1 sp.), Agnaridae (1 sp.), Cylisticidae (1 sp.), Porcellionidae (1 sp. nov.), and Armadillidiidae (11 spp., 7 spp. nov.). This high number is certainly due to the large extension of karst areas in the whole island with over 3,500 caves presently known. Twenty-three species are troglotrophic, three stygobiotic and 12 endogean, some of which occasionally occurring also in caves. Most of the species in the family Trichoniscidae are Tyrrhenian elements belonging to the genera *Catalauniscus*, *Oritoniscus*, *Nesiotoniscus* and *Scotoniscus*, which demonstrate the faunistic affinities of Sardinia with the north-eastern Iberian Peninsula and southern France, to which Sardinia was connected during the Oligocene. Of particular interest are the three stygobiotic species of Trichoniscidae occurring in the karst areas of central-eastern Sardinia. One of these species, *Utopioniscus kuhnei*, was considered to be a very primitive taxon. The other two species recently discovered in caves of the same karstic areas are new to science and show intermediate morphological characters between the troglotrophic and endogean *Alpioniscus* species present on the island and *U. kuehni*. A molecular analysis shows that all the three aquatic species of Trichoniscidae are included in the same clade with *Alpioniscus* species, suggesting that *U. kuehni* is not the most primitive Trichoniscidae but rather a species of *Alpioniscus* secondarily adapted to an aquatic way of life.

## Makauwahi cave reserve, Kauai: Limestone caverns on a volcanic island

DAVID A. BURNEY & L. P. BURNEY



Burney, D.A. & Lida P. Burney 2016. Makauwahi cave reserve, Kauai: Limestone caverns on a volcanic island. Pp. 164 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Kauai, Hawaii; *Taxa*: all; *Other*: paleoecology, archaeology, restoration, cave research, conservation paleobiology.

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Makauwahi Cave, Kauai, is the only large karst feature in the otherwise volcanic Hawaiian Islands. It was formed in eolian calcarenite derived from Pleistocene coastal dunes. A quarter century of multidisciplinary studies has revealed the richest fossil site in the Hawaiian Islands, a uniquely preserved archaeological site, and a sedimentary archive of extreme marine events. It also is home to a living subterranean ecosystem containing endemic troglobites: an eyeless amphipod (*Spelaeorchestia koloana*) and an isopod (*Hawaiioscia* cf. *rotundata*) that feed on exudates from the roots of native plants growing on the cave headprint, and also their troglobite predator, the Kauai blind cave wolf spider (*Adelocosa anops*). These extremely rare and very narrow endemics are afforded full protection and periodically monitored by government scientists. A reserve dedicated to the protection, study, and interpretation of the cave's unique resources operates on the site. Each year over 30,000 people -- local school children, residents, and visitors to the islands from throughout the world -- tour the site and learn about caves and their conservation. Spectacular preservation of fossil vertebrates, invertebrates, plants, and a full range of microfossils spans the Holocene millennia before human arrival, provides some of the earliest well-dated evidence for human arrival, and documents subsequent human ecological history, up to the present. Visitors make personal connections to the goals of cultural and ecological restoration by having the opportunity to see and participate in community collaborations on the site such as native plant propagation and restoration, Polynesian-style traditional agriculture, and experiments in large-scale restoration of lost ecological functions. Published studies from the site have included the naming of new species of extinct birds, insects, and a second endemic Hawaiian bat; evidence for past tsunamis; ancient DNA; delicate perishable artifacts; monitoring results from translocated native plants; and paleoecological studies from microfossils.



## Variation of the subterranean fauna along an island chain

PEDRO OROMÍ, A.J. PÉREZ & H. LÓPEZ



Oromí, P., A.J. Pérez & H. López 2016. Variation of the subterranean fauna along an island chain. Pp. 165 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Canary Islands; *Taxa*: Arthropods; *Other*: troglobiont fauna, diversity, distribution, inter-island relationships.

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The Canary archipelago is constituted by a typical island chain originated by a volcanic hotspot, with the oldest islands situated close to the African continent at the east, being the rest of the islands progressively younger towards the west. All seven islands, except Lanzarote, hold an obligate subterranean fauna adapted to terrestrial environments, either caves or other hypogean habitats. This troglobiont fauna includes as much as 190 different species of arthropods, with hardly any of them occurring in more than one island. Many genera and even higher taxa are represented only in one or a few islands, usually in a relict situation. But some other taxa are represented by different, close related species on several islands, most often on contiguous ones; in these cases it is common to see a gradient of troglomorphism apparently positively correlated with island age. The western, youngest islands of La Palma and El Hierro have the most similar troglobitic faunas, with species still geographically sympatric with their epigean relatives. However, in older islands the same genera are represented by other epigean species that lack hypogean relatives, which have apparently been replaced by non-related but ecologically vicariant species belonging to different genera.



Island Biology 2016  
2nd International Conference on Island Evolution, Ecology and Conservation

## SPECIALIZED SYMPOSIA – BIOGEOGRAPHY



Channel Faial-Pico islands in Azores (Photo: Paulo A.V. Borges)

## Specialized Symposium 17

### (Bg1) Biogeography of species interactions in the Japanese Izu Islands

CHAIRS: MASAMI HASEGAWA & HARUE ABE

## Biogeography and evolution in the Japanese Izu Islands system, a unique geological setting of formation and collision/accretion dynamics of volcanic islands to mainland through tectonic movement

MASAMI HASEGAWA



Hasegawa, M. 2016. Biogeography and evolution in the Japanese Izu Islands system, a unique geological setting of formation and collision/accretion dynamics of volcanic islands to mainland through tectonic movement. Pp. 169 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Izu Islands and the mainland, Honshu; *Taxa*: -; *Other*: reverse colonization, plate movement.

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The Izu Archipelago is a potentially important system in which to study ecological and evolutionary processes. The Izu Archipelago is a chain of volcanic islands off the coast of eastern Japan, which were formed within the past million years in the complex interface of the Eurasian, North America, Pacific, and Philippine plates, a zone where the active intra-oceanic Izu–Bonin arc has been colliding end-on with the mainland Honshu arc for the past 15 million years. This is the only place in the world where the active intra oceanic arc is currently colliding and accreting with the mature Honshu arc, thus providing an unusual opportunity to study phylogeography, evolution and speciation in this unique geological system. These oceanic islands, of course, formed *de novo* without any previous connection to the mainland, and their inhabitants must have colonized via overseas dispersal from the mainland or adjacent islands. However, unlike remote oceanic islands such as the Hawaiian and Galapagos islands, the Izu Islands' close geographical proximity to mainland source populations implies relatively frequent colonization, and additionally, during the geological time scale, island populations have multiple opportunities to re-colonize mainland through collision/accretion of old islands to mainland. These geological settings make this system especially valuable for exploring ecological and evolutionary processes with a perspective different from remote and isolated oceanic islands. With these biogeographic background, this symposium focuses on the past and current ecological processes of biological interactions and their evolutionary consequences from plant succession to prey-predator density cycles observed on the Izu islands.

## Colonization of two early successional plant species with different nitrogen usage affects abundance of soil animals and herbivorous insects, and ecosystem process on volcanic deserts in Miyake-jima Island, Japan

TAKASHI KAMIJO, Y. MORI, Y. KADOKURA, H. HASHIMOTO, K. YAMAJI, Y. MINAMIYA & N. KANEKO



Kamijo, T., Y. Mori, Y. Kadokura, H. Hashimoto, K. Yamaji, Y. Minamiya & N. Kaneko 2016. Colonization of two early successional plant species with different nitrogen usage affects abundance of soil animals and herbivorous insects, and ecosystem process on volcanic deserts in Miyake-jima Island, Japan. Pp. 170-171 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Miyake-jima island, Izu Islands, Japan; *Taxa*: plants, earthworms, beetles; *Other*: succession, nitrogen fixation, herbivore, species interaction, soil development.

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Early plant colonizers modify barren land formed by volcanic activities and improve ecosystem functions. Modification of nutrient availability, especially nitrogen, is one the most important effects of them. Miyake-jima Island, Izu Islands, erupted in 2000, and volcanically devastated sites with heavy deposition of volcanic ash were formed. There are two representative pioneer species: *Alnus sieboldiana* (N-fixing shrub) and *Miscanthus condensatus*. We compared effects of the two species on soils, earthworms as decomposer and chafers (*Anomala japonica izuensis*) as herbivore, and also examined interactions among plants, soils and earthworms. The study sites are in early successional stages (12-14 years after the eruption). Earthworms and soils were sampled under canopies of *M. condensatus* and *A. sieboldiana*. Soil physical properties and soil C and N were also determined. Abundances of chafers and feeding damage on plants were estimated by line censuses and a net bag experiment on shoots. To estimate the diet of earthworms and chafers, we also measured carbon stable isotope ( $\delta^{13}\text{C}$ ) of litters and leaves of the two species, and that of earthworms and chafers. *A. sieboldiana* had higher N concentration in leaves, and soil N was higher under the canopies of them. Earthworm density was also higher under the *A. sieboldiana*. Results of  $\delta^{13}\text{C}$  values showed that earthworm ingested litter of *A. sieboldiana* preferentially. In addition, earthworm density negatively

correlated with soil hardness. Chafers were more abundant and feeding damage was also more conspicuous on *A. sieboldiana*. These results suggest that colonization of *A. sieboldiana*, N-fixing shrub, has more facilitative effects on ecosystem development. In addition, increase of earthworms may advance further soil development. On the other hand, heavier feeding damage seems to decrease *A. sieboldiana*. Therefore, trajectory of ecosystem development seems to significantly vary with difference of the established pioneer species.

## Is tetraploid *Clerodendrum trichotomum* in Japanese archipelago derived from hybridization of diploid ancestors?

LEIKO MIZUSAWA, S. FUJII, M. HASEGAWA & Y. ISAGI



Mizusawa, L., S. Fujii, M. Hasegawa & Y. Isagi 2016. Is tetraploid *Clerodendrum trichotomum* in Japanese archipelago derived from hybridization of diploid ancestors?. Pp. 172 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Izu Archipelago, Japan; *Taxa*: *Clerodendrum*; *Other*: species complex, hybridization, chloroplast capture, tetraploid.

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Recent molecular phylogeographic analysis has revealed that ‘reverse colonization’ (from islands to continents) are more common than that had been thought before. However, the ecological events that happened after the reunion of insular and continental populations, such as hybridization and competition, remain largely unrevealed. On a population that had experienced hybridization, conflict between chloroplast and nuclear DNA phylogenies has been well known because chloroplast is maternally-inherited while nuclear is biparental-inherited. Here we show a possible promotion of new species in Japanese mainland caused by the hybridization among insular populations. In the *C. trichotomum* species complex, four taxa are recognized in Japanese archipelago. *Clerodendrum trichotomum* Thunb. is widely distributed in Japan and East Asia, var. *fargesii* and var. *esculentum* are known from Nansei Islands, and *C. izuinsulare* is known from Izu Islands. Microsatellite analysis with five loci implies that var. *esculentum*, *C. izuinsulare*, and Chinese *C. trichotomum* are diploid whereas var. *fargesii* and Japanese and Korean *C. trichotomum* are tetraploid. Microsatellite analysis also indicate *C. izuinsulare* is genetically more distant from tetraploid *C. trichotomum* than other taxa. However, in contrast, chloroplast haplotype was shared between *C. izuinsulare* and tetraploid *C. trichotomum*. These results suggest that chloroplast of *C. izuinsulare* (diploid) was captured in Japanese *C. trichotomum* (tetraploid) in the past. Hybridization among insular diploid populations may cause the establishment of allotetraploid populations in multiple places in Japan archipelago. Introgressive hybridization between these allotetraploid population, that has *C. izuinsulare* as maternal lineage, and another allotetraploid population may cause the chloroplast capture from diploid *C. izuinsulare* to tetraploid *C. trichotomum*.



## Low pollinator functional diversity in oceanic islands influences pollinators' floral niches

MASAYOSHI K. HIRAIWA & A. USHIMARU



Hiraiwa, M.K. & A. Ushimaru 2016. Low pollinator functional diversity in oceanic islands influences pollinators' floral niches. Pp. 173 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Honshu main island, Izu islands, Japan; *Taxa*: pollinators, plants; *Other*: plant-pollinator interactions, functional diversity, niche shift, long-tongued pollinators, oceanic islands.

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Oceanic islands generally lack larger pollinators with long proboscis compared to continents and continental islands. Lack of a certain functional group of pollinators are expected to influence plant-pollinator interactions. Although many previous studies have been implicitly assumed that a functional role of a given pollinator group is static, some empirical results demonstrated that plant-pollinator interactions could dynamically change depending on pollinator composition within a community. These ideas lead to a prediction that a lack of a certain pollinator functional group may cause niche expansions and/or shifts by other groups in natural communities with high pollinator species diversity. In this study, we examine the impacts of the relative abundance of long-tongued pollinators (RBLP) on community-level flower visitation patterns by comparing continental and oceanic island pollination networks. We conducted flower-pollinator surveys at three coastal sites in the Honshu island, the largest continental island of Japan and at a single site in each of five oceanic islands belong to the Izu islands in the Kanto district in 2013 and 2014. RBLP was significantly lower in oceanic than in main island sites and varied seasonally in each site. Our results revealed that many species with different proboscis lengths increasingly visited long-tubed flowers with decreasing RBLP within a community. However, we found no conspicuous negative impacts of low RBLP and the consequent niche shifts of remaining pollinators on the visitation frequencies to plant species within oceanic island communities. Furthermore, fruit set in three dominant species did not differ between continental and oceanic island sites. These results suggested that pollinators' niche shifts might compensate the lack of long-tongued pollinators in natural plant communities.

## Evolution of color pattern among island lizard populations with different predation regimes

TAKEO KURIYAMA



Kuriyama, T. 2016. Evolution of color pattern among island lizard populations with different predation regimes. Pp. 174 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Izu Islands, Pacific Ocean; *Taxa*: Squamata: Scincidae; *Other*: blue tail, predator-prey, color vision, iridophore, lizard, island.

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Juveniles of numerous lizard species have a vividly blue-colored tail that likely serves to deflect predator attacks toward the autotomizable tail rather than the lizard's body. The shades of blue color in the tails of juvenile *Plestiodon latiscutatus* lizards vary across populations, most notably among those island populations with different predator assemblages. Here, I determine if this intraspecific variation is associated with the differences in color vision capabilities of lizard predator species. If associated, it would be evidence for local adaptation of tail color phenotype – natural selection is maximizing the conspicuousness of the tail to the dominant predator species to increase the chance of successfully deflecting attacks. I also use transmission electron microscopy (TEM) to determine the proximate cellular mechanisms that produce the shades of blue in different populations. I revealed that lizard tails with vivid blue reflectance evolved in communities with either weasel or snake predators, two groups of animals with the ability to detect blue wavelengths. However, lizard tail UV reflectance was much higher in populations with only snake predators; that snakes can detect UV, yet weasels cannot, suggests that high UV reflectance is an adaptation to increase tail conspicuousness specifically to snake predators. Finally, a cryptic brown tail evolved independently on the islands where birds are the primary lizard predator. I suggest that because birds have keen visual acuity, a brown, camouflaged phenotype is more advantageous. I also determined through TEM that the thickness of light reflecting platelets in iridophores, and densities of iridophores and xanthophores, predicted the wavelengths and intensity of light reflected by the lizard tail. For example, blue coloration was produced by selective reflection of short wavelengths of light by the thin light reflecting platelets of the iridophore. Greater iridophore density increased light reflectance, but greater xanthophore density decreased light reflectance.

## Prey-predator dynamics and ongoing co-evolution between lizard and snake on the Izu Islands

MASAMI HASEGAWA



Hasegawa, M. 2016. Prey-predator dynamics and ongoing co-evolution between lizard and snake on the Izu Islands. Pp. 175 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Izu Islands, Pacific Ocean; *Taxa*: Squamata, Scincidae, Colubridae; *Other*: prey-predator, color polymorphism, density cycle.

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Growing interest in the interplay between ecological interactions among community members and evolutionary process stimulated experimental studies on eco-evolutionary feedback dynamics, but few empirical examples exist of evolution affecting ecological dynamics. On the Izu Islands of central Japan, the snake *Elaphe quadrivirgata* exhibited among islands variations in abundance, diet, color pattern, gape shape and body size, and we have been recorded abundance and phenotypic traits of predator snake and its main prey lizard *Plestiodon latiscutatus*. By comparing the long-term monitoring data sets of abundance and phenotypic traits for the predator and prey populations on the islands where the snake exhibits either monotypic or polymorphic color pattern, we tested the ecological effects of predator color pattern evolution on the cycle period of prey-predator density. Polymorphism of predator color pattern maintained by negative frequency dependent selection would incur greater predation impact on prey lizard population, thus providing the first comprehensive evidence of ecological feedback of predator trait evolution on the prey-predator density cycles for the wild animal populations.

## Specialized Symposium 23

### (Bg3) How Macaronesia influenced our perspective on island systems

CHAIRS: ANA SANTOS, ANNA TRAVESET, JAIRO PATIÑO, MARGARITA FLORENCIO,  
SANDRA NOGUÉ & PAULO A.V. BORGES

## The Island Biology Interest Group (IBIG)

ANA M.C. SANTOS, P.A.V. BORGES, M. FLORENCIO, S. NOGUÉ, J. PATIÑO & A. TRAVESET



Santos, A.M.C., P.A.V. Borges, M. Florencio, S. Nogué, J. Patiño & A. Traveset 2016. The Island Biology Interest Group (IBIG). Pp. 177 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global, islands; *Taxa*: all; *Other*: island biogeography, Spain, Portugal.

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Islands are often seen as natural laboratories for the study of ecological and evolutionary processes with wide application in conservation biology and evolutionary studies. Currently the study of islands is going through a period of great progress in terms of new theories and methodological approaches. Many of these new developments are being made by research groups based in Portugal and Spain, and/or come from studies conducted in the archipelagos associated from these two Iberian countries (Azores, Madeira, Canary Islands and Balearic Islands). The Island Biology Interest Group (IBIG) is a working group created within the Asociación Española de Ecología Terrestre (AEET) and the Sociedade Portuguesa de Ecologia (SPECO), which intends to promote the discipline of island biology and the collaboration between researchers interested on island systems. In this presentation, we will give a brief overview of the IBIG, describing its goals and activities.

## The outstanding contribution of Macaronesia to the development of island sciences: Past, present and future

JOSÉ MARÍA FERNÁNDEZ-PALACIOS



Fernández-Palacios, J.M. 2016. The outstanding contribution of Macaronesia to the development of island sciences: Past, present and future. Pp. 178 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Macaronesia; *Taxa*: -; *Other*: ecology, evolution, history, island biogeography, naturalists.

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Ever since the visit of Captain Cook to Madeira in his first trip around the world in 1768, the North East Atlantic volcanic archipelagos today known as Macaronesia (Azores, Madeira, Selvagens, Canaries and Cape Verde) have contributed outstandingly to the development of disciplines (such as evolution, ecology, biogeography, or volcanology) in which island research has been essential to their progress. Among the more famous visitors that found inspiration in the outstanding gea, biota and ecosystems of these islands we should include Forster, Banks, von Humboldt, von Buch, Darwin, Lyell or Haeckel. Despite its prominent place in island research during the XVIII and the XIX centuries, Macaronesia was somehow displaced from the scientific showcase during the XX century with the emergence of the research carried out in other oceanic archipelagos such as Galápagos, Indonesia, New Zealand and, especially, Hawai'i. Nevertheless, in the last decades, fuelled by a generation of both local and continental young scientists, Macaronesia has slowly recovered its ancient pre-eminence in these fields, and has been especially important in the development of new models, among them the GDM (General Dynamic Model) and the GSM (Glacial Sensitive Model) of island biogeography, or in highlighting the role of archipelagos as Pleistocene refugia from which mainland back-colonization is not only possible, but probable.

## Colonization and speciation of an invader: The western house mouse (*Mus musculus domesticus*) in Madeira Island

SOFIA I. GABRIEL, J.B. SEARLE & M.L. MATHIAS



Gabriel, S.I., J.B. Searle & M.L. Mathias 2016. Colonization and speciation of an invader: The western house mouse (*Mus musculus domesticus*) in Madeira Island. Pp. 179 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Madeira archipelago; *Taxa*: *Mus musculus domesticus*; *Other*: house mouse, Madeira Island, chromosomal speciation, Robertsonian fusions.

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Speciation is a key process in evolution, and chromosomal differences between sub-specific forms may have a contributory role. Rearrangements may promote hybrid unfitness leading to reduced interracial gene flow close to the mutation breakpoint, as well as recombination suppression in the same genomic region, processes which could lead to differentiation and ultimately reproductive isolation. The western house mouse (*Mus musculus domesticus*) inhabiting the Madeira island is an excellent model to study the potential role of chromosomes in speciation. From an ancestral karyotype consisting of 40 telocentric chromosomes, six distinct chromosomal races have arisen, characterized by different combinations of centromeric (Robertsonian, Rb) fusions of the telocentrics, sometimes further modified by whole-arm reciprocal translocations (WARTs). This astonishing level of chromosomal variation seems to have been reached in only ~1000 years, the estimated time of colonization of the island by the house mouse. The combination of both molecular (mitochondrial DNA) and paleontological data (radiocarbon dating of bone structures) supports the presence of mice in Madeira one millennium ago, most likely accidentally transported by Viking navigators. The Madeira Robertsonian system has been subject of study for the past 15 years and significant multidisciplinary data has been accumulated (cytogenetic, ecological, physiological, genetic, morphological, reproductive, behavioral, genomic), contributing for an ever increasing understanding of such a complex and fascinating system.



## The impact of edge effects on arthropod $\beta$ spatial and temporal variation in an Azorean native forest

RUI M. NUNES, P. CARDOSO, F. RIGAL & P.A.V. BORGES



Nunes, R.M., P. Cardoso, F. Rigal & P.A.V. Borges 2016. The impact of edge effects on arthropod  $\beta$  spatial and temporal variation in an Azorean native forest. Pp. 180 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Terceira Island; Azores; *Taxa*: Arthropods; *Other*: edge effects;  $\beta$ -diversity, species replacement; richness differences; disturbance, endemics; exotics.

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Arthropods represent a large portion of global biodiversity, but our understanding of their community structure and temporal dynamics is still in its infancy. With this study we aim to investigate the impact of habitat edge effects on spatial and temporal beta diversity in the arthropod communities of native Azorean forests. Considering that edge effects can promote changes in community structure in a fragmented landscape, we are particularly interested in temporal extinctions, colonizations and changes in relative abundance of individual indicator species at edge vs. forest interior. We implemented for the first time in the Azores archipelago a long term arthropod sampling protocol consisting of nine SLAM traps located in the forest interior (3), forest/pasture interface (3) and an intermediate location (3). The SLAM traps were operational for 15 months, with arthropod samples being collected monthly. A total of 12141 individuals were collected, comprising 106 species and 14 orders. Endemics corresponded to 63% of the individuals and 27% of the species in this study. Seasonal patterns are strong in all the nine traps, with the spring and summer periods having the highest species richness and corresponding with the peak abundance of the majority of species. Significant statistical differences were observed between the three sites, particularly between the interior of the forest and its edge. Specifically, species richness was higher in the interior of the forest than in the edge (82 vs. 74 species), and species turnover was found to be the main factor of variation in species composition between sites ( $\beta_{\text{repl}} = 0.255$ ;  $\beta_{\text{rich}} = 0.189$ ). Edge traps also showed higher variation in several diversity metrics, with the interior traps showing more uniform values. These results have clear implications on habitat management and conservation strategies of increasingly fragmented forests in the Azores.

## Snipe in the Azores: Assessing gene flow in the middle of the North Atlantic

TIAGO M. RODRIGUES, P.A.M. ANDRADE, M. RODRIGUES & D. GONÇALVES



Rodrigues, T.M., P. Andrade, M. Rodrigues & D. Gonçalves 2016. Snipe in the Azores: Assessing gene flow in the middle of the North Atlantic. Pp. 181 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: *Gallinago gallinago*, *Gallinago delicata*; *Other*: microsatellites, population genetics, gene flow.

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Owing to its geographic location, the Azores might act as a biogeographic crossroad between the Nearctic and the Palearctic, as suggested by the occurrence of Flora and Fauna from both regions. Among birds, two allopatric sibling taxa, the Nearctic Wilson's (*Gallinago delicata*) and the Palearctic Common (*G. gallinago*) snipe winter in the archipelago, where a population of snipe is also known to breed. Previous molecular and acoustic analyses identified the Azorean snipe population as Common snipe, but the relative contribution of the wintering birds to the local genetic pool remains unknown. We genotyped snipe from the Nearctic, the Azores and the Palearctic for 16 microsatellite loci developed by 454-GsFLX Titanium chemistry. A STRUCTURE analysis revealed three clusters, roughly separating the Wilson's, the Common and the local Azorean snipe. Most Azorean birds clustered together, but some have higher membership coefficient to the Common snipe cluster. Furthermore, the Azorean cluster is not exclusive of the Azorean birds, since some specimens from the Palearctic also have higher membership coefficient to it. Despite the affinity of Palearctic birds to the Azorean cluster, the majority of them formed the Common snipe cluster. During winter, in the Azores, the proportion of birds with high membership coefficient to the latter cluster seems greater than the observed during the breeding season, which corroborates the arrival of birds from the Palearctic. Some snipe from the Azores and the Palearctic have unusually high membership coefficient to the Wilson's snipe cluster. This apparent sharing of genotypes among populations may indicate ongoing gene flow between regions.

## The evolutionary origin of the Macaronesian flora: Lessons from bryophytes

JAIRO PATIÑO & A. VANDERPOORTEN



Patiño, J. & Alain Vanderpoorten 2016. The evolutionary origin of the Macaronesian flora: Lessons from bryophytes. Pp. 182 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Macaronesia; *Taxa*: bryophytes; *Other*: ancestral area estimation, laurel forest, Mediterranean, molecular dating, Neotropics.

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Since the delimitation of Macaronesia by Engler at the end of the 19<sup>th</sup> century, much biogeographical research placed particular emphasis on the endemic element of the vascular flora. According to Engler's refugium hypothesis, the distinctive endemic element of the Macaronesian flora was greatly relict of a formerly widespread subtropical flora that covered southern Europe and North Africa during the Tertiary. Although the timing of the origin of the Macaronesian vascular flora has been recently questioned, phylogenetic evidence unambiguously confirmed the close relationships between the Macaronesian and Mediterranean floras. With a rate of endemism of about 2% and an almost complete absence of radiations, Macaronesian bryophytes exhibit a conspicuously different floristic pattern. Here, we test the niche pre-emption hypothesis, which proposes that radiations are typically hampered by recurrent colonization events, to explain the strikingly low rates of endemism in the Macaronesian bryophyte flora. Using an integrative phylogeographic approach, we reconstruct the timing, tempo, and geographical origin of the colonization of Macaronesia by bryophytes. The temporal and spatial pathways of colonization and speciation in bryophytes are compared with those of angiosperms and the evolutionary mechanisms are discussed to shed light on the origin of the unique Macaronesian bryophyte floristic element.

## The signatures of Anthropocene defaunation: Cascading effects of the seed dispersal collapse on islands

ALFREDO VALIDO, N. PÉREZ-MÉNDEZ, P. JORDANO & C. GARCÍA



Valido, A., N. Pérez-Méndez, P. Jordano & C. García 2016. The signatures of Anthropocene defaunation: Cascading effects of the seed dispersal collapse on islands. Pp. 183 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Canary Islands, Gran Canaria, Tenerife, La Gomera; *Taxa*: *Neochamaelea pulverulenta* (Rutaceae), *Gallotia* spp. (Lacertidae); *Other*: seed dispersal distances, extinction, downsizing, spatial genetic structure, landscape genetic, gene flow.

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A myriad of large-bodied frugivore species have experienced population declines and eventual extinctions matching human expansion (“Anthropocene defaunation”). Loss of these frugivores is expected to trigger negative cascading effects to the plant they feed upon if remnant small- to medium- sized species fail to replace ecological services provided by extinct frugivores. A collapse of seed dispersal may affect plant demography, but also suppress gene flow within and among plant populations. Here, we focus on a compelling case study where human-drive defaunation led to a significant downsizing of the Canarian frugivorous lizards defining a gradient of body size: *Gallotia stehlini* (max snout-vent length: 280 mm; Gran Canaria), *G. galloti* (145 mm; Tenerife), and *G. caesaris* (111 mm; La Gomera). We studied the demographic and genetic consequences of lizards downsizing on *Neochamaelea pulverulenta* (Rutaceae), a plant species which relies exclusively on these lizards for seed dispersal. First, we detected that the frequency distributions of different plant age/size classes did not differ among islands. However, we found significant reductions in seedling recruitment outside the canopy and effective recruitment rate in those populations hosting small- to medium-sized lizard species. Second, we found a significant reduction of the maximum seed dispersal distances mirroring the lizard body sizes gradient with strong implications on the spatial genetic structure in those populations hosting small- to medium-sized lizards. Third, despite no evidence of contemporary reduction in plant genetic diversity among islands, we detected a large-scale effect on population genetic connectivity at insular landscape mirroring the progressive extirpation of large frugivorous lizards. Overall our results demonstrate that preservation of large frugivores is crucial to maintain functional seed dispersal services and their associated genetic imprints, a central conservation target.

## Combined effects of altitude and invasive herbivores on a vulnerable, endemic violet species in an oceanic high mountain ecosystem

JAUME SEGUÍ COLOMAR, M. LÓPEZ-DARIA, A.J. PÉREZ, M. NOGALES & A. TRAVESSET



Seguí Colomar, J., M. López-Daria, A.J. Pérez, M. Nogales & A. Traveset 2016. Combined effects of altitude and invasive herbivores on a vulnerable, endemic violet species in an oceanic high mountain ecosystem. Pp. 184 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Teide National Park, Tenerife, Canary Islands; *Taxa*: *Viola cheiranthifolia*; *Other*: altitudinal gradient, reproductive ecology, summit ecosystems, herbivores.

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Summit areas of oceanic islands constitute some of the most ephemeral and isolated ecosystems on earth, which confers an outstanding distinctness on their biota and a particular vulnerability to climate changes and disturbances. Here we investigated how fitness of an endemic oceanic plant species, *Viola cheiranthifolia*, inhabiting the alpine habitat of Tenerife (Canary Islands), is influenced by the combination of the long altitudinal gradient where it lives (range: 2100-3700 m a.s.l.) and grazing by invasive herbivores. Despite the severe summit conditions, the plant showed no pollen limitation, which is attributed to the high levels of self-pollination levels. Fitness of this vulnerable plant species is, however, extremely reduced owing to the presence of introduced rabbits in the area. Both spatial (among altitudes) and temporal (between years) differences in mean herbivory level affect the reproductive patterns of *V. cheiranthifolia* along the altitudinal gradient. Particular local conditions, such as predator pressure, population size and humidity, showed to affect plant fitness to a greater degree than changes in physical conditions (temperature and wind) associated with altitude. We conclude that more effective strategies need to be implemented to manage the invasive herbivores if we are to preserve this fragile oceanic summit ecosystem.

## Where are we in the parasite biogeography of land vertebrates in Macaronesia?

JUAN CARLOS ILLERA



Illera, J.C. 2016. Where are we in the parasite biogeography of land vertebrates in Macaronesia?. Pp. 185 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Macaronesia; *Taxa*: land vertebrates; *Other*: parasite biogeography, vertebrates, parasite diversification.

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Over the last two decades Macaronesia has proved to be an ideal system for evolutionary biologists who seek to unravel patterns and processes of colonisation, diversification, gene flow and extinction of different taxa. Much of this research has been performed with plants and animals but few studies have analysed this topic using parasite assemblages. Here I review the influence of Macaronesian vertebrate parasites on our understanding of island parasite biogeography. Studies focused on reptiles have provided information on presence, prevalence and genetic characterization of gastrointestinal parasites with some anecdotal information about haematozoans and mites. The most interesting information comes from the *Gallotia* lizards. Results obtained within this endemic genus have provided the highest values of helminth fauna richness recorded in lacertids so far. Such a result can be interpreted as a consequence of their herbivorous diet, which differs to that of the insectivorous diet reported for the continental species. However, most recent studies have been carried out with birds. In general, results support recognized concepts and theories in island biogeography where parasite diversity is positively associated with island area but negatively associated with island isolation. In addition, anthropogenic factors have also been highlighted as important factors governing the distribution and prevalence of parasites. Nevertheless, the huge variation in parasite prevalence and richness (between and within hosts) found across islands makes it difficult to obtain a unique interpretation about the host-parasite relationships. Finally I will introduce future avenues of research that I feel are now needed to better understand the mechanisms that structure parasite communities in Macaronesia.



# Biogeography and conservation of the reptiles of the Cabo Verde Archipelago: Insights from diversity and distribution patterns

RAQUEL VASCONCELOS



Vasconcelos, R. 2016. Biogeography and conservation of the reptiles of the Cabo Verde Archipelago: Insights from diversity and distribution patterns. Pp. 186 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Cabo Verde; *Taxa*: reptiles; *Other*: phylogeography, evolutionarily significant units, richness, historical and environmental factors, general dynamic model.

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Cabo Verde holds the highest number of endemic reptiles of the Macaronesian archipelagos, but these have received little attention until recently. Combining molecular and morphological tools, I have reviewed the systematics of the three extant genera, and identified 40 evolutionarily significant units (ESUs) among 31 endemic taxa. Contrary to the patterns found in the Canary Islands, each taxon corresponded to only an ESU, except in Santiago, the largest, most diverse and middle-age island. Reptile distribution data depicted broad biogeographic patterns: the highest taxa and ESUs richness is found in the southern islands of Santiago and Fogo. Considering single-island endemics, São Nicolau also stands out. Moreover, predictive maps of occurrence allowed detecting uneven richness distributions within islands too: in mountainous islands, inner areas are generally richer than coastal parts. These data allowed also identifying the priority islands and areas to protect the taxonomic and genetic diversity of Cabo Verde reptiles and updating the conservation status of each species. Inter-related historical and environmental factors explain this uneven diversity and distribution patterns. The most revealing historical factors are related with the geology and geography of the archipelago, such as the Pleistocene sea-level falls, volcanic activity, ages and islands' areas, as well as oceanic currents. Environmental factors include topography, habitat, climate and vegetation. High taxonomic diversity in the archipelago may be explained by multiple colonisations and drift, as well as by a founder effect in the different islands. The recent volcanic activity and high ecological stress that could lead to population extinctions, together with the low habitat diversity within some islands - which could restrain opportunities for allopatric diversification comparing to the Canaries-, explain the low intraspecific diversity between lineages of the same island. The above findings are congruent with the general dynamic model of oceanic islands. The high proportion of threatened taxa in Cabo Verde compared to the Canaries might be explained by the increased aridity and smaller area of the islands.



## The butterflies of the Canary Islands and Madeira: Aspects of colonization, differentiation, ecology, and conservation

MARTIN WIEMERS



Wiemers, M. 2016. The butterflies of the Canary Islands and Madeira: Aspects of colonization, differentiation, ecology, and conservation. Pp.187 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Macaronesia; *Taxa*: Papilionoidea; *Other*: butterflies, radiation, molecular phylogeny, endemics, invasive species, reintroduction.

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Butterflies are an important model group for biodiversity research and conservation, and the Canary Islands and Madeira are a hotspot for rare endemic butterfly species in Europe. 20 of the 35 native species are endemic to these archipelagos, and for some of them there is conservation concern, with one species (the Madeiran Large White *Pieris wollastoni*) already extinct, representing the only European butterfly species now thought to be globally extinct. On the other hand, at least eight additional species have colonized the islands in historic times (last hundred years), with potential effect on endemic species, and some endemic species have lately been (re)-introduced to some of the islands. In recent years, molecular data have been accumulated which shed new light on the colonization history and inter-island differentiation. This talk presents an up-to-date overview on the current knowledge of the islands' butterfly fauna, their biogeographic history of colonization and cryptic diversity, including still unpublished molecular data. The results improve our knowledge on the biogeography of the Macaronesian islands, and help to focus conservation efforts.

## Specialized Symposium 6

### (Bg4) Islands within islands: Parasites on insular host populations

CHAIRS: RICARDO J. LOPES & ROBERT E. RICKLEFS

## Galapagos birds and their parasites: Arrival and host relationships

PATRICIA G. PARKER



Parker, P.G. 2016. Galapagos birds and their parasites: Arrival and host relationships. Pp.189 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Galapagos Islands, Ecuador, South America; *Taxa*: birds, insects, protozoa, viruses; *Other*: biogeography, phylogeography, population genetics, disease.

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We have studied the disease ecology of Galapagos birds and their parasites/pathogens since 2001. Only four of sixteen major islands have human populations; we have examined farm animals on all four inhabited islands, and natural populations of endemic birds on all islands. Using a phylogenetic/phylogeographic approach, we estimate the colonization date of the avian lineages, and, when possible, their parasites. This allows us to categorize the host/parasite relationships into three broad groups: (1) hosts and parasites that co-colonized the islands, and for which subsequent co-evolutionary patterns can be described using population genetics, even for host taxa still considered a single species; (2) parasites that colonized independently of current Galapagos hosts, either arriving on an earlier colonization or one subsequent to the current host; (3) parasites or pathogens that are more recent arrivals. This last category presents the largest conservation concern, particularly when the host lineage has been present on the archipelago for a long time without exposure to that category of parasite or pathogen. Our teams involve members from four primary partner institutions: The University of Missouri – St. Louis, the Saint Louis Zoo, the Galapagos National Park, and the Charles Darwin Foundation. We also work with multiple additional international collaborators with special expertise not present among our primary partners. This structure permits the rapid adoption of recommendations based on joint scientific findings into management policy. We currently focus on two pathogens responsible for avian extinctions in Hawaii: the avian *Plasmodium* malarial parasite and the avipoxvirus. We seek to understand whether the local transmission of *Plasmodium* relies on an introduced arthropod vector, which would make it possible to eliminate the vector, and thus the parasite prior to its establishment of a native transmission dynamic.

## Why blackbirds are the main avian host of haemosporidia in Azores and how they cope with infections

RICARDO J. LOPES, J.A. RAMOS & P.M. RODRIGUES



Lopes, R.J., J.A. Ramos & P.M. Rodrigues 2016. Why blackbirds are the main avian host of haemosporidia in Azores and how they cope with infections. Pp. 190 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Azores; *Taxa*: passerine birds and haemosporidian parasites; *Other*: avian haemosporidians, island colonization, parasite biogeography.

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Isolated oceanic island archipelagos are important model systems to study the biogeography and evolution of host-parasite interactions. Additionally, in the present context of increasing global change and human intervention in the environment, our understanding of mechanisms that mediate the invasion of insular systems by novel vectors and pathogens is critical. Here we focus on the five most abundant forest passerine host species and haemosporidian lineages from the genera *Leucocytozoon*, *Haemoproteus* and *Plasmodium*, sampled from all islands of Azores archipelago and in southwest Europe and northwest Africa. We used cytochrome *b* to discern the lineages/haplotypes and obtain comparative data on the parasite richness between continental and island parasite communities. The number of haemosporidian lineages/haplotypes in Azores was small (two *Plasmodium* and one *Leucocytozoon* and no *Haemoproteus*). They were found in all islands and predominantly in the Blackbird *Turdus merula*. Additionally, these lineages also were found primarily in continental Blackbirds, while the *Leucocytozoon* lineages were found exclusively in continental Blackbirds. Suitable vectors for all haemosporidian genera have been recorded in all islands. It is likely that these lineages arrived to the Azores along with Blackbirds, as they are among the most common parasites in continental Blackbirds but are not common in other birds extensively sampled in SW Europe and NW Africa. The absence of *Haemoproteus* parasites is also explained by the very low presence of this genus in Blackbirds. Our observations supports the island syndrome predictions that island parasite assemblages are a subset of source assemblages and that host-parasite interactions are reduced; most of the parasites are specialized in one host species, the blackbird, which may explain why the prevalence in the other host species is so reduced.

## Patterns of diversification of parasites infecting reptiles in the Canary Islands: Different parasites, same answers?

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Perera, A., B. Tomé, A. Sousa, A. Pereira, M.A. Carretero, D.J. Harris, V. Roca & M.F. Jorge 2016. Patterns of diversification of parasites infecting reptiles in the Canary Islands: Different parasites, same answers?. Pp. 191 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Canary Islands; *Taxa*: *Spauligodon*, *Parapharyngodon*, *Hepatozoon*, *Karyolysus*, *Tarentola*, *Gallotia*, *Chalcides*; *Other*: phylogeography, morphology, genetics, pinworms, hemogregarines, host-parasite.

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Understanding how species diversify is one of the more important topics in evolutionary ecology, and oceanic islands have been preferred settings for investigating species formation. In these systems, the diversity of a given taxon is mainly shaped by the time available for colonization, migration rate, and in situ diversification rate. However, in parasites, the picture is more complex, since species-specific characteristics such as life cycle and host specificity may largely influence the patterns observed. In this talk, we will synthesize the work conducted by our team on two groups of parasites infecting reptiles in the Canary Islands: nematode pinworms (genera *Spauligodon* and *Parapharyngodon*) and hemoparasites (*Hepatozoon*/*Karyolysus* group). We analyze the prevalence, intensity, and distribution of these parasites across most of the species of Canarian reptiles (*Tarentola* geckos, *Gallotia* lizards, and *Chalcides* skinks) and characterize their diversity combining molecular and morphological methods. Our results reveal extensive and yet undescribed parasite diversity. Multiple lineages are distributed across the archipelago with some, but not only, geographic congruence. We also find differences in parasitemias across locations, and between different hosts in sympatry, suggesting different host specificity in the parasites analysed. We compare the patterns retrieved for each parasite group to assess the factors driving parasite diversification and distribution across these islands. Finally, we consider how studies of parasites might address some unsolved biogeographic questions regarding the colonization and diversification of the host reptiles from the Canary Islands.

## Do island species experience lower parasite pressure than mainland ones? Diversity, prevalence and host specificity of avian Haemosporidia in the Gulf of Guinea (West Africa)

CLAIRE LOISEAU, R. COVAS, E. LOBATO, J.S. BEADELL, R.C. FLEISCHER, S. REIS, C. DOUTRELANT & M. MELO



Loiseau, C., R. Covas, E. Lobato, J.S. Beadell, R.C. Fleischer, S. Reis, C. Doutrelant & M. Melo 2016. Do island species experience lower parasite pressure than mainland ones? Diversity, prevalence and host specificity of avian Haemosporidia in the Gulf of Guinea (West Africa). Pp. 192-193 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Gulf of Guinea, Africa; *Taxa*: birds, Haemosporidian parasites; *Other*: avian malaria, endemism, host specificity, insularity syndrome.

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Lower species diversity, increased population densities, and ecological niche enlargement are common characteristics of island faunas. It remains to be seen if these characteristics extend to parasite communities. A distinctive parasite environment on islands relative to mainland has been hypothesized as a major driver of evolution on islands. Here we test if and how parasite pressures and host specificity varies between islands and the mainland, using two approaches: i) at the host community level; ii) with paired-species comparisons between islands and the mainland. We used molecular-based methods to identify genetically distinct avian haemosporidian parasites and *Trypanosoma* parasites to describe parasite diversity, prevalence and host specificity between five islands of the Gulf of Guinea and nearby mainland areas. First, we found reduced diversity on islands for haemosporidian lineages, but not for *Trypanosoma*; parasite prevalence was also significantly lower on islands than mainland areas. In addition, host specificity of parasites was not lower on islands compared to the mainland, but lineages found both on islands and the mainland were host generalists. Finally, phylogenetic analyses showed that multiple colonisations played a major role in

the assembly of the parasite communities on the islands. This study supports the hypotheses that both parasite diversity and prevalence are reduced on islands in relation to the mainland. Additionally, we found that colonization is made by generalist species that have high host switching capacities once they settle in a new area. This is an advantageous trait for establishing viable populations in novel environments and increases the chances of persisting on islands where host populations of any given species tend to be small.



# Loss, gain and exchange: Avian malaria in naturally colonising hosts and related insular endemics

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Ishtiaq, F., B.C. Sheldon, I.P.F. Owens, N.J. Clark & S.M. Clegg 2016. Loss, gain and exchange: Avian malaria in naturally colonising hosts and related insular endemics. Pp. 194-195 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: south Pacific islands; *Taxa*: *Plasmodium*, *Haemoproteus*, *Zosterops*, Haemosporidian parasites; *Other*: dynamics of parasite exchange, sequential colonisation.

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Colonising hosts bring novel parasites that can be transmitted to native species, and similarly they can be infected by native parasites. The dynamics of parasite exchange between native and colonising hosts has largely been biased towards studies of human-mediated introductions, where introduced hosts may not encounter closely-related species, potentially limiting exchange of parasites between host species. We establish colonisation patterns of south Pacific islands by two vector-mediated parasites *Plasmodium* and *Haemoproteus* in *Zosterops* (Aves: Zosteropidae) to understand effects of host colonisation and host divergence time on parasite prevalence and diversity and the extent of host sharing in sympatry. We characterized parasite diversity and distribution via polymerase chain reaction (PCR) from avian (*Zosterops* species) blood samples collected from four groups: mainland source, recently colonised (<180 years), anciently colonised (< 0.5 Myr) and island endemic populations. Bayesian methods were used to reconstruct a parasite phylogeny based on mitochondrial DNA (cytochrome *b*) lineages. Parasite lineage accumulation curves were used to estimate parasite lineage richness. A host specificity index (STD\*) was calculated for each lineage. We found (i) both ancient colonist and island endemic species of *Zosterops* exhibited higher haemosporidian diversity than their mainland counterparts. However, there was no reduction in parasite prevalence as a result of host colonisation; (ii) there was evidence of parasite sharing based on host colonisation history; (iii) high divergence between mainland and colonised *Zosterops* parasite lineages possibly suggest that these lineages have colonised the island in the past and have diversified within the islands; (iv) despite missing lineages in colonised *Zosterops*, there were new lineages retrieved which were not shared with mainland or endemic *Zosterops*. Natural colonisation to locations with endemic congeners

possibly facilitates cross exchange of parasite fauna-the transfer of local parasites to colonised host and establishment of native parasite fauna thereby resulting in significant increase in parasite diversity. This appears to be due to extensive parasite sharing within sympatric avian host communities and the possibility of multiple avian invasion events from different archipelagos supplementing the island parasite fauna.

## Forest fragmentation and parasite diversity in an insular system

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Pérez-Rodríguez, A., A. Khimoun, A. Ollivier, C. Eraud, B. Faivre & S. Garnier 2016. Forest fragmentation and parasite diversity in an insular system. Pp. 196 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Guadeloupe and Martinique, Lesser Antilles (France); *Taxa*: *Plasmodium*, *Haemoproteus*, *Loxigilla noctis*, Haemosporidian parasites; *Other*: avian malaria, habitat fragmentation.

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Variation in pathogen pressure is often highly ranked among the many negative effects of forest fragmentation on wild animal populations, yet its effects seem to be context-dependent, so that more studies are needed to define a general pattern concerning the effect of fragmentation on infection risk. We set out to study if forest fragmentation could modify patterns of prevalence and richness of avian hemosporidian parasites infecting an endemic species of the Lesser Antilles: the Lesser Antillean Bullfinch *Loxigilla noctis*. Between 2012 and 2014, a total of 1,098 bullfinches were sampled for parasites in heterogeneous forest fragments on Guadeloupe and Martinique. We employed molecular methods to characterize parasite diversity, and we discovered that two parasite lineages (*Plasmodium* ICTCAY01 and *Haemoproteus* LOXPOR01) comprised the bulk of all hemosporidian infections on both host species. Parasite prevalence varied markedly between hosts and islands, but there was a consistent trend linking higher prevalence with larger, less fragmented forest patches. Remarkably, this link was little affected by climate, despite the sampled fragments spanning a wide range of rainfall regimes. Our work contributes to our understanding of how forest fragmentation may determine parasite pressures on tropical islands, which on the one hand are home to many endemic, often endangered avian species; and on the other hand are frequently under the threat of habitat loss by anthropogenic causes.

## Haemogregarines in Canarian reptiles: A distribution and diversity study

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Tomé, B., A. Pereira, M.F. Jorge, M.A. Carretero, D.J. Harris & A. Perera 2016. Haemogregarines in Canarian reptiles: A distribution and diversity study. Pp. 197 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Canary Islands; *Taxa*: haemogregarines, *Gallotia*, *Chalcides*, *Tarentola*; *Other*: haemoparasites, Apicomplexa, reptiles, lizards, biogeography.

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The Canary Islands are a volcanic archipelago off the coast of northwest Africa, whose genesis follows an east-west chronological pattern. The lizard genus *Gallotia* is one of the most emblematic cases of endemism of these islands, having arrived soon after the emergence of the oldest islands and colonised all seven. Other endemic reptiles are also found in these islands, namely species of the skink genus *Chalcides* and the gecko genus *Tarentola*, which colonised the islands more recently through multiple independent events. However, organisms never travel alone, as they host a variety of lifeforms, including parasites. Parasites provide insights into the host ecology and colonization history, while posing questions of their own. In this study, we screened 839 individuals of Canarian-endemic reptiles for the presence of haemogregarines, which are common blood parasites. We aimed not only to assess the distribution of these parasites, but also to identify and characterize them in a phylogeographic framework. By examining blood slides, 36% of samples were identified as infected. The prevalences and parasitaemia levels were unevenly distributed between host species and locations, with *Gallotia* lizards being the most frequently infected. The phylogenetic relationships of the parasites were estimated using the 18S rRNA gene. Results show the haemogregarines infecting the Canarian reptiles belong to two major groups within the *Hepatozoon/Karyolysus* lineages. One, only found in geckoes from two western islands, clustered with sequences recovered from other gecko hosts (including *Tarentola* species of North Africa). The second group clusters with sequences from lacertids of the Mediterranean region, and was mostly found in *Gallotia* specimens. This latter lineage was occasionally recovered from the other reptile genera, probably representing cross-infections. Nevertheless, sequences in this group did not form a monophyletic unit. Our results indicate a complex biogeographic pattern, possibly involving several colonization events.

Specialized Symposium 10  
(Bg5) Palaeobiogeography, palaeocology and palaeoclimatology in oceanic islands

CHAIRS: SÉRGIO ÁVILA, PEDRO RAPOSEIRO & VITOR GONÇALVES

## Pleistocene glacial/interglacial contrasts in North-West North Atlantic prior vs after MIS 11

CLAUDE HILLAIRE-MARCEL, A. DE VERNAL, O. TÉBOULE & A. AUBRY



Hillaire-Marcel, C., A. Vernal, O. Téboule & A. Aubry 2016. Pleistocene glacial/interglacial contrasts in North-West North Atlantic prior vs after MIS 11. Pp. 199 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Atlantic Ocean; *Other*: pleistocene, glacial/interglacial conditions, Marine Isotopic Stages, MIS 11.

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We will first give a quick overview of the specificity of interglacials preceding MIS 11 vs MIS 11 and earlier interglacials from a global perspective with attention to the fact that all interglacials differ from one another. Then, based on exhaustive studies of ODP and IODP cores from Eirik Ridge (off southern Greenland) and Orphan Knoll (north of Flemish Cap), we will pay more attention to their properties in the NW North Atlantic with respect to linkages with continental ice caps (Greenland, North America, NW Europe) and deep North Atlantic currents. All interglacials prior to MIS 11 suggest overall cooler, possibly more diluted conditions in surface water, with evidence for discrete but frequent and effective ice-rafting and larger residual ice sheets. Intense ice-erosion of Paleozoic Terranes during glacials and deglacials were more pronounced prior to MIS 11, with the single exception of MIS 7 which depicts features not unlike interglacials from the pre-MIS 11 interval. A strong Western Boundary Undercurrent seems to characterize most interglacials prior and after MIS 11. Some focus on MIS 31 and 13 will then permit to highlight specificities of interglacials. MIS 31 stands out during the Jaramillo magnetic reversal as an exceptionally “warm” interglacial. Radiogenic isotope and clay minerals from this interval illustrate chemical erosion, thus soil development over Greenland during interglacials. Micropaleontological investigations (dinocysts vs foraminifera) illustrate relatively cold, low salinity waters at surface, contrasting with warmer but more saline and denser underlying waters, during the interval, pointing to strongly stratified waters (thus no convection in the Labrador Sea) and possibly occasional sea-ice presence in sub-arctic basins. In contrast, MIS 13 seems generally much cooler. Intervals with Heinrich layers indicate the persistence of active ice in NE North America during this interglacial that might be seen as closer to interstadial than true interglacial conditions. It is concluded that interglacials present relatively few analogies and rather illustrate very distinct oceanographical conditions in the NW Atlantic from one to the other. The presence of a strongly resilient Greenland Ice Sheet seems effective since MIS 9 only and convection in the Labrador Sea favored by a strong sub-arctic gyre carrying salt into the surface waters of this basin appears more the exception (MIS 1, BOA?, MIS 11?) than the rule.

## Transatlantic dispersal of the coral-dwelling barnacles belonging to *Ceratoconcha* and their Neogene spread to the North Atlantic islands

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Baarli, B.G., M.E. Johnson, M.C.D. Malay, A. Santos, J. Meco, C.M. Silva, E.J. Mayoral & M. Cachão 2016. Transatlantic dispersal of the coral-dwelling barnacles belonging to *Ceratoconcha* and their Neogene spread to the North Atlantic islands. Pp. 200-201 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

**Key words:** *Location:* Atlantic Ocean and Mediterranean region, with special emphasis on volcanic archipelagos in the eastern Atlantic; *Taxa:* Arthropoda (Cirripeda), Cnidaria, (hematypic corals); *Other:* *Ceratoconcha*, Cirripeda, Macaronesia, oceanic islands, paleobiogeography, stepping-stone, dispersal.

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Coral-dwelling pyrgomatid barnacles (subfamily *Ceratoconchinae*) were widely dispersed through the European Parathetys and Atlantic Ocean during the Neogene, but today are restricted to the Western Atlantic. Herein, the paleobiogeographic spread of the genus *Ceratoconcha* is based on a combination of field, taxonomic, and literature studies. Few records of this genus were known from oceanic islands, previously. We add information on fossils from Lanzarote in the Canary Islands and Maio in the Cape Verde islands. The origin and initial dispersal of *Ceratoconcha* is ambiguous, because the first confirmed appearances occur in lower Miocene strata (Burdgalien) on both sides of the Atlantic in western France and Florida. The two taxa are closely related. Especially close fauna traits down to the species level also are recognized in other barnacles and faunal groups from the two coasts. Gyre formation was very weak at that time and the Atlantic Ocean mid-latitudes were warmer than today. These conditions allowed host hermatypic corals to expand farther north in Europe. Larval transport due to storm activity and the presence of many oceanic islands may have abetted barnacle dispersal. *Ceratoconcha* from mid and upper Miocene strata in the Madeira and Canary Islands, respectively, extend the geographic range of the barnacle to the western edges of a large biogeographic province



covering western France and Angola. *Ceratoconcha* with its hermatypic host corals suffered a severe decline in the eastern parts of the Atlantic after the Miocene Epoch. New data show that corals had a sparse history in the Canary Islands, but occurred more frequently the Cape Verde Islands during the Pliocene. This suggests that the southernmost oceanic islands acted as a tropical refuge for host corals and their likely pyrgomatid symbionts. The temporal range for *Ceratoconcha* in the eastern Atlantic is extended considerably from the early Pliocene to the Pleistocene.

## Biodiversity and biogeographical patterns of the Pleistocene and Holocene littoral gastropod fauna from the Azores

RICARDO J.P. CORDEIRO, C.A.S. MELO, P.G.A. MADEIRA & S.P. ÁVILA



Cordeiro, R.J.P., C.A.S. Melo, P.G.A. Madeira & S.P. Ávila 2016. Biodiversity and biogeographical patterns of the Pleistocene and Holocene littoral gastropod fauna from the Azores. Pp. 202 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: Gastropoda; *Other*: biodiversity, biogeography, Holocene, last interglacial.

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Located in the middle of the northern Atlantic, the Archipelago of the Azores is presently constituted by nine volcanic islands. These are considered a “natural laboratory”, where processes and patterns of dispersal, colonization and speciation can be studied, and ecological, evolutionary and biogeographical theories tested. Although under the influence of the southern branch of the Gulf Stream, several works on different taxonomic groups have shown that the Azorean marine biota is predominantly related to the shores of the eastern Atlantic and Mediterranean Sea. Therefore, there is no correspondence between the present-day sea surface currents in the North Atlantic and the biogeographical affinities of the Azores. This biogeographical paradox still lacks understanding. For any study related with biodiversity and biogeography from a given geographic area is of essential importance to have up-to-date lists of species. Therefore, as a result of the study of the most important Last Interglacial (MIS 5e) fossiliferous sequences of Santa Maria Island and the review of the Recent marine mollusc collection held by the Department of Biology of the University of the Azores, we will present the latest data on the biodiversity of the Pleistocene and Holocene littoral gastropod fauna from the Azores. We will also relate these new data with the already known biogeographic patterns affecting the marine fauna of the Azores, pointing out some hypotheses about the processes and routes of dispersal to the archipelago.

## Biodiversity and biogeography of recent and fossil echinoderms from the Azores

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& S.P. ÁVILA



Madeira, P.G.A., R.J.P. Cordeiro, A.C.F. Rebelo, C.A.S. Melo, A. Kroh & S.P. Ávila 2016. Biodiversity and biogeography of recent and fossil echinoderms from the Azores. Pp. 203-204 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Azores; *Taxa*: Echinodermata; *Other*: biogeographical relationships, late Miocene-early Pliocene, late Pleistocene, Atlantic Ocean.

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We have compiled a database of the Atlantic Ocean and the Mediterranean Sea littoral echinoderms (<200m). A checklist with 897 species was obtained and the biogeographical relationships were studied, with a focus on the Macaronesian archipelagos and an emphasis on the Azores. The Azores is a natural laboratory to test biogeographic models and theories. Santa Maria Island (6.3Ma) has a rich fossil record that includes a wide range of shallow benthic organisms from the Late Miocene-Early Pliocene and Pleistocene (MIS5e) ages. The study of the biogeographical relationships of the Azores shallow-water echinoderms shows that this archipelago's fauna clusters with Canaries, NW African, Iberian coasts and the Mediterranean Sea. The Azores show similar general trends to what is observed in other Macaronesian archipelagos: lack of endemic species, dominance of echinoderm fauna associated with rocky shores and species capable of producing planktonic feeding larvae. Although the relatively low echinoderm diversity in the Azores could be attributed to the archipelago isolation, young geological age, and low habitat diversity (e.g., high-diversity habitats like coral reefs and seagrass beds are absent), the fossil record offers further insights: of the eight Early Pliocene taxa found in the fossil record of Santa Maria Island, only one species (*Echinocyamus pusillus*) survives in the present-day fauna, whereas all the three Pleistocene species recorded in the Last Interglacial (MIS5e) (*Arbacia lixula*, *Paracentrotus lividus* and *Sphaerechinus granularis*) still occur in the Azores region. The dramatic change in the echinoderm fauna composition in the Azores is yet another example of the Pleistocene glaciations impact on the marine shallow-water community. The tropical

Pliocene fauna disappeared from the area at about 3.3-3.0Ma, being progressively replaced by warm-temperate species, resulting in a similar pattern to what is still observed in present-day Azorean coasts, i.e., a close relationship to the faunas of the Northeast Atlantic and Mediterranean.

## The human colonization of islands: A paleo perspective

SANTIAGO GIRALT



Giralt, S. 2016. The human colonization of islands: A paleo perspective. Pp. 205 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Easter Island (Pacific Ocean, Chile); São Miguel Island (Azores, Portugal); *Taxa*: all; *Other*: multiproxy approach, lacustrine sediments, paleoclimatology, human occupation.

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Determining when a particular island was colonized by humans for the first time is not an easy task. Determining the age of these first settlements is of paramount importance owing to they have important implications for understanding, for example, past maritime capacity, and trade and migration patterns. Commonly, this task has been considered from the archeological, anthropological and historical perspectives. However, the scarcity and incompleteness of the archaeological/historical record present in the islands, or even its complete absence, hampers the correct dating of these first human colonizations, usually providing a much younger age. One effective approach to overcome this limitation is through the multiproxy, high resolution characterization of natural archives, such as lacustrine sediment cores. Most often these environmental reconstructions allow to accurately reconstruct when and how humans occupied islands. The anthropic information derived from these environmental reconstructions usually display a much rich and complex human colonization history than is commonly established. The talk will present the environmental history of Easter (Pacific Ocean, Chile) and of São Miguel (Azores archipelago, Portugal) islands reconstructed from the multiproxy characterization of lacustrine sediments. These environmental reconstructions will be used to discuss when and how both islands were most probably first settled.

## Marine island biogeography: Testing large-scale biogeographic patterns of marine organisms in oceanic islands (Atlantic Ocean)

SÉRGIO P. ÁVILA, R. J.P. CORDEIRO, P. G.A. MADEIRA, L. SILVA, A. MEDEIROS, A. C. F. REBELO, C. A.S. MELO, ET AL.



Ávila, S.P., R.J.P. Cordeiro, P.G.A. Madeira, L. Silva, A. Medeiros, A.C.F. Rebelo, C. Melo, A.I. Neto, R. Haroun, A. Monteiro, K.F. Rijdsdijk & M.E. Johnson 2016. Marine island biogeography: Testing large-scale biogeographic patterns of marine organisms in oceanic islands (Atlantic Ocean). Pp.206-207 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: 12 archipelagos/islands, Atlantic Ocean; *Taxa*: Mollusca (Gastropoda), Echinodermata, Algae, Fish; *Other*: island biogeography, marine organisms, marine species-area relationships, marine endemism patterns, large-scale biogeographic patterns, pleistocene sea-level changes.

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Oceanic islands have been the target of fundamental evolutionary and biogeographical studies since the earliest contributions by Darwin and Wallace. Area and isolation were proposed by McArthur &

Wilson as the most important variables to account for island biodiversity. Insular biotas are the direct result of chance events of dispersal and successful colonization, followed by in situ speciation. Whittaker et al. have built upon a General Dynamic Model (GDM) for the biogeography of oceanic islands that puts the dynamics captured in MacArthur and Wilson's model into a geological and evolutionary context, thereby providing "a general explanation of biodiversity patterns through describing the relationships between fundamental biogeographical processes through time and in relation to island ontogeny". This model asserts that the isolation of oceanic island systems has ramifications for evolutionary processes with a strong signal from the biogeographical patterns of the group (i.e. they are 'Darwinian' islands). Furthermore, speciation, extinction (and in sum diversification) rates and migration rates are strongly influenced by island ontogeny. Most of the recent literature has dealt mainly with the terrestrial realm, with only a handful of papers on the marine realm. We examined large-scale biogeographic patterns from oceanic islands, focusing on four groups of littoral marine organisms (molluscs, echinoderms, algae and reef fish) that inhabit shallow waters around twelve Atlantic archipelagos. Patterns between species richness/endemism and a number of variables [island littoral area, age, isolation, average latitude of the archipelago, and mean annual sea surface temperatures] were searched for and tested by means of several models (null, linear, logarithmic, power, logistic and the GDM). We found no support for the GDM on the marine realm, with area being the most important factor to explain present marine biodiversity on volcanic oceanic islands/archipelagos. Important considerations also are made regarding the impact of glacial/interglacial episodes on species richness.



## The role of sea-level changes in oceanic island's biodiversity: The MIS 5e in the Azores

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Melo, C.A.S., A.C.F. Rebelo, R.J.P. Cordeiro, P.G.A. Madeira, V. Raposo & S.P. Ávila 2016. The role of sea-level changes in oceanic island's biodiversity: The MIS 5e in the Azores. Pp.208 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Azores; *Taxa*: Mollusca; *Other*: glacial/interglacial cycles, marine littoral area, sediment transport, insular shelf, NE Atlantic.

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Sea-level changes have long caused variations on area availability (both in marine and terrestrial environments). Reefless volcanic oceanic islands such as the Azores Archipelago are places of upmost importance to study the impact of glacial/interglacial cycles on the biodiversity of insular communities. In the marine realm, the general narrow insular shelf of reefless volcanic oceanic islands enhances large amounts of loose sediments to be lost to abyssal depths during glaciations, causing the disappearance of sandy-related habitats, and the consequent loss of biodiversity in the marine realm. On the other hand, during glacial terminations, sea-level rise results in the increase of littoral area. This increase is associated with warmer climates therefore the arrival of new species is expected. This is true for the marine fossil record of Santa Maria (Azores), where 143 taxa (mainly molluscs) have been identified. An upcoming effort in the study of the palaeobiodiversity of the marine fossil record from Santa Maria Island (where several new MIS 5e outcrops were recently discovered) might raise the number of taxa identified, therefore helping to comprehend the marine palaeobiodiversity richness 130-120.000 years ago in the Azores region, and helping to better define and improve the palaeobiogeographic relationships.

## Rhodolith beds on volcanic oceanic islands: Palaeobiology and palaeobiogeography

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Rebelo, A.C.F., M.W. Rasser, C. Melo, P. Madeira, R. Cordeiro, A.I. Neto & S.P. Ávila 2016. Rhodolith beds on volcanic oceanic islands: palaeobiology and palaeobiogeography. Pp. 209 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Macaronesian archipelagos; *Taxa*: Rhodophyta; *Other*: crustose coralline red algae, rhodoliths, palaeoecology, palaeoenvironment, palaeodepth, Atlantic islands.

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Rhodoliths are nodules of free-living coralline red algae (Rhodophyta) that often form around a lithoclastic or bioclastic nucleus and develop by concentric growth. Living rhodoliths enter the fossil record through a range of taphofacies, recording the story of their development from the nucleus to the surface, which also reflects palaeoenvironmental changes during long-term rhodolith development. Although they are common around many islands of the North Atlantic Archipelagos, including the Cape Verde, Canary, Madeira and Azores, little information exists regarding the life conditions of rhodolith beds in the context of their taxonomical composition, water-depth of formation and distance from shore-line. The improvement of rhodolith beds mapping, the knowledge of rhodolith composition distribution and the comparison between modern and ancient occurrences is essential to better interpret the original conditions under which fossil rhodoliths lived and grew. The gathered information will help to understand the origin of rhodoliths in modern shelf deposits around volcanic oceanic islands. It will also contribute to better constrain palaeoecological interpretations regarding the use of fossil rhodoliths for the deduction of the palaeodepth of deposition of fossiliferous sediments within volcano-sedimentary sequences in oceanic islands.

## Pleistocene area as predictor of species richness on volcanic islands

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Key words: *Location*: 52 islands in seven archipelagos (Azores, Canaries, Cape Verde, Hawaii, Madeira, Mascarene Islands); *Taxa*: terrestrial gastropod species; *Other*: sea level change, palaeo-area, oceanic islands, dynamic equilibrium model, general dynamic model.

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The Dynamic Equilibrium Theory (DET) states that extinction, migration, colonization and speciation - the processes that shape species richness on islands - are eventually influenced by island surface-area and isolation. On timescales of 100 ky, island surface-areas are shaped by repeating sea-level cycles. During the Pleistocene, sea levels were up to 120-130 m lower than present and, as a result, volcanic islands were larger than today. Since the Last Glacial Maximum (LGM) 22 ky ago, sea level rise resulted in the contraction of the surface-areas of oceanic islands. Using linear mixed models, we assessed whether Pleistocene palaeo-areas explain insular endemic and native (non-endemic) gastropod species richness on 53 volcanic islands across seven archipelagos. We compared the models which include palaeo-area to models based on the DET, and to the species-area relationship. We found that palaeo-areas are correlated with current areas. Nevertheless, for a high proportion of islands (20%) palaeo-area and current area are not closely related because of differences in bathymetry. Furthermore, it should be noted that this is an asymmetrical relationship because areas during LGM were always larger than today. We found that palaeo-area was a positive predictor for species richness of endemics but a negative predictor for non-endemic native species. We suggest that endemic species

on these islands have adapted to repeated glacial-interglacial surface-area contractions and that endemic species densities increase resulting from surface-area contraction. Conversely, surface-area contraction will lead to higher extinction rates for native species which are not adapted to the repetitive surface-area contraction cycles. Additionally, colonization by native species during higher sea-levels might be hindered by the high density of endemic species and reduced target effect. We suggest that insular species-area relationships need to be re-visited to incorporate the effect of Pleistocene palaeo-area.

# Quantifying palaeogeographical rates of changes of continental islands in the Aegean Sea by sea level rise: Towards a novel framework for assessing biogeographical implications of palaeogeographical change

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Simaiakis, S.M., K.F. Rijdsdijk, E.F.M. Koene, J.H. Van Boxel, P. Stocchi, E.E. Van Loon, C. Hammoud, S.J. Norder, E. Georgopoulou, K.A. Triantis & E. Tjørve 2016. Quantifying palaeogeographical rates of changes of continental islands in the Aegean Sea by sea level rise: Towards a novel framework for assessing biogeographical implications of palaeogeographical change. Pp. 212-213 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Greece, Aegean archipelago, East Mediterranean Sea; *Taxa*: -; *Other*: relative sea level rise, dynamic equilibrium theory, genetic diversity, connectivity, isolation.

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Since the Last Glacial Maximum ca. 22 kyr BP, sea levels have risen up to 130 m globally; as a result peninsular islands became disconnected from the adjacent mainlands and continental islands partly drowned, fragmented and shrunk in size. We developed a framework to test biogeographical

hypotheses on insular biota of continental islands that are affected by sea level rise. We present an elaborate reconstruction of the palaeogeographical history of the Aegean archipelago by modelling the effects of sea level rise and quantifying timings and rates of connectivity loss, fragmentation and area reduction over time steps of 1000 years during the past 22 kyr. We applied an advanced sea level model taking into account the geophysical complexity associated with continental settings of the Aegean archipelago to obtain metrics on surface-area reduction and connectivity loss over time. The reconstructed chronology for the drowning of the Aegean Sea revealed large differences between island histories, regarding both absolute changes in area and area-change rates as well as in absolute distances to neighboring islands or to the mainland, and in distance-change rate at different periods. The palaeogeographical sea level rise Area-Distance Change (ADC) typology for the continental islands based on their different historic rates of connectivity loss, fragmentation and area reduction allows for testing how species richness and genetic diversity of the Aegean islands are affected by differences in rates of change in area, distance and fragmentation.

# The Last Interglacial in northeastern North America and the northern North Atlantic: Evidence for warmer climate and ocean conditions than during the Holocene and possibly MIS 11

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Vernal, A., B. Fréchette, C. Hillaire-Marcel & N. van Nieuwenhove 2016. The Last Interglacial in northeastern North America and the northern North Atlantic: Evidence for warmer climate and ocean conditions than during the Holocene and possibly MIS 11. Pp. 214-215 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: northeastern North America; northern North Atlantic; *Taxa*: all; *Other*: interglacial, pollen assemblages, climate change, Holocene, ocean circulation regimes, Marine Isotopic Stages, MIS 11.

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The climate conditions of the last interglacial (LI) in northeastern and southeastern Canada are documented based on pollen data from Baffin Island and Cape Breton Island, respectively. The LI pollen assemblages indicate very different vegetation than at present and a northern limit of the deciduous forest biome as far as 500 km north of its modern position. The application of the modern analogue technique also reveal warmer climate during the LI than at present, 4-5°C warmer on Baffin Island at ~67-70°N in the Canadian Arctic, and up to 7°C warmer on Cape Breton Island, at ~45°N, in eastern Canada. The contrast between LI and Holocene climates is also illustrated by marine data (dinocysts, foraminifers, oxygen and carbon isotopes) that document warmer than Holocene conditions in surface waters in the northwest North Atlantic (up to 5.5°C in summer, notably off southwest Greenland). The LI also depicted very distinct distributions of intermediate and deep waters in the northern vs southern Labrador Sea. Moreover, an important zonal atmospheric circulation component at mid-latitudes of the North Atlantic is also evidenced from the pollen content of marine cores collected in central North Atlantic (IODP Site 1304), which strongly suggests an origin from south-eastern Canada. Altogether the data demonstrate much warmer conditions along northeastern North America margins, from North to South. The mild conditions along the coastlines and the relatively warm waters off eastern Canada and southern Greenland suggest reduced Arctic outflow components through the East Greenland Current and Labrador Current. Comparisons with records from eastern North Atlantic lead us to conclude in a more zonal climate prevailed during the LI in comparison with the Holocene, especially the early Holocene that was marked by a particularly pronounced west to east gradient of temperatures. Hence, the thermal optimum of the LI and that of the Holocene provide two examples of very different climate and ocean circulation regimes in the



circum-Atlantic region. The few data available for the marine isotope stage (MIS) 11 suggest sea-surface conditions similar to modern in the northwest North Atlantic although there are evidences for reduced volume of the Greenland ice sheet volume and cool temperate terrestrial conditions over southern Greenland, thus unique climate pattern at the scale of the last Ma.

## Spatial distribution of subfossil diatom and chironomid assemblages' in surface sediments of a remote oceanic lake: The case of Lake Azul (Azores archipelago)

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Raposeiro, P.M., A. Saez, S. Giralt, A.C. Costa & V. Gonçalves 2016. Spatial distribution of subfossil diatom and chironomid assemblages' in surface sediments of a remote oceanic lake: The case of Lake Azul (Azores archipelago). Pp. 216 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: diatoms and chironomids; *Other*: distributional patterns, taxon richness, oceanic islands.

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Until recently, the distribution of diatom and chironomid species assemblages and their attributes (e.g. species richness) in relation to water depth and sedimentary environments have been identified but not quantified, especially in remote oceanic islands as those of the Azores archipelago. The influence of environmental variables on diatom and chironomid distribution and taxa richness in a deep, monomitic lake in São Miguel Island (Azores archipelago, Portugal) is assessed. Particular attention is given to community variation along depth gradient along which many environmental variables abruptly change in Lake Azul. Surface-sediment diatom and chironomid assemblages were collected in Lake Azul along three transects with variable slope (0 to 10°) from shoreline to the centre deep basin of the lake at a resolution of 1 m water depth. Ordinary least squares (OLS) regression was used to test the species richness and abundance of diatoms and chironomids in sediment vs water depth. Abundance and taxon richness data were related to 8 limnological variables using multivariate techniques (PCA, dbRDA and DISTLM). A hump-shaped relationship between species richness and water depth was noted with a peak occurring at intermediate depth levels (9.0-9.8 m). Water column variables were the most important variables, followed by sediment and geochemistry variables in explaining the distributions of diatoms and chironomid assemblages along the depth gradient in Lake Azul.

## Lost ecosystems of Corvo Island, Azores

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Connor, S., A. Gomes, S. Haberle, W.O. van der Knaap, K. Petr, J.F.N. van Leeuwen, T. Lewis, S. Piva & N. Porch 2016. Lost ecosystems of Corvo Island, Azores. Pp. 217 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Corvo Island, Azores, Portugal; *Taxa*: terrestrial and aquatic plants, diatoms, insects; *Other*: palaeoecology, Holocene, environmental change, human impacts.

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As with many oceanic archipelagos, Azorean ecosystems were subject to intense anthropogenic impacts following the islands' colonisation in the 15<sup>th</sup> century. The degree of habitat modification on some islands has been so great that it is difficult to imagine the pre-colonial biota, let alone understand its ecology. On the Azores, historical descriptions and remnant habitats have been the primary sources of information on the islands' pristine ecosystems. Palaeoecological data offer the chance to reconstruct past ecosystems and gauge the magnitude of past human impacts. Such data can also detect extinctions, invasions and ecological responses to environmental drivers such as climate change. Using a sediment core from Corvo Island's iconic crater, Caldeirão, we reconstructed pre-colonial ecosystems from fossil pollen, seeds, beetles and diatoms. Radiocarbon dating indicates that the fossil record covers several millennia before human arrival. Our data document changes in pristine forest composition influenced by climatic and edaphic factors. Human arrival, however, is associated with the most remarkable changes in the record. These include complete forest loss, rapid erosion, extirpation of some Azorean endemics and the spread of exotic species. Corvo's ecosystems today bear little resemblance to their pre-colonial counterparts. Despite the attractiveness of biodiversity checklists and niche-based modelling for conservation, they assume relationships between species and environments that may in fact be human-mediated. Failure to account for the extraordinary levels of historical human impact on island ecosystems could unintentionally lead to poor conservation outcomes.

# Reconstructing the palaeovegetation of Madeira and Azores Islands: Overview and future perspectives

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Góis-Marques, C.A., L. de Nascimento, M.P.S.M. Sequeira, J.M. Fernández-Palacios & J. Madeira 2016. Reconstructing the palaeovegetation of Madeira and Azores Islands: Overview and future perspectives. Pp. 218 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Macaronesia (Azores and Madeira Archipelagos); *Taxa*: plants; *Other*: Quaternary, Palaeoecology, vegetation.

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The subaerial evolution of volcanic islands, characterized by recurrent and varied volcanic activity alternating with quiescence, erosion and sedimentation periods, provides, from a taphonomical point of view, excellent opportunities for palaeovegetation to be preserved as fossils. The palaeobotanical history of the Portuguese Macaronesian Islands, mostly aiming at understanding the geological evolution of oceanic volcanic islands, shows that the search and discovery of plant macrofossils was led since the 19th century by eminent naturalists like Lyell or Darwin. The plant remains reported in the 19th and 20th centuries are mainly composed of macrofossils (leaf, logs, branches and roots) and mesofossils (e.g. small fruits, seeds and flowers). More recently, microfossils (pollens and spores) have also been reported but understudied. Additionally, charcoal, wood, peat and palaeosols have been used for radiocarbon dating of volcanic events in both archipelagos, but lack a paleontological approach. In Madeira archipelago, a total of seven fossiliferous localities ranging from at least 1.8 Ma to the present, containing macro and mesofossils are reported. In the Azores archipelago at least 24 macrofossil plant localities, ranging in age from Pleistocene to present, are known from six islands (Faial, Pico, São Jorge, Terceira, São Miguel and Santa Maria). However most sites and floras require a modern revision. In both archipelagos, there is a potential to increase the number of sites, especially with microfossil prospection. The recovery and analysis of palaeobotanical and palynological data, complemented by actuopalaeontological and neocological studies, is essential for a palaeoecological reconstruction of both archipelagos. Moreover, radiometric dating of the fossiliferous sites will deliver important input for phylogenetic and biogeographical studies.

## A first approach to the Canarian pine forest long-term ecology

LEA DE NASCIMENTO, S. NOGUÉ, C. CRIADO, R. J. WHITTAKER, K. J. WILLIS & J. M. FERNÁNDEZ-PALACIOS



de Nascimento, L., S. Nogué, C. Criado, R.J. Whittaker, K.J. Willis & J.M. Fernández-Palacios 2016. A first approach to the Canarian pine forest long-term ecology. Pp. 219-220 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Tenerife (Canary Islands); *Taxa*: *Pinus canariensis* and other Canarian taxa; *Other*: fossil pollen, human impact, late Holocene, palaeoecology, pine forest, volcanic activity.

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Palaeoecological records extend our view of ecological processes allowing us to understand how ecosystems respond to a particular disturbance through time. Islands worldwide are subject to major disturbance factors, i.e. climate change, geological events and human impact, but their extent and time-span may vary according to each island characteristics. In the Canary Islands, long-term vegetation reconstructions, obtained from the analysis of fossil pollen, have recently shown that climate and humans have driven changes in vegetation composition. Despite we are starting to observe some similarities in island ecosystem responses, especially in the event of human impacts, more data is needed to better interpret such responses and to increase our understanding on the effect of climate change and geological events on vegetation dynamics. With this aim a new site has been studied on the island of Tenerife, Caldera de La Orotava, an old crater located in the northern slopes of Tenerife at an elevation of 1180 m above sea level, currently surrounded by Canarian pine forest plantations. This record gives us the opportunity to study pine forest long-term dynamics for the first

time on Tenerife. The time spanned by the record (2500 years ago to the present) allows to establish the forest baseline before the expansion of the aboriginal population on the island (between 2500-2000 years ago), and to assess human impact on prehistoric (2500-500 years ago) and historic periods (the last 500 years). In addition, the presence of a pyroclastic layer in the lower part of the sequence may represent the arrival of volcanic material from the Montaña Blanca eruption (around 2000 years ago), taking the opportunity to explore the impact of volcanic activity on the pine forest, a fire prone ecosystem in the Canary Islands, and its recovery from a long temporal perspective.



## SPECIALIZED SYMPOSIA – Conservation



Terra-Brava native forest in Terceira, Azores, one of the most well preserved fragment of native forest in Azores (Photo: Paulo A. V. Borges)



## Specialized Symposium 2

### (Cv1) Biodiversity and conservation of island plants

CHAIRS: MÓNICA MOURA, LUÍS SILVA & JULI CAUJAPÉ-CASTELLS

## Oceanic island plant conservation in a changing world: Lagging or leading?

JULI CAUJAPÉ-CASTELLS



Caujapé-Castells, J. 2016. Oceanic island plant conservation in a changing world: Lagging or leading?. Pp. 223 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Canary Islands; *Taxa*: Canarian native and endemic plants; *Other*: phylogeny, genetic diversity, cryptic taxa, conservation strategies, widespread taxa, endangered taxa.

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As in many other areas worldwide, plant conservation in oceanic islands is almost exclusively focussed on highly threatened (CR+EN) species. On the contrary, widespread endemics have received only anecdotal attention, even though (unlike many threatened taxa) most of them still may have abundant genetic diversity that the CBD prompts us to conserve. Based on recent molecular phylogenetic and genetic diversity data for Canarian endemic plant lineages, the lecture will pick out examples of (i) the great heterogeneity in divergence times within the CR+EN category, and (ii) the existence of taxonomically disconsidered and cryptic taxa both in widespread and restricted endemics. Cogent with the increasing availability of multidisciplinary data, we will present supporting evidence for (a) implementing differential conservation “treatments” for phylogenetically modern CR+EN species (that may give rise to the endemics of the future) and phylogenetically ancient CR+EN species, and (b) adding “preventive” actions (i.e. aimed at protecting the differentiation processes already evident in many widespread species) to the current conservation practice in oceanic islands, which is only ‘palliative’ and devoted to implement (and publicize!) the painstaking efforts devoted to the CR+EN species (many of which are in an evolutionary cul-de-sac). Likewise, it seems imperative that population reinforcement and reintroduction actions take into account the most elementary tenets of evolutionary and population genetics theory, and the already numerous evidences that reveal the existence of rugged “genetic insularities” within oceanic islands. Most of the investigations that sustain this contribution were supported by projects ENCLAVES (MAC/3/C141) and DEMIURGO (MAC/1/C20), and by the Cabildo de Gran Canaria.

## Faial Botanic Garden: Nature conservation into practice

PEDRO CASIMIRO, J. MELO & C. FREITAS



Casimiro, P., J. Melo & C. Freitas 2016. Faial Botanic Garden: Nature conservation into practice. Pp. 224 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: Azorean endemic plants; *Other*: conservation, Faial Botanic Garden.

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Located on the Mid-Atlantic Ridge, the archipelago of the Azores is the westernmost part of Europe and the meeting point of unique plant species. Part of the Regional Government of the Azores, and belonging to Faial Natural Park, the Faial Botanic Garden carries out a conservation program, comprising “in situ” and “ex situ” conservation measures, while deeply involved in education and scientific research. The main goals of this program are: to carry out conservation actions in priority habitats and landscapes, to establish Action Plans for the Conservation of all priority species of the Azores flora and to implement environmental education and scientific research. The program follows the premise that “In situ” conservation actions are the ultimate goal for “Ex situ” conservation, that should be regarded as a safeguard and supplier of the necessary inputs. The Garden keeps the most complete collection of plants from the Azores, offering visitors extensive information. A propagation facility is focused on rare species for population and habitat recovery, while collecting biological data. The Seed Bank of the Azores, housed in the Garden, implements a regional campaign for seed collection. Seed sample preparation and germination tests provide extensive data on seed biology. Wide areas of the Natural Park are being intervened under the coordination of Faial Botanic Garden, especially by controlling invader plants but also other risk factors, and focuses on population, habitat and landscape protection.

## Isolation patterns affect the conservation of the critically endangered *Lactuca watsoniana*

ELISABETE F. DIAS, M. MOURA, H. SCHAEFER & L. SILVA



Dias, E.F., M. Moura, H. Schaefer & L. Silva 2016. Isolation patterns affect the conservation of the critically endangered *Lactuca watsoniana*. Pp. 225 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores, Macaronesia; *Taxa*: *Lactuca watsoniana* (Asteraceae); *Other*: conservation, population genetics, endemic, microsatellites.

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Oceanic island plants are widely used as model species in evolution and conservation biology, and it is often stated that island taxa in comparison with continental relatives show reduced genetic diversity. However, several recent studies have shown that this theory is incorrect. In the Azores, the population genetics patterns within endemic taxa vary in terms of diversity and differentiation. *Lactuca watsoniana*, an endangered and rare Azorean plant with low number of individuals per population, was expected to display a low genetic diversity or even inbreeding depression. This study screened the genetic structure and diversity in all known populations by applying eight newly developed microsatellite markers to 136 individuals. The dataset was analysed using PolySat (PCoA), SPAGeDi (genetic diversity indexes), Arlequin (AMOVA) and STRUCTURE (Bayesian genetic cluster analysis). The results were unexpected, showing (i) a high level of genetic diversity (total heterozygosity=0.85; multilocus average proportion of private alleles= 26.5%,  $F_{is}$ =0.19); (ii) the existence of five well defined genetic groups, largely defined by the respective islands ( $F_{st}$  = 0.45); (iii) that *L. watsoniana* is a tetraploid species. Although the largest proportion of genetic variation was found within populations (55%), the genetic variation between islands (27 %) corresponded to the highest value for all Azorean plant species studied so far. The genetic distance among populations seems to be explained by the geographical distance and by geographical barriers. Based on these results, it is imperative to implement accurate conservation strategies for each of the remaining populations not only to preserve their genetic diversity but also to increase the population effectiveness. This is especially urgent, given that most of the remaining populations are threatened by habitat loss and degradation resulting from changes in land use, namely expansion of pastureland, invasions by exotic species, introduced herbivores, and disturbance of sensitive areas by tourists and locals.

## Seed bank of Azores: Preserving the Azorean flora

CÁTIA FREITAS, P. CASIMIRO & J. MELO



Freitas, C., P. Casimiro & J. Melo 2016. Seed bank of Azores: Preserving the Azorean flora. Pp. 226 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Faial Botanic Garden, Azores; *Taxa*: Azorean endemic and native plants; *Other*: seed bank, conservation.

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Biodiversity is essential for human existence, and it is the insurance of population's life quality, contributing to a healthy environment, pure air and good quality of fresh water. The main threat to biodiversity is human activities; the loss of biodiversity is irreparable and brings consequences in ecosystem resilience and vitality. In the Azores the endemic and native species distribution continues threatened, and it is known that one vascular plant is extinct, and several plant species continue at risk. The Seed Bank of Azores was established in 2003, in Faial Botanic Garden, aiming the conservation of the endemic and native flora to the Azores. The species are preserved through the conservation of their seeds at conditions of negative temperature and absence of humidity. In order to achieve its main goal, it was established a target to preserve 80% of all endemic flora possible to bank by 2020. As result of a strategy based on rigorous scientific standards and procedures, and a harvest campaign conducted in all Azorean islands, there are currently preserved at the Seed Bank of Azores 53 endemic and native plants of the Azores. In order to ensure the viability of the stored seeds, germination tests are periodically performed, and germination protocols are also optimized. To ensure that the storage conditions don't affect the germination ability of *Azorina vidalii* and *Lotus azoricus* seeds, tests were performed on stored seeds. Since for *Myosotis azorica* the optimal germination conditions weren't known, germination tests were carried out to optimize them.

## Threat analysis and conservation plans for selected Azorean endemic plants on Corvo Island

JULIE A. WEISSMANN & HANNO SCHAEFER



Weissmann; J.A. & H. Schaefer 2016. Threat analysis and conservation plans for selected Azorean endemic plants on Corvo Island. Pp. 227 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Corvo Island, Azores; *Taxa*: *Azorina vidalii*, *Euphrasia azorica*, *Myosotis azorica*, *Solidago azorica*; *Other*: plant conservation, pollination biology, grazing pressure.

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Like many other islands across the world, the Azores archipelago has a high percentage of endemic species in its indigenous flora, and the majority of these unique species (c. 75%) is endangered. The endemic plants of the Azores suffer from different anthropogenic disturbance effects, including habitat fragmentation, introduced species, and grazing pressure. In order to protect these plants, detailed management strategies have to be developed but the data needed for this are mostly lacking. We studied populations of four endangered endemics on Corvo Island in July and August 2015 and tried to determine the main threats affecting their survival. Two of the focal species (*Myosotis azorica* and *Euphrasia azorica*) are confined to mid-elevation habitats, whereas the two others (*Azorina vidalii* and *Solidago azorica*) are mainly found near the coast. Reproductive success was determined via direct pollinator observation, estimation of seed set and counting of juvenile plants. All four species were found to be pollinated by a mix of introduced and probably native insect species (Diptera, Apidae, and Lepidoptera), and therefore do not seem to be threatened by pollinator loss. Seed set was high for all except possibly *Solidago azorica*. The main reason for the declining populations of *Myosotis* and *Euphrasia* is most likely grazing pressure, whereas the populations of the mostly coastal *Azorina* and *Solidago* seem to be stable. A successful conservation plan will have to integrate the needs of the endemic plants and of the local stakeholders.

## Phylogenetic and biogeographic patterns in the endemic flora of the Juan Fernández Islands, Chile

TOD F. STUESSY, D. J. CRAWFORD & E. RUIZ



Stuessy, T.F., D.J. Crawford & E. Ruiz 2016. Phylogenetic and biogeographic patterns in the endemic flora of the Juan Fernández Islands, Chile. Pp. 228 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Juan Fernandez Islands, Chile, Pacific Ocean; *Taxa*: *Azorina vidalii*, *Euphrasia azorica*, *Myosotis azorica*, *Solidago azorica*; *Other*: plant conservation, pollination biology, grazing pressure.

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The Juan Fernández Archipelago consists of two major islands of approximately the same size (50 km<sup>2</sup>) situated west of continental Chile at a latitude of 33°S. Robinson Crusoe Island (4 MY) is located 667 km west of Valparaíso, and Alejandro Selkirk (1-2 MY) is situated 181 km further west into the Pacific Ocean. This geographic and geological context allows strong inferences on phylogeny and biogeography to be made among the 126 endemic species of angiosperms and ferns, including thirteen endemic genera and one endemic family (Lactoridaceae). Based on recent molecular phylogenetic and population genetic studies on many of these taxa, it is now possible to estimate more precisely the phylogenetic patterns and infer modes of speciation for the entire endemic flora. Both cladogenetic and anagenetic modes of speciation have taken place among the endemic species, making this archipelago particularly favorable for comparisons between these two processes. Significant is that the older island is closer to the principal source region (South America) and hence would be expected to have received immigrants first. The biogeographic progression rule generally applies, but many exceptions can be documented. The advantage of this study is that due to the small size of the endemic flora, plus persistent efforts by many workers over the past three decades, a comprehensive synthesis of patterns of phylogeny and biogeography is now possible.



## Reproductive biology in the Canarian flora: Guidelines for the recovery and conservation of natural populations of threatened endemics

JULIA PÉREZ DE PAZ, R. FEBLES, O. FERNÁNDEZ-PALACIOS & M.O. CORRAL



Pérez de Paz, J., R. Febles, O. Fernández-Palacios & M.O. Corral 2016. Reproductive biology in the Canarian flora: Guidelines for the recovery and conservation of natural populations of threatened endemics. Pp. 229 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Canary Islands; *Taxa*: *Neochamaelea*, *Jasminum*, *Limonium*, *Parolinia*, *Argyranthemum*, *Lotus*, *Dracaena*; *Other*: flowers, sexual systems, dioecy, duo-heterodichogamy, self-incompatibility, conservation.

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The flower itself, which comprises most of the evolutionary innovations of flowering plants, bears special significance for understanding the origin and diversification of angiosperms. The reproductive cycle of angiosperms, begins long before seeds are formed. Sexual and self-incompatibility systems are strongly influenced by the evolutionary history of plant lineages control the reproductive success or seeds set (progeny), with decisive influence on the genetic and morphological diversity of natural populations. In endangered species, knowledge of flowers and evolutionary history has an unquestionable predictive value for potential variations in floral biology and reproductive abnormalities. Here we report some reproductive syndromes present in the Canarian flora with examples of different plant lineages and their relevancy in conservation biology. Different morphological and physiological traits of the flower are able to predict the reproductive success and establishment of populations on the islands. The meaning of the structures of the flower in these endemics has revealed various manifestations including genera with sexual heteromorphisms and pathways to dioecy (*Neochamaelea*). Floral manifestations of morphological and physiological self-incompatibility have made possible the detection of heteromorphic sporophytic system on genera like *Jasminum* (Oleaceae) and *Limonium* (Plumbaginaceae). Other systems such as homomorphic sporophyte systems (SSI) with experimental cross pollinations were detected on endemic genera like *Parolinia* (Brassicaceae) and *Argyranthemum* (Asteraceae), or the self-incompatibility system of late action (LSI) on Fabaceae genus (*Lotus*). The gametophytic system (GSI) can be cited as one of the possible differentiating characteristic between the Macaronesian drago (*Dracaena draco*) and the Canarian drago (*D. tamaranae*) with less evident floral syndromes. The study of flower morphology has been particularly illuminating because it has allowed the detection of reproductive failure and corrective recovery strategies, favouring fertile mating and adult crossings.

# Conservation genetics of the highly endangered Azorean endemics *Euphrasia azorica* and *Euphrasia grandiflora* using new SSR data

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Moura, M., E.F. Dias, L. Silva & M.G.B. Maciel 2016. Conservation genetics of the highly endangered Azorean endemics *Euphrasia azorica* and *Euphrasia grandiflora* using new SSR data. Pp. 230 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: *Euphrasia azorica*; *Euphrasia grandiflora*; *Other*: endemic, microsatellites, population genetics.

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Genus *Euphrasia* L. (Orobanchaceae) comprises approximately 350 species of hemi-parasitic plants. In the Azores Islands, two endemic species are recognized: *Euphrasia azorica* H.C. Watson, an annual herb, in Flores and Corvo, and *Euphrasia grandiflora* Hochst. ex Seub., a semi-shrub, in Pico, São Jorge and Terceira. Both species are highly endangered and protected by the Bern Convention and Habitats Directive. A population genetics study was conducted with six new microsatellite primer pairs in 159 individuals of *E. azorica* and *E. grandifolia*, sampled from populations in Flores, Corvo, Pico and São Jorge. Fragment analysis showed that *E. azorica* is a diploid while *E. grandiflora* is a tetraploid. The *E. grandiflora* population of Morro Pelado (SJMP) in São Jorge, displayed higher genetic diversity when compared with all others (0.191 of expected heterozygosity ( $H_e$ ); 63.5% of polymorphic loci), while the *E. azorica* population of Madeira Seca in Corvo, showed the lowest ( $H_e$ =0.066; 19.05% of polymorphic loci). Private and less common bands were also overall higher in *E. grandiflora* populations, and, specifically, in SJMP. Population genetic structure analysis confirmed the existence of clear interspecific differentiation, and island-specific genetic patterns in *E. azorica* populations. The genetic structure obtained for *E. grandiflora* populations is less clear since the populations of Mistérios in Pico Island and of Pico da Esperança in São Jorge share the same genetic group, although a putative spatial genetic barrier was retrieved between both islands. Even if different ploidies in *Euphrasia* are an obstacle for reproduction, translocations between islands or between populations of a same island should be avoided due to the complex genetic structure found. Further analyses are required to understand the colonizing history of *Euphrasia* in the Azores and the evolution of the different ploidy levels currently occurring in both species.

## Towards a more holistic research approach to plant conservation: The case of rare plants on oceanic islands

LUÍS SILVA, E. F. DIAS, J. SARDOS, E. BRITO DE AZEVEDO, H. SCHAEFER & M. MOURA



Silva, L., E.F. Dias, J. Sardos, E.B. Azevedo, H. Schaefer & M. Moura 2016. Towards a more holistic research approach to plant conservation: The case of rare plants on oceanic islands. Pp. 231 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: *Veronica dabneyi* (Scrophulariaceae); *Other*: conservation, holistic, islands, plants, rare, research.

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Research dedicated to rare endemic plants is usually focused on one given aspect. Holistic studies, addressing several key issues, might be more useful, supporting management programmes while unravelling basic knowledge about ecological and population-level processes. A more comprehensive approach to research is proposed, encompassing: phylogenetics /systematics, pollination biology and seed dispersal, propagation, population genetics, species distribution models, threats and monitoring. We present a holistic study dedicated to *Veronica dabneyi* Hochst. ex Seub. (Scrophulariaceae), an endangered chamaephyte endemic to the Azores. *Veronica dabneyi* was mainly found associated with other endemic taxa; however, invasive plants were also present and together with introduced cattle, goats and rabbits are a major threat. Most populations grow at somewhat rocky and steep locations that appear to have acted as refuges. Seed set in the wild was generally high and recruitment of young plants from seed seemed to be frequent. In the laboratory, it was possible to germinate and fully develop *V. dabneyi* seedlings, which were planted at their site of origin. No dormancy was detected, and time for 50 % germination was affected by incubation temperature. Eight new microsatellite markers were applied to 72 individuals from 7 sites. A considerable degree of admixture was found between samples from the two islands Flores and Corvo, with 98 % of the genetic variability allocated within populations. Levels of heterozygosity were high, and no evidence of inbreeding was found. Species distribution models based on climatic and topographic variables allowed the estimation of the potential distribution of *V. dabneyi* on Flores and Corvo. Projection of the expected habitat in Faial largely coincided with the only historic record of *V. dabneyi* on that island. This research could be the basis for the design of a recovery plan, showing the pertinence of more holistic research approaches to plant conservation.

## Case study of the Critically Endangered island endemic *Roussea simplex*: Crucial need to quantify and hierarchise threats

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Baider, C., V. Graepel, S. Trotzer, V. Couttee, M.A.A. Karghoo, P. Bissessur & F.B.V. Florens 2016. Case study of the Critically Endangered island endemic *Roussea simplex*: Crucial need to quantify and hierarchise threats. Pp. 232 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Mauritius; *Taxa*: *Roussea simplex* (Rousseaceae); *Other*: invasive species, fitness, pollination, species decline, species interaction, depredation.

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*Roussea simplex* (Rousseaceae) is the sole species of a Mauritius endemic genus. It was common in the 1930's, but fewer than 100 individuals were known by 2005. Natural regeneration had never been recorded. This situation prompted investigations to elucidate the species' ecology and lay the foundation for its conservation. Through elegant studies, previous authors showed that of the observed flower visitors, only an endemic gecko could pollinate the plant. The same reptile appeared to be the sole seed disseminator of *Roussea*. Furthermore, it was found that infestation of the flowers and ripe fruits by the alien ant *Technomyrmex albipes* led to breakdown of the mutualism between the gecko and the plant, providing so far the best plausible explanation for the decline of the species and lack of observed natural regeneration. Studying the same system, we found that the picture is much more complex. *Roussea* is subjected to a wider range of threats, some of which are much worse than the broken-down mutualism and, at times, they interact in a synergistic or antagonistic manner, while also varying spatially and temporally. This includes, for example, predation by invasive alien rats which destroy up to about 95% of all flower buds or flowers. Potential reduction in pollination success due to nectar robbing, and a degree of destruction of flower buds and flowers by introduced monkeys were also recorded. Invasive alien plants also pose a serious threat to *Roussea* populations both directly on the established plants, and indirectly by reducing the availability of microsites for germination. Our study shows the complexity and multi-faceted threats that declining endemic island plants may face and calls for the need to quantify and hierarchise these if we are to succeed in effectively reverse declines towards extinction.

## Population genetic structure in the tetraploid *Viola cheiranthifolia* (Teide violet), a high mountain endemic from the Canary Islands

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Rodríguez-Rodríguez, P., I. Saro, A. Naranjo Cigala & P.A. Sosa 2016. Population genetic structure in the tetraploid *Viola cheiranthifolia* (Teide violet), a high mountain endemic from the Canary Islands. Pp. 233 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Tenerife, Canary Islands, Spain; *Taxa*: *Viola cheiranthifolia*; *Other*: alpine, endemic, microsatellites, polyploid.

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*Viola cheiranthifolia* Humb. & Bonpl (Teide violet) is an endemic species from Tenerife Island (Canary Islands, Spain) that is localized within the boundaries of Teide National Park and belongs to *Viola* sect. *Melanium*. It is a small shrub that grows at 3600 m a.s.l in the rocks of the Teide volcano, being the highest flowering plant in Spain. The species has been recognized as vulnerable only in the national Red List of Vascular Flora, but not in the new catalogue of protected species published by the Canarian Government. We have analysed 266 individuals from 9 localities with 14 nuclear microsatellite markers developed by our group. The peak profiles showed a tetraploid pattern, due to the allopolyploid origin of *Viola* sect. *Melanium*. In Macaronesia, this section also includes the endemics *Viola palmensis* (La Palma Island) and *Viola paradoxa* (Madeira island). Although the species within *Viola* sect. *Melanium* are allopolyploid, our data did not show disomic inheritance for all loci, maybe due to partial polysomic inheritance between the subgenomes. Consequently, we have analysed the dataset as autotetraploid with algorithms that allow genotypic ambiguity, implemented in the softwares “Polysat”, “Structure”, “Genodive” and “SPAGeDi”. According to Bayesian analysis, PCoA and Rho’s statistic, there is a clear genetic structure separating the groups from Teide volcano and those from “Las Cañadas del Teide”. The caldera of “Las Cañadas”, where any individuals have been found, could be the geographical barrier that explains this separation. The populations with the highest genotypic diversity are “Guajara” and “Montaña Blanca”. The selfing rate based on identity disequilibrium was about 0.5, which agrees with the conclusion that *V. cheiranthifolia* would have a high rate of autogamy. This study will contribute to a better knowledge of the conservation status, reproductive biology and population differentiation of *V. cheiranthifolia*, important aspects for a correct management of a narrow endemism.



## Specific threats connected with climate change impacts on oceanic islands

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Beierkuhnlein, C., D.E.V. Harter, A. Provenzale, S.D.H. Irl, D. Kienle, A.H. Schweiger, R.G. Gillespie, J.M. Fernández-Palacios, K.A. Triantis, M.J. Steinbauer & A. Jentsch 2016. Specific threats connected with climate change impacts on oceanic islands. Pp. 234 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

**Key words:** *Location:* global oceanic islands; *Taxa:* Island endemics; *Other:* climate warming, upward shift, lowland attrition, vectors, protected areas, biodiversity loss.

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Oceanic islands contribute enormously and beyond their spatial size to global species richness due to their endemic flora and fauna. In the face of anthropogenic climate change and the related increase in temperature, shifts in precipitation regimes, and modified climatic variability and seasonality linked with extreme events, island biota are exposed to novel challenges and threats. Here, we analyze climatic pressures that are expected to become increasingly important on islands during this century. We highlight the specific limitations of island species for habitat shift or for reaching refugia with conditions still favorable for population survival. Particularly, we discuss threats to single-island endemics related to their environmental niches because such endemics are likely the most threatened species due to their small-range sizes, small populations and low genetic diversity. Interactions between different aspects of environmental change such as land use change, increased connectivity with other terrestrial habitats and pollution can enhance the effects of climatic changes but also, in part, mitigate negative impacts. Uncertainties need to be identified and coping strategies must be developed and translated into practice. Conservation strategies need to address these threats at an early stage. Protected areas should be evaluated in terms of their climatic amplitude and spatial heterogeneity, leading to the development of 'climate change-proof protected areas'. Current developments in earth observation and remote sensing combined with species distribution modelling will open doors to new perspectives in the assessment and monitoring of threatened island biota.

## Analyses of Multiplexed-Shotgun-Genotyping (MSG) data reveal cryptic biodiversity in Macaronesian *Tolpis*

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Mort, M.E., J.K. Archibald, M.J.S. Gibson, H. Bontrager, D.P. Hauber, L.B. Silva, M.M. Sequeira, M. Moura, A. Santos-Guerra, J.K. Kelly, M. Gruenstaedl, J. Caujapé-Castells & D.J. Crawford 2016. Analyses of Multiplexed-Shotgun-Genotyping (MSG) data reveal cryptic biodiversity in Macaronesian *Tolpis*. Pp. 235-236 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Macaronesia; *Taxa*: *Tolpis* spp.; *Other*: Multiplexed-Shotgun-Genotyping, cryptic diversity.

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*Tolpis* (Asteraceae) includes 12-14 currently recognized species that are distributed widely in Macaronesia, with two species each present in the Azores and Madeira, one species in Cape Verde (CV), and the remaining species present in the five western islands of the Canary Islands Archipelago (CI). The genus is the focus of ongoing breeding/mating system studies that illustrate significant variation in breeding systems and relatively high levels of reproductive isolation between certain populations, including some populations occurring in close proximity to one another that are morphologically indistinguishable. These data, along with high levels of morphological diversity among populations of several widespread species complexes, suggest the presence of cryptic diversity in lineages of *Tolpis* in the Canary Islands (*T. laciniata* and *T. lagopoda*). In addition, *T. succulenta*, a species distributed in the Azores and Madeira, is clearly not monophyletic based on previous phylogenetic analyses. Furthermore, the levels of divergence among populations of the CV endemic *T. farinulosa* have yet to be estimated in a phylogenetic context. Thus, although *Tolpis* has been the focus of several broad phylogenetic studies, there is little to no resolution of lower level (i.e., between



populations) relationships, which precludes delimiting species. We employed analyses of MSG data from a broad sample of *Tolpis* species from all of the Macaronesian archipelagoes where the genus occurs. Taxonomic sampling was structured to include populations present on substrates of wide geological age, populations known to vary in breeding/mating systems, and/or populations that are morphologically divergent from other conspecific populations. The resulting analyses confirm that several currently recognized species do not form monophyletic groups and may be worthy of taxonomic recognition. Many of these lineages include only a few small populations and thus should be considered as high priority for conservation efforts.

## Breeding and mating systems, and breeding relationships in Macaronesian *Tolpis*: Applications to the conservation of diversity

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Crawford, D.J., D.P. Hauber, L.B. Silva, M.M. Sequeira, M. Moura, A. Santos-Guerra, J.K. Kelly, M.J.S. Gibson & M.E. Mort 2016. Breeding and mating systems, and breeding relationships in Macaronesian *Tolpis*: Applications to the conservation of diversity. Pp. 237-238 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Macaronesia: Azores, Madeira, Canary Islands; *Taxa*., *Tolpis* (Asteraceae); *Other*: conservation, reproductive biology.

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Divergence and speciation in lineages in oceanic archipelagos do not occur via the same mechanisms, which mean that effective studies to elucidate and conserve diversity must include a variety of approaches. In effect, one of the important byproducts of broad and intensive systematic-evolutionary studies in an insular lineage is application of the results to effective conservation planning. Once molecular phylogenetic studies have resolved populations as distinct clades, it would be of interest to determine whether there are intrinsic isolating barriers between those clades and other clades. This information would be valuable in judging whether such populations represent distinct, isolated gene pools with the potential to evolve independently of other populations. In Macaronesian *Tolpis*, there are examples of both the presence and absence of postzygotic isolating factors between groups resolved by phylogenetic analyses. In addition to conserving for additional study of elements recognized by one or more criteria, it is desirable to assess the factors important in the maintenance and partitioning of diversity within and among populations. Greenhouse and molecular marker studies show that breeding/mating systems vary among *Tolpis* populations in what have been assumed to be obligately outcrossing species. In addition, the frequency of flowering and the complex pattern of self seed set in at least one species of *Tolpis* may be used for estimating effective population sizes which

in turn have important conservation implications. Inbreeding depression in self seed can be estimated from marker data, and this may be weighed against outbreeding depression between populations for assessing the value of “genetic rescue” for small, genetically depauperate populations.

## Phylogenetic analysis of wild beets (*Beta* s.l. Amaranthaceae) suggests species radiation as a putative consequence of the Messinian Salinity Crisis

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Romeiras, M.M., A. Vieira, D. Silva, M. Moura, A. Santos-Guerra, D. Batista, M.C. Duarte & O.S. Paulo 2016. Phylogenetic analysis of wild beets (*Beta* s.l. Amaranthaceae) suggests species radiation as a putative consequence of the Messinian Salinity Crisis. Pp. 239-240 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Macaronesian Islands; *Taxa*: crop wild relatives *Beta*, *Patellifolia*; *Other*: CWR, conservation of genetic resources, Betoideae, gene pools.

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The Western Mediterranean Region and Macaronesian Islands are one of the top biodiversity hotspots of Europe, containing a significant native genetic diversity of global value among the Crop Wild Relatives (CWR). Sugar beet is the primary crop of the genus *Beta* L. (subfamily Betoideae, Amaranthaceae) and despite the great economic importance of *Beta*, and of the close relative *Patellifolia* species, a reconstruction of their evolutionary history using widespread-sampling is still lacking. We analyzed nrDNA and four cpDNA regions to reconstruct the phylogenetic relationships within the subfamily Betoideae. The phylogeny recovered on a time-calibrated Bayesian-tree revealed a deep genetic differentiation between *Beta* and *Patellifolia* species, which may have occurred in the Late Oligocene. Additionally, the occurrence of a West–East genetic discontinuity indicates that Mediterranean *Beta* species were probably differentiated by the end of the Miocene, and can be interpreted as a signature of species radiation induced by dramatic habitat changes during the Messinian Salinity Crisis (MSC, 5.96-5.33 Myr). Western and eastern *Beta* species inhabit very contrasting ecological areas, from salt marshes to mountainous zones respectively, supporting not

only their isolation-by-distance but also possible refuge hypothesis. The subsequent end of the MSC could additionally have promoted further differentiation by vicariance. Some of these western wild beets later expanded and colonized the Macaronesian Islands. The main conclusions of this study are: 1) recognition of *Beta* and *Patellifolia* as different genera supported by ancestral split; 2) ecological divergence of *Beta* in Mediterranean during the Messinian Salinity Crisis; 3) recent speciation of *Beta* and *Patellifolia* endemics on Macaronesia (Plio-Pleistocene). Finally, three evolutionary lineages were identified corresponding to major gene pools of sugar beet wild relatives, which provide useful information for establishing conservation priorities in the Western Mediterranean Region, including the hotspot area of the Macaronesian Islands.

## Conservation genetics of *Vachellia anegadensis*, a British Virgin Island endemic plant

SARA BÁRRIOS



Bárrios, S. 2016. Conservation genetics of *Vachellia anegadensis*, a British Virgin Island endemic plant. Pp. 241 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Anegada, British Virgin Islands; *Taxa*: *Vachellia anegadensis* (Mimosaceae); *Other*: conservation genetics, endemism, in situ conservation, threat status.

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During a botanical expedition in 2008, the critically endangered species *Vachellia anegadensis* (Britton) Seigler & Ebinger (Mimosaceae) was found on the volcanic island of Fallen Jerusalem in the British Virgin Islands (BVI). This species was previously thought to be endemic to the limestone island of Anegada, also part of the BVI Archipelago. Urgent work was needed to inform conservation action by determining the distribution of *V. anegadensis* across Anegada and Fallen Jerusalem, investigating the genetic variability within and between islands and by documenting the main threats affecting this species. Fieldwork was undertaken for mapping, sampling of vouchers and leaflet material for DNA extraction, and to collect associated information. Genomic DNA was extracted from leaflet material, and the AFLP (Amplified Fragment Length Polymorphism) method was applied, obtaining 354 different sized markers. A presence-absence data matrix comprising all markers for 123 samples was analysed using Principal Coordinate Analysis (PCoA) based on Jaccard's Coefficient distance while genetic variability was investigated with AFLP-SURV. The genetic structure of the populations was investigated with STRUCTURE. Information on the current threats to this species were also compiled to re-assess the IUCN Red List category. Results from both analyses show that the genetic variability of *V. anegadensis* does not exhibit any patterns, in relation to the two islands of Anegada and Fallen Jerusalem. Individuals of *V. anegadensis* in Anegada do not have unique genotypes that are not represented on the individuals on the island of Fallen Jerusalem. For the reassessment of *V. anegadensis*, a down-listing from Critically Endangered (CR) to Endangered (EN B1ab(iii,v)+2ab(iii,v)) is proposed. Conservation recommendations include an increase of the *in situ* protection measures for *V. anegadensis* on the island of Anegada, by establishing the proposed protected areas designated in the BVI protected areas system plan 2007-2017, published in 2008.

## Anagenetic speciation and genetic variation in *Dysopsis hirsuta* (Müll. Arg.) Skotts. (Euphorbiaceae), an endemic of Robinson Crusoe Island, Juan Fernández Archipelago, Chile

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López-Sepúlveda, P., H. Montoya, G. Fuentes, K. Takayama, P. Peñailillo, J. Greimler, D.J. Crawford, M. Baeza, E. Ruiz, L. Letelier & T.F. Stuessy 2016. Anagenetic speciation and genetic variation in *Dysopsis hirsuta* (Müll. Arg.) Skotts. (Euphorbiaceae), an endemic of Robinson Crusoe Island, Juan Fernández Archipelago, Chile. Pp. 242-243 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Juan Fernández Archipelago, Chile; *Taxa*: *Dysopsis hirsuta* (Müll. Arg.) Skotts., *D. glechomoides* (A. Rich.) Müll. Arg.; *Other*: anagenesis, genetic variability, AFLP, structure, conservation.

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The diversity of vascular plants on oceanic islands is the result of numerous biological processes. Among the most important ones are two modes of speciation: anagenesis (or phyletic speciation) and cladogenesis. In both cases the founding population contains a small subset of the parental genetic variability. Particularly in anagenesis, the founder population changes over time by drift, mutation, and recombination to the point where it is recognized as a distinct species. The Juan Fernández Archipelago, located 670 km from mainland Chile is comprised of three islands characterized by high levels of endemism, and offers unique opportunities to study evolutionary processes in this insular setting. The genetic consequences of the anagenetic process in *Dysopsis hirsuta* (Müll. Arg.) Skotts. are investigated, comparing genetic diversity and divergence in ten insular and four continental populations of its ancestor *D. glechomoides* (A. Rich.) Müll. Arg., using AFLP markers. The genetic



variability of the island endemic *D. hirsuta* is similar to that of the parental species, as well as the absence of geographical structure in island populations. The NeighbourNet trees among all individuals don't show a clear separation between the island and continental populations, and the highest values of variation after AMOVA analysis are within populations. Thus, *Dysopsis hirsuta* exhibits a similar trend to other species derived anagenetically in the Juan Fernández Archipelago, such as *M. schulzei* (Myrtaceae) and *Drimys confertifolia* (Winteraceae) with levels of diversity similar to their continental progenitors, indicating that mutation and recombination have replenished genetic diversity that may have been lost during the initial colonization and establishment in the archipelago.

## Phylogenetic diversity of the Campanulaceae in Macaronesia

TIAGO MENEZES, M. M. ROMEIRAS, M.M. SEQUEIRA & M. MOURA



Menezes, T., M.M. Romeiras, M.M. Sequeira & M. Moura 2016. Phylogenetic diversity of the Campanulaceae in Macaronesia. Pp. 244 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

**Key words:** *Location:* Macaronesia; *Taxa:* *Azorina vidalii*, *Campanula erinus*, *C. jacobaea*, *C. bravensis*, *Lobelia urens*, *Musschia aurea*, *M. isambertoi*, *M. wollastonii*, *Trachelium caeruleum*, *Wahlenbergia lobelioides*; *Other:* phylogenetic diversity, ITS, cpDNA.

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The Campanulaceae include ca. 84 genera with about 2300 species, and their classification has raised controversy due to conflicts between morphological characteristics and molecular genetic data. Several indigenous and naturalized Campanulaceae species are commonly found in Macaronesia and despite several molecular studies already published for this family, the phylogenetic relationships between the Macaronesian species are still far from resolved. The present study, based on a wide taxonomic sampling covering all the Macaronesian archipelagos, aims to clarify the phylogenetic diversity and colonization status of these Campanulaceae species, as well as their relationships with continental taxa. We selected seven endemic species: *Azorina vidalii* in Azores; the endemic genus *Musschia*, with three species (*M. aurea*, *M. wollastonii* and *M. isambertoi*) in Madeira, the Cape Verde *Campanula* species (*C. bravensis*, *C. jacobaea*) and *Wahlenbergia lobelioides* subsp. *lobelioides*, a Macaronesian endemic (with doubtful status in Cape Verde). Additionally, *Lobelia urens*, *Campanula erinus* and *Trachelium caeruleum* were also selected due to their unclear native status. The ITS region and six cpDNA markers (atpB, matK, petD, rbcL, trnL-F and psbA-trnH) were screened. The results support an ancestral connection between the Cape Verde *Campanula* and *A. vidalii*. The *Musschia* are evolutionarily more distant from the other Macaronesian groups. *Wahlenbergia lobelioides* spp. *lobelioides* and *T. caeruleum* revealed inter-archipelago differentiation, which may indicate the existence of ongoing evolutionary processes. The occurrence of clear intra-archipelago differentiation in *A. vidalii* was confirmed, while *C. bravensis* and *C. jacobaea* showed low intraspecific variability. We hope that the phylogenetic information generated during this study, integrated with distribution data and Red List conservation status assessments, will allow us to derive appropriate conservation guidelines for the studied species within the hotspot area of the Macaronesian region.

## Genetic diversity and structure of the endemic *Ammi* populations in the Azores

ÂNGELA VIEIRA, E. F. DIAS & M. MOURA



Vieira, A., E.F. Dias & M. Moura 2016. Genetic diversity and structure of the endemic *Ammi* populations in the Azores. Pp. 245 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: *Ammi seubertianum*; *Ammi trifoliatum*; *Ammi huntii*; *Other*: microsatellites, endemic, genetic structure, conservation.

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The systematics of Euro-Mediterranean native *Ammi* species (Apiaceae) still raises questions and the same happens with the rare Azorean endemic *Ammi* taxa. Three endemic species were firstly described: *Ammi trifoliatum* (Wats.) Trel., for Flores island, *A. seubertianum* (Wats.) Trel., for Pico and São Miguel, and *A. huntii* (Wats.) Trel., for São Miguel. Many taxonomic changes have been conducted including from one to three species. Regarding the two presently accepted species, *A. trifoliatum* occurs in all the islands, except Santa Maria and Graciosa while *A. seubertianum* has a narrower distribution being present in Santa Maria, São Miguel and Pico. In this research, the population genetic diversity and structure of the Azorean *Ammi* species were assessed using eight specifically designed SSR markers. Sampling was conducted in seven islands: *Ammi seubertianum* was collected from three populations and 26 individuals; and *A. trifoliatum* from 13 populations and 167 individuals. Four herbarium samples of *A. huntii* from Kew and the Natural History Museum of Denmark were also included to further clarify the Azorean taxonomy of this genus. The population of Morro Pelado in São Jorge showed the highest genetic diversity, while Norte-Topo, in the same island, showed the lowest. None of the populations analyzed displayed signs of putative inbreeding. Our results did not indicate a clear genetic structure separating the two currently accepted species, with high levels of gene flow present. According to a PCoA analysis, the sampled individuals appeared mixed, regardless of the species, with the exception of the Terceira populations and Ribeirinha in Pico that grouped slightly apart from each other and from the remaining individuals. AMOVA indicate a majority of genetic variation within populations. Our results seem to indicate that putative species-characteristic morphological differences are not reflected at the molecular level, and that only one species of endemic *Ammi* might occur in the Azores.

## Specialized Symposium 7

### (Cv2) Biodiversity and place: exploring relationships from a psychological perspective

CHAIRS: ANA MOURA ARROZ, MARIA LUÍSA LIMA, SUSAN CLAYTON  
& JUAN IGNACIO ARAGONÉS

## The impact of environmental condition and identity on emotional responses to environments

SUSAN D. CLAYTON



Clayton, S.D. 2016. The impact of environmental condition and identity on emotional responses to environments. Pp. 247 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: -; *Other*: psychology, conservation, identity, emotion, environment.

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Research has shown that natural environments have the potential for many positive impacts on human well-being, including enhanced cognitive functioning, creativity, and stress reduction. Nature also has impacts on people's identity, or sense of themselves; people can vary in the extent to which they feel a personal connection to a place or to the environment in general. This sense of connection has been associated with support for environmental conservation. To date, little if any research has examined the potential for this sense of connection to moderate the effects of nature on well-being. In addition, prior research has emphasized the positive effects of attractive environments, but not the potential for negative impacts of degraded environments. The present research examined the impact of attractive and degraded environments on mood. Participants viewed a slideshow of outdoor images and completed a mood rating on-line. Connection to place and to the environment as a whole were also measured. Results suggest that, depending on the condition of the environment depicted, environments can have a positive or a negative effect on mood. Implications for conservation efforts are discussed.

## Using place identity and social norms to promote biodiversity

MARIA LUÍSA LIMA & C. A. BRANCO



Lima, M.L. & C.A. Branco 2016. Using place identity and social norms to promote biodiversity. Pp. 248 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Lisbon; *Taxa*: -; *Other*: social norms, place identity, recycling behavior, environmental identity.

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Pro-environmental behavior has often been studied as the result of individual values or individual, rational decision-making. However, research from a more social approach to environmental psychology have been stressing the importance of other types of variables. For example, social norms have been shown as important determinants of energy saving, sustainable transportation or recycling behaviour. Social identities are also important predictors of sustainable behavior. Research has shown that identification with pro-environmental groups or place identity have important consequences for engaging in pro-environmental behavior. However, this research tends to be residual and mainly focused on descriptive analyses or case-studies. In this presentation, we present two studies that address an important and practical research question: can we use social identities and social norms to promote pro-environmental behavior? Following the frameworks of Social Identity Theory and Normative Focus theory we expect that: (H1) descriptive social norms will have impact on behavior; and that (H2) social identity will moderate this association. Two experimental studies were put in place in Lisbon. Place identity (identification with the Parish) and descriptive norms about pro-environmental behavior (the recycling ranking of Lisbon Parishes) were manipulated. Both self-reported intentions to recycle and observation of actual behavior in the experimental situation were assessed, after controlling for past recycling behavior and environmental identity. Consequences for intervention and the promotion of biodiversity are discussed.

## Representations of nature, environmental identity and connectedness with nature

JUAN IGNACIO ARAGONÉS & L. PASCA



Aragonés, & L. Pasca 2016. Representations of nature, environmental identity and connectedness with nature. Pp. 249 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: -; *Other*: pro-environmental behaviour, nature, self and nature.

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The most common theories to explain the reasonable Ecological behavior are: Theory of Planned Behavior, and Value-Belief-Norm Theory. Though none of them have the capability enough to explain the reasons a person behaves in an environmentally responsible way. This one, among other reasons, researchers have chosen along the XXI century various alternative hypotheses that allowed or favored further explanation of the pro-environmental behavior. Among them should be highlighted: environmental Identity, the inclusion of nature in self, the connectedness to nature, love and care for nature or emotional affinity towards nature, among others. In all of them the relationship between the self and Nature appears as a thread. Of course, in some cases more to the reference of the emotional aspects and in others to the cognitive ones. This kind of relationship is outstanding, because it always puts in a relation a psychological construct about nature, either explicit or implicitly under the environmental term, however, in any case there is no prior research about what is understood by nature. This paper discusses some empirical results from different studies showing how they are organized, according to the degree of human intervention, both the elements that Nature and Landscape types presented. It also shows that there is a relationship between scores of the variables referring to the involvement of self in nature and the assessments made about the extent to which the elements and landscapes are part of nature. Finally, it should be considered the need to address what people understand by nature to properly evaluate these constructs.



## Bonds to places: Suggestions for risk communication in the Azores

ISABEL ESTRELA REGO, R. GABRIEL, I. R. AMORIM & A.M. ARROZ



Rego, I.E., R. Gabriel, I.R. Amorim & A.M. Arroz 2016. Bonds to places: Suggestions for risk communication in the Azores. Pp. 250 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: -; *Other*: place identity, place attachment, environmental risks, risk communication.

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The Azores is an archipelago famous for its beauty and nature; notwithstanding it faces multiple risks and natural hazards. Risk communication to address hazard preparedness and response should be grounded on research findings sensitive to specificities of the context and the existing bonds between inhabitants and environment. Place identity and place attachment have not yet been fully explored with respect to the adoption of protection measures and conservation behavior. After presenting a research project on the perception and communication of environmental risks with a local focus, we will discuss some of its preliminary results concerning aspects associated with the relationship that people develop with the places where they live. Results from a survey conducted with a representative sample of 999 Azorean residents revealed that the reported high level of belonging to the living place was not significantly related to most of the usual predictors considered in similar studies (e.g. sex, educational level, values, environmental attitudes, intentions, and concerns, etc.). A PCA analysis conducted on the reasons to live in one's place of residence indicated five relevant components: *bucolic nature, roots, social integration, pragmatic* and *instrumental*. In smaller islands, however, the bond to the place of living seems to be even stronger than in larger islands. Concerning the bonds to different spatial levels, a PCA analysis clearly distinguished global from local level and, consistent with other studies, most respondents indicated a stronger identification with local settings – archipelago and island of birth. The sense of belonging to a particular place is correlated to the length of residence in that place, and the longer the time of residence and a person's age, the harder it is for the respondents to envision themselves living elsewhere. This strong sense of belonging will be presented as an asset to promote endemic biodiversity and to mitigate other environmental risks.

## Does nature play a central role for place identity in the Azores?

ANA MOURA ARROZ, R. GABRIEL, I.R. AMORIM & I.E. REGO



Arroz, A.M., R. Gabriel, I.R. Amorim & I.E. Rego 2016. Does nature play a central role for place identity in the Azores?. Pp. 251 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: -; *Other*: place identity; place attachment; environmental risks; conservation behaviour.

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There is growing evidence that environmentally significant action depends not only on instrumental and financial motivations, but also on less tangible ones, including affective attachments to and identification with nature and place. However, not all studies support the significance of these relationships, and the relationship between connectedness to nature and place identity is far from clarified. We intent to identify the relevance of nature in Azorean icons and the reasons for living in the Azores in order to promote pro-conservation behaviors. To investigate these issues, we conducted two studies in the Azores using a stratified representative sample of 999 residents. A classification decision tree (CHAID), applied to entities and artifacts considered as Azoreans icons and to the arguments relevant to people's choices, revealed in the first study, that Nature (and other related concepts such as "sea" or "landscape") is the main Azorean icon. It also showed that this icon is supported by different reasons, such as: its virginal, untouched and pure character (*natural*); its uniqueness and distinctiveness (*specificity*); and stunning *beauty*. Data from the second study shows that the magnitude of place identity increases from global to local geographic levels, and that the majority of respondents (60,8%) report higher values of belonging in relation to their living places. Nature is also very relevant concerning place identity contents. The results of a principal component analysis showed that, among the five resulting dimensions for the reasons why people live in the Azores (*bucolic nature*, *roots*, *social integration*, *pragmatic* and *instrumental* reasons), *bucolic nature* alone is responsible for about half (37,1%) of the total variance explained (72,5%). Results will be discussed in the light of the following questions: Can connectedness to nature be a promoting factor of place identity/attachment? Can connectedness to nature predict pro-conservation behaviors?.

## Place identity and biodiversity conservation in the Azores

ISABEL R. AMORIM, A.M. ARROZ, R. GABRIEL, I.E. REGO, P.A.V. BORGES & M.L. LIMA



Amorim, I.R., A.M. Arroz, R. Gabriel, I.E. Rego, P.A.V. Borges & M.L. Lima 2016. Place identity and biodiversity conservation in the Azores. Pp. 252 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: -; *Other*: place identity, endemic biodiversity, conservation, questionnaires, uniqueness.

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The negative impact of biodiversity loss on ecosystems and Human well-being has been established, but despite all efforts biodiversity is still declining worldwide. New approaches to tackle this problem are thus in demand and should include increasing biodiversity awareness, given the mounting evidence that biodiversity awareness is crucial for its conservation. The Azorean islands house unique species that cannot be found elsewhere, being its conservation a priority. Several conservation interventions were developed in the region targeting mostly students, and visitors of museums and alike venues. However, these represent a small portion of the people living in the Azores and because conservation success greatly relies on the involvement of locals, it is important to widen the number of people reached. We therefore conceived a project to: i) design biodiversity awareness communication strategies to be implemented outside traditional venues, and ii) investigate the properties that make a strategy successful. A strategy that we proposed to test is to take advantage of the apparently strong place identity of Azoreans to promote the unique biodiversity of the archipelago. To quantify place identity and investigate the importance of exclusivity as a valuation argument among people living in the Azores, we used data from several surveys by questionnaires applied between 2005 and 2015. Preliminary data based on two surveys suggests that Azoreans have in fact a strong place identity; concerning valuing what only occurs in the Azores, a survey shows that "only exists in the Azores" is the least used argument to justify willingness to protect specific species, while the other shows that exclusivity is the second most used reason to justify selecting a particular item as the symbol of the Azores. These results will guide the strategies to use in the development of the interventions to test and may unveil new strategies not originally planned.

Specialized Symposium 4  
(Cv3) Conservation of Invertebrates in Mid-Atlantic  
Islands

CHAIRS: VICKY KINDEMBA & PAULO A.V. BORGES

## IUCN Red Lists: Adaptations to invertebrates and new tools under development

PEDRO CARDOSO



Cardoso, P. 2016. IUCN Red Lists: Adaptations to invertebrates and new tools under development. Pp. 254 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: invertebrates; *Other*: co-extinction, publication process, sampled red list index, species distribution modelling, surrogates.

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The conservation of invertebrate species faces a series of challenges. One of the best ways to overcome them is to assess species according to the IUCN criteria. Red listing species helps highlighting the threats to their survival and facilitates their inclusion in international, national or regional lists of protected taxa. Yet, the current criteria are biased towards vertebrates and are extremely difficult to apply to invertebrates, contributing to the underrepresentation of invertebrates in the IUCN Red List. There are however ways to overcome these difficulties: (1) the use of AOO and EOO and respective trends as surrogates for population size; (2) use co-extinction processes in case host species are already listed; and (3) adapt criteria thresholds to better reflect the reality. Besides these suggestions, a series of tools are now under development that will facilitate the process: (1) a better use of the Sampled Red List Index approach; (2) the optimization and standardization of methods for species distribution modelling; and (3) the use of indexed journals as publication venues for assessments.

## How can we transform the criterion B of IUCN' Red List in a useful tool for setting conservation priorities with Invertebrates of island regions?

JOSÉ LUIS MARTÍN ESQUIVEL



Martín Esquivel, J.L. 2016. How can we transform the criterion B of IUCN' Red List in a useful tool for setting conservation priorities with Invertebrates of island regions?. Pp. 255 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Tenerife (Canary Islands); *Taxa*: Gastropoda, Coleoptera, Diptera; *Other*: invertebrate conservation, threatened species, IUCN, setting conservation priorities, islands.

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IUCN has a number of criteria for assessing the risk of extinction that have been widely used to prepare red lists. Although these criteria are useful in assessing the global risk of threatened species are not equally suitable for setting conservation priorities because they tend to overestimate the threat when applied in small island (<2.500 km<sup>2</sup>). This has been expressly recognized in the "Guidelines for using the IUCN red list categories and criteria". Criterion B is the most commonly used to produce red lists of invertebrates; however, the extensive thresholds of this criterion may cause the inclusion of large numbers of insular species in the categories of greatest threat. This is a major drawback from the point of view of conservation management by the difficulty to identify which species need to be saved first among the wide list of threatened species. The conservation actions generally have no sufficient resources to address at once a simultaneous recovery of all threatened species. This work develops a method to transform the criterion B of IUCN in a tool for setting conservation priorities in invertebrates. Is applicable to geographically well-defined regions such as islands, but could be equally valid in mountain regions and other ecologic island ecosystems. The method focuses on the identification of thresholds based on percentiles of the home ranges of species belonging to a particular taxonomic group, on a previously defined geographic area of evaluation. This method facilitates the identification of species that require more urgent action. The method has been tested in three animal groups of invertebrates in the Canary Islands with different vagility; molluscs, beetles and flies. We have also contrasted the results of evaluations on a single island with evaluations of groups of islands (archipelago), and considering different sampling scales.

## What we know and what we don't know about the conservation status of island endemic invertebrates

AXEL HOCHKIRCH



Hochkirch, A. 2016. What we know and what we don't know about the conservation status of island endemic invertebrates. Pp. 256 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Canary Islands; *Taxa*: Orthoptera; *Other*: conservation, invertebrates, invasive species, habitat management.

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Many tropical and subtropical islands are biodiversity hotspots, maintaining a large number of endemic species. Most of these species are invertebrates and as native non-flying vertebrates are usually rare on these islands, invertebrates may even play an important role as flagship species for conservation. However, our knowledge on invertebrates is still limited. Many species are still undescribed, but even more importantly for most described species we have a lack of knowledge on their ecology and habitat requirements. This knowledge is crucial to start any conservation action for these species. The major threats to islands invertebrates are destruction and deterioration of their habitats by human land use, invasive species and climate change. Due to their small range sizes, island-endemic invertebrates face a higher extinction risk than those on the mainland. We therefore need a collective effort to focus on the conservation of island-endemic invertebrates globally. I show some examples, how some smaller research projects on endemic Orthoptera of the Canary Islands have started to collect the necessary data for conservation and may finally give rise to larger conservation projects.



## Golden, Spiky and Blushing: Establishing invertebrate conservation on the Atlantic island of St Helena

VICKY KINDEMBA



Kindemba, V. 2016. Golden, Spiky and Blushing: Establishing invertebrate conservation on the Atlantic island of St Helena. Pp. 257 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: St Helena; *Taxa*: invertebrates; *Other*: IUCN, Red-listing, UK's Overseas Territories, Darwin Initiative.

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The island's of the UK's Overseas Territories (UKOTs) hold over 1,000 invertebrate endemics. Despite the global importance of the UKOTs for invertebrates, there is very limited understanding of invertebrate biodiversity and, as a result, many of these important species are threatened by human impacts. Even though much of this endemic fauna is threatened, only a small percentage of invertebrate species have been IUCN Red-listed. As a result, there is a need to improve information and understanding of invertebrates and also their conservation needs in the UKOTs. Buglife, with funding from the Darwin Initiative and in partnership with St Helena National Trust, St Helena Government and the Centre for Ecology and Hydrology, has been delivering Bugs on the Brink project for the last three years, to set up invertebrate conservation work on the island. Achievements of the project include a full baseline data-set of the island's invertebrates, Red-listing, training of professionals, identification guide, a reference collection; as well as outreach with schools and the wider island to improve understanding of St Helena's amazing invertebrates. The Bugs on the Brink project has also helped to initiate the establishment of an IUCN invertebrate specialist group for the Mid-Atlantic tropical islands.

# Planning for a long-term monitoring program for island forest mountain spiders and beetles: A simplified COBRA Protocol for monitoring beta diversity

PAULO A.V. BORGES, P. CARDOSO, P. OROMÍ, C. THÉBAUD, D. STRASBERG  
& B.C. EMERSON



Borges, P.A.V., P. Cardoso, P. Oromí, C. Thébaud, D. Strasberg & B.C. Emerson. 2016. Planning for a long-term monitoring program for island forest mountain spiders and beetles: A simplified COBRA Protocol for monitoring beta diversity. Pp. 258-259 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Terceira (Azores), Tenerife (Canaries) and La Réunion (Mascarenes); *Taxa*: Araneae, Coleoptera; *Other*: island conservation, forests, disturbance regimes, ecological gradients, global change; long-term monitoring, sampling standardization.

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Current island native forest habitats are particularly important repositories of threatened endemic arthropods that are frequently restricted to higher elevations. As a consequence of the ongoing deleterious impacts of invasive species, land-use changes and climatic changes, the long-term conservation of island forest mountain invertebrates is considered a priority. During the project NETBIOME –ISLANDBIODIV a modified version of COBRA protocol was used to inventory alpha diversity of spiders and beetles on pristine native forest of three islands, Terceira (Azores), Tenerife (Canaries) and La Réunion (Mascarenes). The modified COBRA protocol incorporated the following standardized methods that totaled 28 samples: AAS - active aerial searching during the night (4 hours); BLM - searching under bark, lichens and mosses during the day (2 hours); TWS - searching in decaying trunks, dead wood on the ground, and under stones during the day (2 hours); FBD - foliage beating during the day (2 hours); FBN - foliage beating during the night (2 hours); FSD - foliage sweeping during the day (2 hours); FSN - Foliage sweeping during the night (2 hours); PIT- Pitfall

traps (12 samples). Monitoring is essentially different from inventorying, that was the main objective of the original COBRA protocol. Here we will describe a new optimized and standardized COBRA protocol designed to respond to long-term changes of spider and beetle diversity, i.e., designed to measure beta diversity. Using data collected in the above mentioned islands and using simulation methods the new COBRA protocol was optimized to only six samples using: AAS - active aerial searching during the night (four hours); FBN - foliage beating during the night (two hours). With this new solution it is possible to quantify and monitor long-term changes in communities with minimal effort and using a method that proved to be suitable, efficient, feasible, flexible, transparent and accountable.

Specialized Symposium 5  
(Cv4) Conservation of island vertebrates

CHAIRS: CHRISTIAN VINCENOT & SOPHIE PETIT

## Cracks in island keystones: Threat synergies and life history traits push island flying foxes (*Pteropus* spp.) to the brink

TIGGA KINGSTON



Kingston, T. 2016. Cracks in island keystones: Threat synergies and life history traits push island flying foxes (*Pteropus* spp.) to the brink. Pp. 261 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Mauritius; *Taxa*: Chiroptera, *Pteropus niger*; *Other*: bats, culls, human-bat conflict, threat synergy, stakeholders, habitat.

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Over 50% of the *Pteropus* species, bats also known as flying foxes, are listed as Critically Endangered, Endangered, or Vulnerable. Of these threatened species, nearly all (27 of the 31) are island species and, portentously, four of the five bat species lost to extinction globally were island *Pteropus*. Flying foxes are keystone species on islands, providing essential ecosystem services as pollinators and seed dispersers to native flora. In many localities, particularly remote oceanic islands, alternate pollinator and dispersers are few and bats are central to habitat conservation. Population declines compromise these services, and extinction of island *Pteropus* will likely precipitate a cascade of losses. Here I review the status of island *Pteropus* and highlight their central role in native communities. I discuss how threats to flying foxes (habitat loss, hunting, human-bat conflict, climate change) are intensified on islands and combine with life history characteristics (long lifespan and low reproductive rates) and island stakeholder complexity to imperil so many species.

## Prioritization frameworks for island vertebrate conservation

FRANCK COURCHAMP, C. BELLARD, C. BERTELSMEIER, L. S. BULL, S. D. GREGORY  
& D. B. HARRIS



Courchamp, F., C. Bellard, C. Bertelsmeier, L.S. Bull, S.D. Gregory & D.B. Harris 2016. Prioritization frameworks for island vertebrate conservation. Pp. 262 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: global; *Taxa*: vertebrates; *Other*: invasive alien species, eradication, strategy, prioritization, conservation.

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Following the urging threat presented by invasive species worldwide and the dire limitation of conservation resources, a consensus is emerging that we need to undertake eradications more strategically to minimize biodiversity loss. In response to this, we present a very simple and flexible framework for prioritizing invasive alien species eradication programs, based on several, facultative steps at different scales. First, one should look at which places are the more likely to be invaded by the species of concern, at the global (macroscopic) scale. Different types of models can provide prioritization of places on Earth where invasive species are likely to be more important. Second, one should also prioritize according to temporal scale, as conservation should be planned for decades, and invasive threats change with climate changes and sea level rises. Recent work has shown that the places where biological invasions are very worrisome currently will not necessarily be the same as places where they will be a problem in 50 years. In addition, many places where invasive alien species could be eradicated may end up under water in the coming decades, thereby voiding conservation efforts there. Third, at the ecological scale, one needs to account for feasibility, economic cost, reinvasion risk (natural or human-aided), ecological complexity (accounting for potential “surprise effects”) and conservation value. We present a simple framework equating these factors according to the weight managers give them, to rank places of concern according to final conservation gain. The choice of parameter weights may depend on the priority given to the different variables by managers, but this framework allows comparison of different weights placed on different variables (e.g. costs vs reinvasion risk). We provide examples of how prioritization could be achieved according to different criteria of importance as appreciated by managers in diverse conditions.

## Overabundance of a parakeet on a Caribbean island threatens a keystone bat-cactus mutualism

SOPHIE PETIT, A. ROJER & L. PORS



Petit, S., A. Rojer & L. Pors 2016. Overabundance of a parakeet on a Caribbean island threatens a keystone bat-cactus mutualism. Pp. 263 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Curaçao; *Taxa*: cacti, birds, bats; *Other*: bat-cactus mutualism, cactus pollination, cactus recruitment, predation of cacti, seed predation by birds.

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The semi-arid Caribbean island of Curaçao has three columnar cactus species, which are pollinated by two bat species. These cacti provide important resources during the dry season to many animal species and are central to the Curaçao ecosystem. When ripe, fruit pericarps open, exposing pulp and numerous seeds, dispersed by vertebrates. We studied datu (*Stenocereus griseus*) and kadushi (*Subpilocereus* syn. *Cereus repandus*) fruits and seeds. Unlike in Venezuela, very few fruits reached maturity on Curaçao (2.0% to 4.3% at a windy site), because of birds (mostly the parakeet *Aratinga pertinax*), depriving bats of important resources. Parakeets opened fruits that were very young and hard. Seeds that germinated came from five- or six-week old fruits, with most germination occurring at week 6 after pollination (ripe fruit). Seedlings originating from riper fruits tended to be taller at 10 months for kadushi and survive better for datu. The extensive clearing of cactus scrub having taken place on Curaçao has been accompanied by the development of irrigated gardens, which may provide important resources to parakeets and may have improved their breeding success over the last several decades. This current lack of balance has several serious implications, including the reduction of bat populations and other animals that need ripe fruits, and the lack of recruitment among cactus populations, with potential for ecosystem collapse. Indeed, scrutinising 2.65 ha of cactus scrub ground at 10 sites revealed only 6 seedlings  $\leq 10$  cm, and it is likely that low abundance of seeds is responsible for low recruitment.



## Conservation challenges in the Ryukyu Archipelago: Public perception of an endemic fruit bat and ongoing conflicts

CHRISTIAN E. VINCENOT



Vincenot, C.E. 2016. Conservation challenges in the Ryukyu Archipelago: Public perception of an endemic fruit bat and ongoing conflicts. Pp. 264 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Ryukyu archipelago (Nansei Shoto), Japan; *Taxa*: *Pteropus dasymallus*; *Other*: interview, social survey, killing, megabat, flying fox.

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Often termed “the Galapagos of the East”, the Ryukyu archipelago, which spans from Kagoshima (mainland Japan) to Taiwan, is a typhoon-prone region home to many endemic and endangered species. The geography, vertebrate biodiversity, and social situation of this region, as well as some of the current conservation challenges it faces, will be briefly introduced during this talk, which will then focus more particularly on the case of the Ryukyu flying fox (*Pteropus dasymallus*). Although it has been listed and designated as Natural Monument, this solitary fruit bat, once common in Taiwan, where it is now virtually extinct because of overhunting, has not been the focus of much conservation effort in Japan (except on the Daito islands, a very small portion of its distribution range). It is also generally absent from tourist brochures, national park information boards, and other outreach media. This may come as a surprise as the country hosts only two extant allopatric megabats. Two social studies were conducted to assess public perception of *P. dasymallus*. The first one revealed a poor level of awareness of this species by local inhabitants, as well as a global lack of knowledge as regards its ecological value. This was correlated with a disinterest for its conservation, as expressed by a low willingness-to-pay in an embedded contingent valuation scenario. Targeted interviews with agricultural workers and field observations uncovered several threat factors that were unaccounted for by previous national and international assessments. Among these, the long-lasting and silent deliberate killing of *P. dasymallus* by farmers was documented for the first time and its underlying reasons analyzed. On the whole, these two studies combined demonstrate once more how neglecting the social dimension may lead to overlooking important conservation threats, and also suggest that the culling of fruit bats may be underreported on some islands.

## Mass culling of a globally threatened island flying fox: What lessons can we draw?

FRANÇOIS B.V. FLORENS



Vincenot, C.E. 2016. Mass culling of a globally threatened island flying fox: What lessons can we draw?. Pp. 265 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Mauritius; *Taxa*: *Pteropus niger*; *Other*: threatened species, culling, fruit bat, evidence-based conservation, human-wildlife conflicts.

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Mauritius, otherwise well known for some resounding conservation successes achieved through the application of state-of-the-art science and sound ecological reasoning, has recently captured international attention through the decision to mass cull a globally threatened flying fox species to try boosting fruit producers' profits. Appeals from local and international experts and major conservation organizations including the IUCN, WWF and BCI to adopt an evidence-based stance, failed. Some 40% of the bat population was destroyed by the cull, which lasted a few weeks at the end of 2015. An estimated additional 10% was destroyed by illegal shooting done concurrently and which continued during months after the official cull was over. The decision to cull was justified by exaggerated population size of the bats and a level of damage they inflict to crops that contradict scientific evidence, as well as the belief that the mass culling would reduce these damages. As predicted by scientists, no crop damage reduction was perceptible and the government has voiced its intentions to carry out further mass culling in 2016. Interestingly, the country's conservation law was weakened to enable the cull, but the decision to cull was still made in violation to the law. This episode indicates how far a government might be prepared to go to implement a political decision, when the leverage of conservation groups is perceived as relatively insignificant. In a world where human-wildlife conflicts are on the increase and intensifying, it matters to learn from this unfortunate Mauritius episode so as to forestall further similar instances. In the medium and longer term, more research, and better education and communication seem important to remedy such situations. However, it may also be time for conservationists to give greater place to economic arguments, such as boycotts of environmentally destructive industries, in their conservation toolbox.

## Island restoration through invasive mammal eradication

JAMES RUSSELL, N. HOLMES & H. P. JONES



Russell, J., N. Holmes & H.P. Jones 2016. Island restoration through invasive mammal eradication. Pp. 266 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: mammals (introduced), land birds, seabirds, reptiles; *Other*: eradication, conservation, restoration.

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Eradication of introduced mammals from islands has been an important conservation tool for over 100 years. Expanding from early work in New Zealand, over 1,000 eradications have now occurred on islands around the world. These eradications are an exceedingly high return-on-investment conservation intervention for island restoration. Over 561 populations of 216 native vertebrate species on 176 islands have benefitted from these eradications, resulting in IUCN red-list down-listings. However, there is a number of emerging challenges in the use of invasive mammal eradications as an island restoration tool. Tropical islands are under-represented, more challenging for mammal eradications, and require greater conservation investment. Better prioritization of target islands and species is required for mammal eradication. Island eradications must be scaled up to larger islands, and inhabited islands. Doing so will require a better understanding of the sociology of island communities. Techniques for eradicating invasive mammals in the presence of native mammals are urgently required. The validity of this conservation tool must be defended against ethical challenges and from those who might deny the impacts of invasive species. Mammals can reinvade islands rapidly and a better understanding of the biological processes involved as well as tools for prevention and reaction are required, in order to protect investment in mammal eradications.

## Novel insights on cost-effective ways to protect island vertebrates from the impacts of invasive non-native carnivores

LISE RUFFINO, T. CORNULIER, M. K. OLIVER, E. J. FRASER & X. LAMBIN



Ruffino, L., T. Cornulier, M.K. Oliver, E.J. Fraser & X. Lambin 2016. Novel insights on cost-effective ways to protect island vertebrates from the impacts of invasive non-native carnivores. Pp. 267 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Europe; *Taxa*: American mink (*Neovison vison*), seabirds, land birds, amphibians; *Other*: community-based management; invasive predators; island conservation; population dynamics.

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Non-native invasive carnivores have triggered catastrophic declines in island vertebrate populations. In much of Europe, the American mink *Neovison vison* represents a serious threat to island and riparian biodiversity, with dramatic impacts on a suite of island-nesting species of conservation and economic interests (e.g., razorbills, black guillemots, common eiders). While active management interventions have been demanded to protect island species from extinction, they often need to be conducted over protracted periods, or even permanently because of potential ongoing reinvasion risks from adjacent mainland areas. Novel management approaches are, therefore, crucially needed to maximise benefits to biodiversity while minimising economic costs. In this talk, I will present several case studies in northern Europe where mink have been controlled for >15 years to protect local bird, mammal and amphibian communities. I will draw on the outcomes of these projects to illustrate how we can learn from various environmental and social contexts to inform cost-effective management globally. More particularly, I will demonstrate how data from a long-term mink culling programme in the Scottish Western Isles could be exploited using an innovative modelling framework to predict likely times of mink extinction and produce strategic management recommendations to foster eradication. I will then explore the possibility of employing unpaid, volunteer citizens from different social communities in the control of invasive predators across Europe. Community-based management represents a promising alternative way to decrease invasive species management operational costs, while achieving conservation benefits over large geographic scales.

## Management of rare and endemic species within a dynamic natural disturbance regime and among anthropogenic threats in the Commonwealth of the Mariana Islands

JIM KEANY & L. ZARONES



Keany, J. & L. Zarones 2016. Management of rare and endemic species within a dynamic natural disturbance regime and among anthropogenic threats in the Commonwealth of the Mariana Islands. Pp. 268 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Commonwealth of the Northern Mariana Islands; *Taxa*: vertebrates; *Other*: disturbance, threats, endangered species.

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With a land mass of 183 square miles, the Commonwealth of the Mariana Islands is host to number of rare and endemic birds, reptiles, one species of fruit bat, and recently discovered invertebrates. Management of the dispersed islands has required a unique strategy of inventory, risk assessment, and applied ecology. While some species have made miraculous comebacks from low populations following WWII battles, others are struggling as a result of natural disturbances (primarily typhoons), habitat alteration, and current and proposed US military training. The presentation will summarize the CNMI's ecological management approaches, discuss natural and anthropogenic threats, and highlight the management of several species as examples.

## Interactive effects of marine subsidies, herbivory and predation on the ecology of Mediterranean island reptile populations

JOHANNES FOUFPOULOS, Z. GIZICKI & P. PAFILIS



Foufopoulos, J., Z. Gizicki & P. Pafilis 2016. Interactive effects of marine subsidies, herbivory and predation on the ecology of Mediterranean island reptile populations. Pp. 269 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Aegean Sea, Greece; *Taxa*: multiple plant, invertebrate and vertebrate taxa; *Other*: goats, invasive species, seabirds, nutrient subsidies, top-down vs. bottom-up processes.

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On islands worldwide, reptiles are frequently the most important vertebrate residents, both in terms of aggregate biomass and total population size. While some research has been done on the effects of predation on vertebrate population sizes, little is known on the effects of marine nutrient subsidies or herbivory on island vertebrate population sizes. We present the results of an investigation on the effects of seabird-delivered marine subsidies, herbivory by introduced goats, and predation by native predators on the populations of reptiles living on islands in the Aegean Sea (Greece). Our results indicate that reptile population densities are determined by a hierarchical interplay between predation on the one hand, and nutrient availability - mediated by goat browsing and seabird subsidies - on the other. Predation by snakes significantly depresses lizard densities on islands that are big enough to support resident snake populations. On snake-free islands only, lizard numbers are positively associated with breeding seabird populations, presumably because of seabird subsidies. Also only on snake-free islands, lizard numbers are negatively associated with density of stocked goats. Experimental goat removal and addition experiments lead to the same results. Goats appear to affect lizard populations through multiple independent pathways. Consumption of vegetation by goats leads not only to reduced presence of invertebrate prey, but also to reduced availability of thermal refugia. In addition, goats lead to the introduction of invasive ticks that switch hosts from goats to parasitize lizards and affect lizard reproductive success.

## A conservation strategy for the amphibians of Madagascar: An overview of the main threats and of the planned conservation activities

ANGELICA CROTTINI, J. DAWSON, J.P. LEWIS, F. RABEMANANJARA, N. RABIBISOA, T. RAKOTONANAHARY & F. ANDREONE



Crottini, A., J. Dawson, J.P. Lewis, F. Rabemananjara, N. Rabibisoa, T. Rakotonanahary & F. Andreone 2016. A conservation strategy for the amphibians of Madagascar: An overview of the main threats and of the planned conservation activities. Pp. 270-271 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Madagascar; *Taxa*: amphibia; *Other*: ACSAM2, New Sahonagasy Action Plan, Amphibian Program Lead, infectious diseases, invasive species, coordination.

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Madagascar hosts one of the richest amphibian communities in the World with more than 330 currently described species and at least 150 further species already identified and waiting formal description. The native amphibian fauna of Madagascar is constituted by five independent anuran radiations. Of these, around 99% of species and 88% of genera are endemic to Madagascar and its in-shore islands ranking the country third in the world for number of endemic amphibian species. Like others around the world Madagascar's amphibian fauna is under threat with currently around 30% of all described species listed in Threatened categories under the IUCN Red Listing, though no recent extinction has been recorded. Habitat loss and degradation are the primary threats facing these species, with collection for the international pet trade also likely to have a significant impact on particular species. The recent discovery of amphibian chytrid fungus highlights a new, potentially



devastating, threat to the country's amphibian fauna. Together with the recent discovery of an invasive alien toad spreading in the central east coast of Madagascar, these are now posing new challenges to not only amphibians, but all biodiversity in Madagascar. The conservation of Malagasy amphibians has long been an important issue and the need for collaborative, coordinated approach across all stakeholders has been repeatedly stressed. This need led to the organization of two crucial workshops for amphibian conservation (in 2006 and in 2014), leading to the development of the Sahonagasy Action Plan and, more recently, the New Sahonagasy Action Plan 2016-2020. These efforts are now being translated into a coordinated response, starting with the recruitment of an amphibian program team in country who will oversee the implementation of the action plan through an open partnership approach.

## The masked owls of Lord Howe Island: Consequences of the introduction of a top-order predator to an oceanic island

DAVID MILLEDGE



Milledge, D. 2016. The masked owls of Lord Howe Island: Consequences of the introduction of a top-order predator to an oceanic island. Pp. 272 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Lord Howe Island, NSW, Australia; *Taxa*: owls, rats, seabirds; *Other*: introduced predator, ecological balance, meso-predator release.

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Approximately 100 individuals of five owl species were introduced to Lord Howe Island during the 1920's to control a population explosion of the black rat *Rattus rattus*, which was consuming resources crucial to the survival of the human inhabitants. The masked owl *Tyto novaehollandiae* was the only owl species to successfully establish from this introduction and it has now integrated the Island's ecology as the sole resident top-order predator. It is listed as a Threatened species in its natural range but is considered a pest species on Lord Howe Island, principally because it is seen as a threat to breeding seabirds. The masked owl occurs on the Island in dense rainforest, occupying small, over-lapping home ranges, roosts and nests in a range of sites and feeds primarily on the introduced black rat and house mouse *Mus musculus*. It also takes small numbers of breeding seabirds and land-birds, most of which are listed as Threatened, but at present appears to be having no adverse effects on their populations. The proposed removal of the masked owl, as mandated by the Lord Howe Island Biodiversity Management Plan and intended to occur in conjunction with implementation of the Rodent Eradication Plan, requires very careful management. Removal of owls without coincident removal or substantial reduction of the black rat population could result in the phenomenon of meso-predator release, with drastic impacts on the Island's biodiversity. On the other hand, removal of black rats without the removal of the owls is likely to cause a shift in the prey base to breeding seabirds and endemic land-birds, with undesirable consequences.

## Please don't eat the birds! Wildlife hunting in São Tomé Island

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Carvalho, M., J.M. Palmeirim, R.F. Lima, F.C. Rego & J.E. Fa 2016. Please don't eat the birds! Wildlife hunting in São Tomé Island. Pp. 273 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: São Tomé and Príncipe, West Africa; *Taxa*: birds; *Other*: wildlife hunting, Columbidae, endemic species, oceanic islands, sustainability, conservation.

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The island of São Tomé (Gulf of Guinea, central Africa) is a recognized biodiversity hotspot, particularly known for the uniqueness of its bird fauna. Four endemic species of pigeons are hunted in São Tomé, for food and for profit. We collected baseline data to advise on the management of these wild populations, taking into account their importance as a resource but also their conservation. We used line transects placed across the island's main habitats to estimate population densities and semi-structured interviews with hunters and rural consumers to assess extraction. The results show that endemic pigeons are harvested for commercial purposes by a small and specialized group of hunters, but also opportunistically by most hunters and many rural inhabitants. The hunting pressure on the endangered maroon pigeon *Columba thomensis* and on the vulnerable São Tomé green-pigeon *Treron sanctithomae* determines their patterns of distribution and abundance, and their extraction is probably unsustainable. Harvesting of the near threatened island bronze-naped pigeon *Columba malherbii* is probably still practiced at sustainable levels, even though it is the most hunted species. Nevertheless, more research is essential to advise adequate management measures. The least concern São Tomé lemon-dove *Columba [larvata] simplex* is the only species that is not commercially hunted, and exploitation for subsistence is sustainable. The long-term conservation of São Tomé's endemic pigeons requires the development of specific measures; it is essential to promote and enforce legal restrictions on hunting and trading, search for alternative livelihoods for commercial hunters, demote bird hunting and define strategies of consumer education and awareness.

## Conservation of Macaronesian sparrowhawk and laurissilva habitat in Madeira Island

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Gouveia, C.S., L. Castelló, L.T. Costa, A.I. Fagundes, S. Hervias, M. Nunes, C. Gonzalez, J.A. Lorenzo, D.M.G.G Menezes, N. Coelho, C. Medeiros, P. Freitas, A.F. Martins & N. Serralha 2016. Conservation of Macaronesian sparrowhawk and laurissilva habitat in Madeira Island. Pp. 274 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Madeira Island, Portugal; *Taxa*: *Accipiter nisus granti*; *Other*: Macaronesian sparrowhawk; laurissilva; habitat recovery.

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The Macaronesian Sparrowhawk is an endemic subspecies of the Macaronesian region and is probably one of the less known subspecies of *A. nisus*. Listed in Annex I of the Birds Directive and classified as a priority subspecies, the population of some Canary Islands was diminished because of the deforestation of a large area of Laurel forest. In Madeira, frequent wildfires are drastically reducing forest patches, but no study has been carried out on this island in order to know the conservation status of this forest species. The LIFE Fura-Bardos project (2013-2017, LIFE12 NAT/PT/000402) has been initiated in Madeira and Canary islands, aiming at the monitoring and conservation of this subspecies. In Madeira, the project is coordinated by SPEA in collaboration with regional entities and further aims to achieve habitat recovery and protection of Laurel forest areas. As a result, detailed data on the subspecies' distribution, ecology and population trends will soon allow to define suitable management and conservation measures. Preliminary data show that the species is distributed around the entire island of Madeira and in different types of habitat (Laurel, mixed and exotic). Most nesting territories are located in valleys, sometimes very deep and with streams and near open areas. The reduction of invasive alien plants populations in the laurel forest with the recovery of a significant area of burnt Laurel forest, is implemented by a team working on revegetation and invasive species control. Conservation measures for Laurel forest that result from this work will contribute to the conservation of the Macaronesian Sparrowhawk and other biodiversity.

## Praia Islet: Two decades of ongoing seabird conservation

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Neves, V., L. Aguiar, M. Bolton, M.C. Magalhães, C.P. Nava, L.F. Palou, C. Picanço, P. Raposo & J. Bried 2016. Praia Islet: Two decades of ongoing seabird conservation. Pp. 275 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Praia islet, Graciosa Island, Azores; *Taxa*: seabirds; *Other*: wildlife sanctuary, conservation, habitat restoration, endemic, Monteiro's storm-petrel, predators.

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The seabird assemblage of the Azores Archipelago was dramatically reduced following human colonization in the XV century, and consequent introduction of mammals and reduction of breeding habitat. Praia Islet (0.12 km<sup>2</sup>) remains undoubtedly one of the most important seabird colonies in the archipelago and despite its small size, this Special Protection Area is home to one of the most diverse seabird communities in the region. The islet is currently free of ground predators, but its close proximity to Graciosa Island implies the need for close regular monitoring. Aerial predators on the other hand have long caused disturbance to the breeding seabirds, and these include short- and long-eared owls (*Asio otus* and *A. flammeus*), yellow-legged gulls (*Larus michahellis atlantis*), turnstones (*Arenaria interpres*) and European starlings (*Sturnus vulgaris*). More recently the Madeiran lizard (*Lacerta dugesii*) has been responsible for the death of chicks of the Azores-endemic Monteiro's storm-petrel (*Hydrobates montei*). Restoration of seabird breeding habitat began in 1995 and over the last two decades it has involved 1) rabbit eradication, 2) control of soil erosion, 3) native plant reintroduction, 4) vegetation control (especially *Tamarix africana*) 5) lizard control 6) starling control and 7) installation of artificial nests for common terns (*Sterna hirundo*), roseate terns (*Sterna dougallii*), Madeiran storm-petrels (*Hydrobates castro*) and Monteiro storm-petrels. Since instigation of conservation measures, the terns have returned to breed on the islet. In 2015 the breeding numbers of common and roseate terns totalled 250 and 600 pairs, respectively, making Praia islet the second largest European colony of roseate tern. Monitoring results show a continuous increase in the number of breeders and prospecting non-breeders occupying the artificial nests for both storm-petrel species. Between 2000 and 2014, the number of Monteiro's and Madeiran storm-petrel pairs breeding in the artificial nests increased by 170% and 232%, respectively.

## Using ancient DNA to inform conservation of Caribbean land mammal fauna

ROSEINA H. WOODS, I. BARNES, M.J.F. BROWN & S. T. TURVEY



Woods, R., I. Barnes, M.J.F. Brown & S.T. Turvey 2016. Using ancient DNA to inform conservation of Caribbean land mammal fauna. Pp. 276 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Caribbean; *Taxa*: Capromyidae; *Other*: ancient DNA, taxonomy, conservation, insular rodent.

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The Islands of the Caribbean are a globally important biodiversity hotspot. A large proportion of the land mammals found on these islands consists of endemic species representing recent evolutionary radiations or ancient clades. Islands are often disproportionately affected by human-caused extinctions and the Caribbean is not different, with 100 species of land mammals driven to extinction since the late Quaternary. Only a few species in two endemic families (Capromyidae and Solenodontidae) now survive; both families have been recognised as priorities for conservation in view of their evolutionary distinctness. This talk focuses on the Capromyids, rodents restricted to the Greater Antillean islands of Cuba, Hispaniola, Jamaica, and the Bahamas Archipelago. Obtaining data for baseline studies of population status has its difficulties; many endangered species are nocturnal and/or arboreal, often occur in remote landscapes, and are by their very nature rare. In particular, further research is needed to clarify the taxonomic status and relationships of the genera *Capromys* and *Mesocapromys* that have populations across Cuba and its offshore archipelagos. All populations within the *Capromys* genus are considered the same species (*Capromys pilorides*). The genus *Mesocapromys* has not been subjected to the same level of molecular study and presently contains several separate recognised species based on diagnosed morphological differences. Genetic study of these species is vital to help ensure that unrecognised but potentially distinct taxa can receive conservation attention, and that populations misinterpreted as distinct species are allocated the appropriate resources. The use of specialist techniques to successfully extract DNA from ancient sources is a relatively recent occurrence. In situations where the subject species is difficult to procure for molecular study, vast collections held by museums may be the only option for understanding the genetic relationships between populations. This study has been able to extract and sequence DNA from museum and zooarchaeological specimens to generate a phylogeny for the Caribbean capromyids. These data are of particular importance to improve species classifications and thus provide a starting point for future conservation of the Caribbean capromyids.

## Specialized Symposium 8

### (Cv5) From extinction to restoration: Madagascar, the Mascarenes and the Seychelles

CHAIRS: ERIK DE BOER & DAVID BURNEY



## Extinction and restoration from Madagascar to Rodrigues: Conservation paleobiology on the eighth continent and the last place on Earth

DAVID A. BURNEY



Burney, D.A. 2016. Extinction and restoration from Madagascar to Rodrigues: Conservation paleobiology on the eighth continent and the last place on Earth. Pp. 278 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Madagascar and Mascarene Islands; *Taxa*: all; *Other*: paleoecology, restoration, extinction, human impacts, conservation paleobiology.

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Paleoecological and historical studies from the islands of the southwest Indian Ocean have provided insight concerning the human transformation of island ecosystems. A review of the contrasting histories of continental-scale Madagascar and tiny remote Rodrigues reveal much about the full range of similarities and differences in the course of human-induced change on islands. People reached Madagascar in the late Late Holocene; over the next two millennia the entire endemic megafauna disappeared, including giant lemurs, elephant birds, dwarf hippopotami, and giant tortoises. Rodrigues Island, by contrast, was one of the last habitable islands on earth Earth to be colonized. Beginning in the late 17th century, eyewitness accounts published at ca. 30 yr intervals by four naturalists show that giant tortoises and the Solitaire, a flightless pigeon larger than the Dodo of neighboring Mauritius, disappeared in a half century. Paleoecological results from fossil pollen, dung fungus spores, and charcoal in the case of Madagascar, and detailed eyewitness accounts from Rodrigues, each suggest that a cascading sequence of ecological events – megafaunal decline, followed by plant biomass accumulation and subsequent increased wildfire, and coupled with biological invasion -- worked synergistically to change these places forever and generate novel, relatively depauperate ecosystems. Mounting evidence suggests that this is the sequence almost worldwide with human arrival. Historical details provided by Rodrigues may provide a “Rosetta Stone” for understanding prehistoric island biotic transformations in general. Current work focuses on fossil studies in Rodrigues to provide historically verifiable calibration for comparison to results collected over the last four decades in Madagascar and islands throughout the world. In addition, Rodrigues and its distant neighbor Mauritius have been pioneers in applying this knowledge of the past to ecological restoration efforts. Successes with giant tortoise rewilding in the Mascarenes have now spawned an ambitious plan to reintroduce giant Aldabran tortoises back to Madagascar.

## Restoring and conserving the remains of the ecosystem of the Dodo: Lessons from a 4200 year old multitaxic bone bed

KENNETH F. RIJSDIJK, P. G.B. DE LOUW, H. J.M. MEIJER, L. P.A.M. CLAESSENS, F.B.V. FLORENS, C. BAIDER, N. PORCH ET AL.

Rijsdijk, K.F., P.G.B. De Louw, H.J.M. Meijer, L.P.A.M. Claessens, F.B.V. Florens, C. Baider, N. Porch, V. Tataya, A. Janoo & E.J. de Boer 2016. Restoring and conserving the remains of the ecosystem of the Dodo: Lessons from a 4200 year old multitaxic bone bed. Pp. 279-280 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Mauritius, Indian Ocean; *Taxa*: insular vertebrates; *Other*: hydrology, global change, fresh water bodies, hyper-eutrophication, extreme drought.

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A multitaxic vertebrate bone bed in Mauritius represents one of the most diverse, richest and youngest (4200 yr BP) natural bone beds identified on a volcanic island so far. The bone bed is a natural mass grave, which was formed by mass mortalities of vertebrates (dodos, giant tortoises, fruit bats and passerines) within a period of less than 100 years, due to anomalous extreme drought events. Death was caused by fresh water scarcity, increased salinity and hyper-eutrophication due to defecation of concentrated fauna inducing cyanobacterial blooms and ultimately water poisoning. The natural mass grave forms an ideal analogy to study the response of an insular ecosystem to future global warming. In spite of mass mortalities, insular vertebrate species survived rapid climate changes until humans

colonized Mauritius more than 3500 yrs later, suggesting successful adaptation of insular vertebrates to natural climatic extremes. During the 4200 yr BP drought period Mauritius must have provided alternative fresh water pools that allowed parts of the populations to survive. A hydrological sensitivity analysis on island scale is essential to identify the location and activity of fresh water pools, and to identify the locations of fresh water pools that persisted during extreme droughts in the past. Flightless insular vertebrate species, although locked on the island, were free to seek alternative fresh water pools in periods of water scarcity. We identify the following factors explaining the survival of insular species: 1) biotic resilience through adaptation to extreme stress conditions, 2) the spatiotemporal dynamics of fresh water pools, and 3) the access to alternative water resources for fauna under stress. Currently, insular vertebrate populations locked in reserves have little or no fall back options during foreseeable periods of extreme climate hazards from Global Change and it is therefore essential to assess whether fresh water quantity and quality within reserves will be maintained during droughts when developing conservation strategies.

## Historical land use change and soil loss on Mauritius (Indian Ocean)

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Norder, S.J., A.C. Seijmonsbergen, S.D.D.V. Rughooputh, E.E. Van Loon, V. Tatayah, T.A. Kamminga & K.F. Rijdsdijk 2016. Historical land use change and soil loss on Mauritius (Indian Ocean). Pp. 281 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Mauritius, Indian Ocean; *Taxa*: -; *Other*: social-ecological systems, temporal couplings, historical land use change, historical soil erosion, RUSLE.

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Temporal couplings such as historical interactions between land use change and soil loss are greatly responsible for the current state of a wide range of ecosystem services of the social-ecological system on the volcanic island of Mauritius. Islands are ideal study systems for assessing the role of past socioeconomic drivers on deforestation and soil loss. The history of population growth on Mauritius, land conversion, and soil loss are closely interlinked. Knowledge of historical soil loss patterns and historical land use change might be used in the restoration, preservation and management of native ecosystems on the island. Six well documented historical land use maps, starting from initial colonization of Mauritius in 1638, were used as input parameters to model two scenarios of cumulative soil loss, with and without human colonization, using the Revised Universal Soil Loss Equation in a Geographic Information System. The scenarios show that historical land use change since 1638 has resulted in a cumulative soil loss which is five times larger than the baseline scenario without colonization. Our temporal analysis provides a framework for quantifying historical human-environment interactions on an island, and illustrates to what extent the current state of the soil of a social-ecological system is negatively affected by past human-environment interactions. Key is the realization that both historical and present-day deforestation and soil loss on Mauritius are influenced by distant socioeconomic drivers.

## Revisiting patterns of habitat transformation and extinction in La Réunion (Mascarene Islands)

DOMINIQUE STRASBERG, O. FLORES & C. AH-PENG



Strasberg, D., O. Flores & C. Ah-Peng 2016. Revisiting patterns of habitat transformation and extinction in La Réunion (Mascarene Islands). Pp. 282 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: La Réunion; *Taxa*: plants and animals; *Other*: conservation, invasions, natural habitats, oceanic island, restoration.

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La Réunion is the last of the Mascarene Islands with large areas of untransformed habitats. These still cover 100 000 ha. Despite a recent human colonization in the 17<sup>th</sup> century, the native biota experienced a rapid and drastic extinction of the vertebrate fauna. At the regional scale, the pattern of habitat transformation is analyzed by comparing past and present vegetation maps and by documenting subfossil archives and reports of early travelers. Native areas are currently under protection by a national park where most protected habitats and flagship species are targeted by coordinated conservation actions. Several management programs aim at controlling the main introduced, invasive species. Nevertheless, forest dynamics studies confirm the lack of recovery of native plant communities after natural disturbances or restoration actions; this can be explained by dispersal limitation of most native trees, new plant invasions and major changes in frugivore community composition.

## Introduced mammals on western Indian Ocean islands

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Russell, J., N. Cole, N. Zuël & G. Rocamora 2016. Introduced mammals on western Indian Ocean islands. Pp. 283 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: western Indian Ocean; *Taxa*: mammals (introduced); *Other*: La Réunion, Madagascar, Maldives, Mascarenes, Mauritius, Seychelles, Zanzibar.

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The diversity of introduced mammals and their introduction history varies greatly across the western Indian Ocean (WIO) islands, from ancient introductions on islands off the east coast of Africa where extant terrestrial native mammal communities exist, to recent invasions in the past decades on islands in the Mascarene archipelago. We compile the distribution of sixteen introduced mammal taxa on 28 island groups comprising almost 2,000 islands. We recorded all mammal eradications, and species recoveries which could be attributed to introduced mammal eradication or control. All island groups have been invaded by mammals, and invasive cats and rats in particular are ubiquitous, but cultural contingency has also led to regional invasions by other mammals such as lemurs, civets and tenrecs. Mammal eradications have been attempted on 45 islands in the WIO, the majority in the Seychelles and Mauritius, and where successful have resulted in spectacular recovery of species and ecosystems. Invasive mammalian predator eradication or control in association with habitat management has led to improved conservation prospects for at least 24 species, and IUCN red-list down-listing of eight species, in the Mascarene Islands. Future island conservation in the region will need to take account of global climate change and predicted sea-level rises and coastal inundation. Greater investment and prioritization in island conservation in the region is warranted, given its high biodiversity values and the extent of invasions.

## Incorporating evolutionary and ecological traits of the iconic *coco de mer* palm in forest restoration

CHRISTOPHER N. KAISER-BUNBURY, P. J. EDWARDS, F. FLEISCHER-DOGLEY, L.L. PIÑERO & N. BUNBURY



Kaiser-Bunbury, C.N., P.J. Edwards, F. Fleischer-Dogley, L.L. Piñero & N. Bunbury 2016. Incorporating evolutionary and ecological traits of the iconic *coco de mer* palm in forest restoration. Pp. 284 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Seychelles; *Taxa*: coco de mer palm *Lodoicea maldivica*; *Other*: ecological restoration, ecosystem engineer, endemic palm forest, invasive alien plants, evolution of island gigantism, Western Indian Ocean.

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The island of Praslin, Seychelles, suffers from severe habitat degradation. Restoring native plant communities is strongly compromised by extremely poor soils and the spread of invasive alien plants. The endemic coco de mer palm *Lodoicea maldivica* has evolved with Praslin's poor soils, and remaining coco de mer palm forests are comparatively resistant to plant invasion. Here we describe the palm's unique functional characteristics, including its gigantic seed, and leaves that form huge funnels which flush particulate material to the base of the trunk when it rains. We show that these traits enable the palm to thrive on poor soil and form monodominant stands. With the funneling mechanism, *Lodoicea* improves its nutrient supply and that of its dispersal-limited offspring. Moreover, shed leaves prevent germination and survival of alien plants, thus suppressing spread of invasive plants in palm forest. We argue that both the palm's acquired functions, adapted to the conditions on the granitic island, and its ability to selectively benefit native forest regeneration, qualify *Lodoicea* as a keystone species for long-term ecological restoration of degraded land on Praslin.



## Achievements and challenges in conserving and restoring native terrestrial ecosystems on Mauritius

FRANÇOIS B.V. FLORENS & C. BAIDER



Florens, F.B.V. & C. Baider 2016. Achievements and challenges in conserving and restoring native terrestrial ecosystems on Mauritius. Pp. 285 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Mauritius; *Taxa*: plants and animals; *Other*: invasive alien species, *Psidium cattleianum*, *Rattus* spp, threatened species, recovery, Mascarenes.

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Mauritius, an eight million year old volcanic island covering 1,865 km<sup>2</sup> in the south west Indian Ocean biodiversity hotspot, was one of the last islands reached by humans but has since become one of those being ecologically most severely impacted. The original terrestrial vegetation has been reduced 20-fold, forcing the bulk of the native biota to survive in a confetti of habitat fragments currently sustaining increasing pressure from hordes of invasive alien plants and animals such as the strawberry guava, the black rat and the long-tailed macaque. The island's biota has sustained high extinction rates and the survivors, who include the rarest species globally, are for the most part threatened with extinction. Mauritius may hold considerable value as a laboratory to study human-caused extinctions, in particular given that the situation prevailing locally (e.g. the extents of human overpopulation, habitat destruction and pressures from invasive alien species etc.) may arguably be regarded as what awaits many other tropical islands worldwide. On a more optimistic note and owing to the same attributes, Mauritius may also play the role of a laboratory of conservation and restoration. Indeed, the island is already known for some resounding conservation successes, in particular of its endemic birds, and certain conservation efforts that have been or are setting the pace worldwide. The island has some of the highest density of scientific papers per surviving species or extent of habitat left. Conservation challenges however remain acute and have been worsening in recent years by an already low yet still weakening commitment of the government to biodiversity conservation. This is epitomized by the recent mass culling of 40% of the world population of the Mauritius Flying Fox which was already threatened with extinction and which plays a keystone role as pollinator and frugivore in the Mauritian forests.

## Future directions for island rewilding in the Western Indian Ocean

DENNIS M. HANSEN



Hansen, D.M. 2016. Future directions for island rewilding in the Western Indian Ocean. Pp. 286 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Western Indian Ocean; *Taxa*: vertebrates and plants; *Other*: rewilding, conservation, restoration, extinction.

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Rewilding, here defined as the functional replacement of an extinct species by another species, is a controversial conservation tool. Especially on islands, most objections to this form of rewilding inevitably take the form of “look at all the islands where aliens have wreaked havoc,” often with straw-man arguments that use taxa with life-history and functional traits that are a far cry from those proposed for use in island rewilding projects. The discussion needs to move on from currently mostly being “conversation biology” dominated by pro or con- opinion pieces, to progress rewilding towards empirical conservation biology. Compared to continental rewilding projects, islands are perfect model systems to test and to advance rewilding science. Anthropogenic extinctions happened much more recently, and island ecosystems are simpler and with smaller species. Overall, island rewilding allows the pursuit of restoration trajectories radically different to those available with only the surviving native species. I will first briefly review the currently used taxa in island rewilding projects and then identify and discuss a next-stage, broader set of focal taxa. Secondly, I will present approaches designed to ensure that island rewilding projects have clear functional targets, pursued via open-ended management that allows for changes in the restoration trajectories as new data become available. Such data could come from targeted experimental set-ups that are integrated into each rewilding project from the very start, as well as from new evidence from targeted paleoecological and historical studies. I will especially focus on the role of experimental, small-scale, and reversible approaches that can directly feed into larger-scale projects.

## Specialized Symposium 24

(Cv6) Protected areas in islands: Are we doing everything  
wrong?

CHAIR: ARTUR GIL

## The Open Standards for the practice of conservation: Strategically planning and adaptively managing island biodiversity

ANDREW S. BRIDGES



Bridges, A.S. 2016. The Open Standards for the practice of conservation: Strategically planning and adaptively managing island biodiversity. Pp. 288 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: San Clemente Island, global; *Taxa*: all; *Other*: adaptive management, open standards, conservation planning.

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Global biodiversity is threatened by climate change, sea level rise, human population growth, and invasive species proliferation. Island biotas, evolved in relative isolation and characterized by high endemism, limited ranges, and small populations, are particularly vulnerable. Consequently, the conservation biology community places special emphasis on protecting insular biodiversity. Conservation planners need a methodical, standardized, and robust system for designing, assessing, and communicating the effectiveness of their efforts. Such a system is necessary for efficient adaptive management and for sharing findings with the conservation community at large. In response to this need, the Conservation Measures Partnership developed the Open Standards for the Practice of Conservation. This system incorporates theories and principles of adaptive management from a variety of disciplines to produce a planning and evaluation process broadly applicable across temporal, geographic, and programmatic scales. The Open Standards allows teams to systematically select conservation targets, identify threats, develop mitigation strategies, and produce theories of change addressing assumptions and linking concepts. It emphasizes conservation outcomes over actions, and is designed to incorporate both biodiversity and human well-being into the process. It also produces tangible goals and objectives, defines progress metrics, and facilitates ongoing adaptive management by documenting results of strategies which allows methods to be refined. Finally, it provides a conservation planning lingua franca facilitating communication among organizations, and has an optional software package and web-based commons to encourage sharing and collaboration. The Open Standards has been adopted by wide variety of conservation organizations world-wide and is particularly applicable to island conservation projects. As an illustration, we applied the Open Standards process to a long-term endangered species recovery program on San Clemente Island, California. We found it allowed us to capture institutional knowledge, evaluate programmatic effectiveness, discover data gaps, reveal tacit assumptions, and form stakeholder consensus. Despite our program's long history, the process yielded surprising insights while engaging and empowering our stakeholders, codifying our goals, and providing a much-needed road map complete with milestones for future recovery efforts. We highly recommend considering the Open Standards approach for planning island conservation projects.

## Improving conservation education strategies in integrating totally protected area with their surroundings: Scientific evidence and theoretical approaches of Lambir Hills National Park

JANUARIE KULIS



Kulis, J. 2016. Improving conservation education strategies in integrating totally protected area with their surroundings: Scientific evidence and theoretical approaches of Lambir Hills National Park. Pp. 289 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Lambir Hills National Park, Miri, Sarawak, Malaysia; *Taxa*: all; *Other*: theories, scientific findings, conservation, education, isolated, community.

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Lambir Hills National Park was gazetted on 15<sup>th</sup> May 1975, protecting a sandstone geographical feature of 6,949 ha with the highest altitude of 465 m. The park is located in Sarawak, East Malaysia and about 10 km from South China Sea. Since 40 years ago, Lambir Hills National Park has been a place of interest for long term ecological monitoring of primary forest among researcher and scientist with biology background. Much theory and scientific findings have been published, yet not effectively being used in addressing conservation issues such as low density of mammals in consequences of plants evolution, high carbon storing in relation to tree and a decrease in tree diversity. As time passing by, the park has becoming more isolated from the larger forest area and migration of species seems vulnerable. Many have not realized the effect of isolation and surrounding land conversion on viability of totally protected area to function as a balance ecosystem thus no effort to overcome the situation. Long term involvement of surrounding community plays an important role to support the future strategy in integrating their area with the park. This paper serves to describe a long term strategies in terms of conservation education in influencing surrounding community as a first step to overcome current issues.

## Vulnerability assessment of Azorean marine resources to climate change

CRISTIANA A. BRITO, M.J. CRUZ, A. SOUSA & M.R.R. PINHO



Brito, C.A., M.J. Cruz, A. Sousa & M.R.R. Pinho 2016. Vulnerability assessment of Azorean marine resources to climate change. Pp. 290 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: Chordata, Mollusca, Crustacea; *Other*: climate change, marine vulnerability assessment, fisheries, marine resources, sensitivity, exposure, island ecology.

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Azores have a wide variety of different marine ecosystems which are important for shelter several species. These ecosystems suffer many pressures (e.g. overfishing, pollution or habitat destruction) that could cause a decline in marine populations. Furthermore, climate change is an extra pressure to species, and can have huge impacts in the distribution, abundance and phenology of fish and other marine species. Vulnerability assessments can indicate which species are most at risk and assist in a better management of marine resources and fisheries, ultimately providing their sustainability. We used a factor-based vulnerability assessment index to study the vulnerability to climate change of 19 marine fish and invertebrates of Azores region. The objectives of this assessment were to: 1) develop a vulnerability ranking across species, 2) determine attributes/factors driving vulnerability and 3) identify data quality and data gaps. For the application of the index a workshop with 14 experts' was conducted. The index uses two types of factors: sensibility and exposure. Sensibility evaluates how each species responds to climate change (e.g. complexity in reproductive strategy, population growth rate, sensitivity to temperature). Exposure assesses the degree of climate change that each species will be subjected to, depending on their distribution area (e.g. changes in temperature, salinity or primary production). Using twelve sensibility attributes and five exposure factors, experts evaluated the vulnerability of each selected species. Species were selected, based on the following criteria: a) to include populations of the different ecosystem components (pelagic (large and small), bathypelagic, benthic, coastal and oceanic), and b) to have economic value to Azores region. Additionally, in the case of benthic populations, we also considered different communities aggregated in depth in the Azores ecosystem. With the results we ranked species according with their vulnerability degree, further identifying species and populations where urgent management measures are required.

## Conservation projects by external partnerships as success stories for management of Macaronesian Protected Areas

LUÍS T. COSTA, J. TEODÓSIO, A.I. FAGUNDES, C. S. GOUVEIA & P. L. GERALDES



Costa, L.T., J. Teodósio, A.I. Fagundes, C.S. Gouveia & P.L. Geraldès 2016. Conservation projects by external partnerships as success stories for management of Macaronesian Protected Areas. Pp. 291 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Macaronesia, Azores, Madeira, Cabo Verde; *Taxa*: birds, plants; *Other*: Protected Area management, partnerships, endemism, conservation.

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SPEA is the BirdLife partner in Portugal and an environmental non-for-profit organisation aiming the conservation of threatened species and its habitats. Macaronesia has been an instrumental and key geographical area because of its endemics and globally threatened bird species. Since 2002 SPEA is working along with Protected Areas managers through projects in order to enhance the conservation of several endemic species of birds: the Azores Bullfinch and the Monteiro's Storm-petrel in the Azores (São Miguel, Corvo and Graciosa islands), Macaronesian Sparrowhawk and Bugio Petrel in Madeira, and the Raso Lark in Cabo Verde. In all these projects a new approach has been used by the organisation, by attracting external funds and complementing the activity of the administration for developing pioneer work with positive results for the conservation status of those species. Furthermore, it allowed developing local partnerships, promoting the sites as touristic and educational areas, promoting research and attracting dozens of students and volunteers that brought positive outcomes regarding conservation, knowledge and social and economic benefits in the Protected Areas and its surroundings. A thorough presentation of the results of the main projects, as well as an analysis of the pros and cons of this approach are given for discussion of a model providing excellent outcomes but still not achieving a self sustainability at the long-term.



## Combining genetic and landscape tools for reserve design on islands: The reptiles of Socotra as a model study

RAQUEL VASCONCELOS & P. TARROSO



Vasconcelos, R. & P. Tarroso 2016. Combining genetic and landscape tools for reserve design on islands: The reptiles of Socotra as a model study. Pp. 292-293 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Socotra (Yemen); *Taxa*: reptiles; *Other*: Protected Areas, intraspecific and interspecific diversity, representativeness and persistence, conservation planning.

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Targeting evolutionary processes in conservation planning has been fully acknowledged in scientific literature but rarely implemented in terrestrial systems without the use of surrogates. Distribution of genetic variation may present different patterns than species distribution that should be taken into account to maximize persistence of conservation units. This work primarily aims to relate genetic and species richness of widespread and restricted range taxa with landscape features and to compare the impact of targeting genetic versus species diversity to guide reserve design, using Socotran reptiles as models. Socotra (Yemen) has high levels of endemic specific and intraspecific diversity in regard to its area and great conservation interest (UNESCO Natural World Heritage site; within Horn of Africa biodiversity hotspot). Reptiles are the most important vertebrate group and the taxa with the most complete genetic sampling in that archipelago. We first predicted the occurrences of all reptile species using ecological niche models and then used new R-packages to interpolate maps of phylogenetic patterns which avoid the caveats of deterministic interpolation methods. We used reserve selection algorithms to evaluate differences in the prioritization exercises by quantifying the selected pixels, target achievements for each conservation feature, and by spatially comparing different outputs. Results clearly indicate that, even though intraspecific and interspecific richness presented strong spatial correlations, differences reached circa 30% in some areas. Spatial differences were much stronger when considering wide distribution taxa than when considering restricted range taxa. Genetic and specific richness of restricted range taxa presented stronger positive relations with altitude than wide range or total taxa. This work provides an innovative methodological framework for supporting

the use of genetic diversity in reserve design which can be applied to other island systems with well-known genetic diversity. It can also assist in local-scale conservation planning as Socotra's Protected Areas will soon be re-evaluated.

## The vulnerability to climate change of the forest in the protected areas of Tenerife (Canary Islands)

JOSÉ LUIS MARTÍN ESQUIVEL



Martín Esquivel, J.L. 2016. The vulnerability to climate change of the forest in the protected areas of Tenerife (Canary Islands). Pp. 294 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Tenerife, Canary Islands; *Taxa*: Spermatophyta; *Other*: Protected areas, climate change, adaptation to climate change, vegetation, forest.

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The Canary Islands has an extensive network of protected areas, covering the main natural habitats of the archipelago. Some of these habitats as the Canary pine forests, thermophilic forest or laurel forest, exist only in the Macaronesian region and have their best representation in the Canary Islands, if not the only (pines and scrub high mountain). However, the archipelago is also a region where climate change is manifesting with great notoriety. In certain sectors at higher altitudes is even twice as globally registered worldwide. In mountain islands the expected response of species and forests to rising temperatures is a displacement to greater elevations. This has been observed in several regions where the treeline is moving upward. The same response has been checked in plants and especially in birds and insects. However, climate change happens so fast that most species hardly have time to put into practice such strategy due to its limited dispersibility. The problem is more acute in the case of the long-lived species such as many trees and affects the aforementioned habitats. Tenerife is the largest island of the archipelago and houses the greatest biodiversity. The European project "ClimaImpacto" developed by Canary Government between 2010-13 to assess climate change and its possible consequences, elaborated a detailed cartography of the magnitude of this change. As a result of comparing this map with the distribution of vegetation, was possible to identify the most vulnerable natural areas and plant communities. This has permitted to design a management strategy of protected areas to achieving a better adaptation of forests and biodiversity to the new climate scenario.

## Key Biodiversity Areas and conservation priorities in Macaronesia: The BEST III initiative

FRANCISCO M. WALLENSTEIN, L. M.C. MADRUGA & J. M.N. AZEVEDO



Wallenstein, F.M., L.M.C. Madruga & J.M.N. Azevedo. 2016. Key Biodiversity Areas and conservation priorities in Macaronesia: The BEST III initiative. Pp. 295 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Macaronesia; *Taxa*: -; *Other*: biodiversity, key areas, conservation.

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The BEST III initiative, coordinated by IUCN on behalf of the European Commission, aims to (i) deliver Ecosystem Profiles containing a definition and prioritization of Key Biodiversity Areas (KBAs) in all European overseas regions, countries and territories using common methodologies, (ii) identify conservation actions for these areas, and (iii) propose an investment strategy to carry out these actions. In this context, Fundo Regional para a Ciência e Tecnologia is coordinating the Macaronesian Hub, mobilizing experts, policy makers and the civil society, having defined 44 KBAs for the Azores, 132 for the Canary Islands and 18 + 1 corridor for Madeira. The characteristics of these areas in terms of coverage and overlap with existing protected areas, as well as the difficulties in the process of defining them will be presented and discussed. The proposed conservation actions will also be presented and discussed with the audience.

Island Biology 2016  
2nd International Conference on Island Evolution, Ecology and Conservation

## SPECIALIZED SYMPOSIA – ECOLOGY



Terra-Brava in Terceira, Azores, in the interface between exotic plantations of *Cryptomeria japonica* and native grasslands (Photo: Paulo A. V. Borges)

## Specialized Symposium 9

### (Ec1) Freshwater systems in oceanic islands

CHAIRS: PEDRO RAPOSEIRO, VITOR GONÇALVES, ANA COSTA



## Are the food-web dynamics in species poor Island lakes different from those in the more species rich mainland lakes?

NICOLAS VIDAL, S. L. AMSINCK, V. GONÇALVES, J.M.N. AZEVEDO, L.S. JOHANSSON, K.S. CHRISTOFFERSEN, TORBEN L. LAURIDSEN ET AL.



Vidal, N., S.L. Amsinck, V. Gonçalves, J.M.N. Azevedo, L.S. Johansson, K.S. Christoffersen, T.L. Lauridsen, M. Søndergaard, R. Bjerring, F. Landkildehus, K.P. Brodersen, M. Meerhoff & E. Jeppesen 2016. Are the food-web dynamics in species poor Island lakes different from those in the more species rich mainland lakes?. Pp. 299-300 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores, Faroe Islands; *Taxa*: fish, macro-invertebrates, zooplankton; *Other*: food webs, climate, insular lakes, space-for-time substitution.

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Space-for-time substitution studies (SFTS, e.g. latitudinal gradient analyses) are often used to unravel climate effects on lake biota, and have shown a reduction in size, changes in diet and more frequent reproduction of fish in warmer climates, with stronger cascading effects such as lower zooplankton and higher phytoplankton biomasses. SFTS results from continental lakes are, however, potentially confounded by biogeographical and evolutionary differences leading to often higher species richness in warm lakes. To reduce these confounding effects, we studied species-poor lakes located in two remote island groups with contrasting climates but similar seasonality: The Faroe Islands (cold;  $6.5 \pm 2.8^\circ\text{C}$ ) and the Azores (warm;  $17.3 \pm 2.9^\circ\text{C}$ ). We analysed community and food web structure using a stable isotopes approach investigating fish, macro-invertebrates, and zooplankton in 20 lakes. We found a 1) smaller mean body size of fish in the Azorean warmer lakes 2) a higher predation

pressure on zooplankton and consequently higher phytoplankton abundance at the same nutrient levels, 3) a less wider carbon range for basal organisms and for the whole food web appeared. These patterns are similar to findings in more species rich continental systems. In contrast to continental fresh waters, however, Layman metrics of the fish food web were similar in the two climatic regions despite differences in basal organisms. Our results from insular systems suggest that temperature generally differences drive the changes in fish size structure with consequent cascading effects in the lake ecosystems.

## Islands within islands: The Azorean lakes

ANA C. COSTA, V. GONÇALVES & P. M. RAPOSEIRO



Costa, A.C., Vítor Gonçalves & Pedro M. Raposeiro 2016. Islands within islands: The Azorean lakes. Pp. 301 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: freshwater macroinvertebrates; *Other*: lakes, macroinvertebrates, biogeography, environmental factors, land use.

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In the Azores, lakes are a conspicuous landscape feature occurring across a wide gradient of biological, climatic and anthropogenic conditions, from the heavily human-impacted to the relatively pristine ones. Twenty of these split among from 4 of the 9 islands archipelago have been regularly sampled from 2005 to 2012 as part of the regional freshwater monitoring program within the WFD framework. Macroinvertebrates component of the biota was used as a surrogate to illustrate how the environmental factors influence the composition patterns of these lentic communities. The lakes examined in this study exhibit a wide range of physical and chemical properties, reflecting the islands spread along a large geographical area. They constitute an ideal set to test hypotheses about the individual and combined effects of island biogeography and its interplay with regional and local scale filters to shape the composition and distribution of freshwater assemblages. Results show that the highest diversity of lake macroinvertebrates was observed in São Miguel, the largest island of the archipelago where more diverse and large lakes are also found. PERMANOVA, a permutational multivariate analysis of variance, indicated significant differences in macroinvertebrate assemblages between islands and lakes within them, but not between sampling seasons. Main variables that account for such differences were assessed by CCA analysis and Interactive Forward selection to be in both cases, geographic ones (e.g. latitude and longitude) and local ones (e.g. water conductivity and watershed land use - percentage of agriculture). The later method strengthens the importance of the biogeographic filters in the observed differences among assemblages composition, and the contribution of hydrological factors and those related to land use. These results agree with those observed in the archipelago streams but also have important implications in data analysis for monitoring purposes.

## Cyanotoxins in Azorean lakes: Introducing molecular methods for the awareness of production potential

RITA I.P. CORDEIRO, R. LUZ, V. SILVA, D. M. PACHECO, V. GONÇALVES & A. FONSECA



Cordeiro, R.I.P., R. Luz, V. Silva, D.M. Pacheco, V. Gonçalves & A. Fonseca 2016. Cyanotoxins in Azorean lakes: Introducing molecular methods for the awareness of production potential. Pp. 302 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Azores; *Taxa*: Cyanobacteria; *Other*: cyanotoxins, cyanobacteria, PCR, public health.

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Cyanotoxins are secondary metabolites produced by cyanobacteria, such as microcystins and saxitoxins. These toxins are harmful to environmental and public health and have been responsible for the poisoning of animals and humans who ingest or come into contact with toxic blooms. Surveillance of the aquatic ecosystems is therefore obligatory, and methods to achieve such require a prompt answer regarding the cyanotoxins that are being produced. Although cyanobacteria blooms of several species are frequent in Azorean lakes, only microcystins are being monitored by chemical methods, for which positive results with high concentrations were found in several lakes. Unlike chemical methods, molecular methods are able to identify the presence of cyanotoxin before its production, allowing the early warning of its toxicological potential. In this work we used molecular techniques to detect cyanotoxin producing-genes in Azorean lakes and its applicability as an initial screening in the water quality surveillance. Samples from 15 lakes have been collected in order to assess the presence of cyanobacteria (phycocyanin producing-gene: PC-IGS) and the cyanotoxin producing-genes: *sxtA* for saxitoxin, *anaC* for anatoxin-a, *mcyA*, *mcyB*, *mcyC*, *mcyD*, *mcyE* and *mcyG* for microcystin and *pks* and *ps* for cylindrospermopsin. Isolated species from these lakes were used in order to determine the producing species and create positive controls. The PC-IGS gene was identified in 27 of the 79 samples (34,2%). Regarding cyanotoxin producing-genes microcystin (13,9%) and saxitoxin (10,1%) were the most frequent. Although less frequent, the *anaC* gene was also detected in 3,8% of the samples. These results show the risk for cyanotoxin production in Azorean lakes not only for microcystins but also for other cyanotoxins that presently are not monitored. Therefore, the introduction of molecular methodologies in the Azorean monitoring program for microcystin, saxitoxin and anatoxin-a and the implementation of a warning system for public health is recommended.

## Effects of prolonged drought on rainforest streams in the Luquillo Mountains, Puerto Rico

ALAN P. COVICH, T. A. CROWL & O. PEREZ-REYES



Covich, A.P., T.A. Crowl & O. Perez-Reyes 2016. Effects of prolonged drought on rainforest streams in the Luquillo Mountains, Puerto Rico. Pp. 303 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Caribbean, Neotropics; *Taxa*: freshwater decapods; *Other*: connectivity, predation, waterfalls, upstream-downstream migrations.

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The range of abiotic conditions of tropical inlands ranges from very warm lowlands to cold, seasonally snow-covered, high-elevation streams on volcanic islands, such as on the "Big Island" of Hawaii. Because most islands have relatively small drainage basins, the connectivity among headwater and downstream habitats is increasingly threatened by prolonged drought. Although some regions routinely have major differences in precipitation, those drainage networks in non-seasonal Caribbean catchments are especially vulnerable to more frequent and extensive drought. Regional impacts of droughts have already begun to increase in some Caribbean streams. Studies on the effects of two historic droughts in 1994 and 2015 in Puerto Rico documented a series of changes including a pulse of increased inputs of riparian forest leaf litter, lower dissolved oxygen, and warmer, slower moving water. Headwater habitats became isolated and previous patterns of upstream migrations by freshwater palaemonid shrimps (*Macrobrachium carcinus*, *M. crenulatum*) shifted apparently in response to increased densities of these large predatory shrimps in pools. These species and other migratory species have an amphidromous cycle of reproduction where adults live in freshwater and their larvae drift down-stream to estuaries before the post larvae (that require various level of salinity) can complete their development and their later migration upstream to grow and reproduce as adults. Comparisons with potential drought impacts on other streams throughout the tropics suggest that there will be similar effects on decreased connectivity among migratory pathways used by the dominant species of shrimps and fishes. The onset of drought also leads to concerns about limited water supplies for urban areas that can stimulate dam building and development of storage reservoirs. Often these structures do not included functional by-pass facilities leading to even more long-lasting disruption of migratory pathways and loss of ecosystem services provided by the native freshwater biodiversity.

## Environmental drivers of change in macroinvertebrate assemblages on isolated oceanic island streams: Madeira Island as case study

JULIE-CAMILLE RIVA, V. GONÇALVES, A. C. COSTA, S. J. HUGHES & P. M. RAPOSEIRO



Riva, J.-C., V. Gonçalves, A.C. Costa, S.J. Hughes & P.M. Raposeiro 2016. Environmental drivers of change in macroinvertebrate assemblages on isolated oceanic island streams: Madeira island as case study. Pp. 304 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Madeira Island; *Taxa*: freshwater macroinvertebrates; *Other*: land use change, stream, macroinvertebrates, endemic taxa.

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Freshwater systems on the volcanic oceanic islands of Macaronesia and the macroinvertebrate communities that occupy them differ strongly from mainland systems. This is a result of their geological origin, relatively small size, catchment morphology and distance from potential sources of colonization. The spatial distribution patterns of benthic macroinvertebrate assemblages were assessed from collections made at 40 sites on isolated oceanic island streams of Madeira Island. Cluster analysis using SIMPROF revealed a significant multivariate structure among samples and identified six distinct groups (e.g. reference, agriculture and urban). Distance-based multivariate linear models and partial redundancy analysis identified electric conductivity, ammonium, shading and substrate variables as principal environmental factors driving change in macroinvertebrate assemblages along spatial gradients. The results of this study provide support for current and future stream ecosystem research and baseline information for developing integrated freshwater management strategies for streams on the Madeira archipelago.

## Stream biota in remote oceanic islands: The role of local, regional and geographical factors in structuring diatom and macroinvertebrate communities

VÍTOR GONÇALVES, P. M. RAPOSEIRO, H. S. MARQUES & A. C. COSTA



Gonçalves, V., P.M. Raposeiro, H.S. Marques & A.C. Costa 2016. Stream biota in remote oceanic islands: the role of local, regional and geographical factors in structuring diatom and macroinvertebrate communities. Pp. 305 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: diatoms and macroinvertebrates; *Other*: oceanic islands; streams; diatoms; macroinvertebrates; driving factors; geographic, regional and local filters.

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Freshwater systems on the volcanic oceanic islands of Macaronesia and the biological communities that occupy them differ strongly from European mainland systems. This is a result of their geological origin, relatively small size, catchment morphology and distance from potential sources of colonization. In these islands, the identification of higher scale geographical processes (e.g., island location) that shape regional (catchment and landscape patterns) and local factors (e.g., water quality, microhabitat) is particularly important to a correct understanding of biota distribution. To assess the contribution of these processes in the composition of diatom and macroinvertebra assemblages in insular permanent streams 37 sites in 14 streams across the Azores archipelago were studied and related to environmental variables. Ordination techniques were used to identify the forcing factors that best explain the composition of diatom and macroinvertebrate assemblages. Both for diatoms and macroinvertebrates, variance explained by local factors dominated over the regional and geographic fractions. This result supports the notion that insular stream ecosystems and their communities are under strong abiotic control, as well as their continental counterparts. However, these communities, especially macroinvertebrates, shown significant differences in distribution among islands. While diatom assemblages respond more to local factors along the longitudinal stream gradient (from natural or anthropogenic origin), macroinvertebrate assemblages have significant differences between islands (related to latitude and island age complex) but do not respond to stream longitudinal gradient. The results of this study provide support for current and future stream ecosystem research and baseline information for developing integrated freshwater management strategies for streams on the Azorean archipelago.



## Leaf litter decomposition in Atlantic islands is driven by microbes and depends on litter quality and environmental conditions

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Ferreira, V., P.M. Raposeiro, A. Pereira, A.M. Cruz, A.C. Costa, M.A.S. Graça & V. Gonçalves 2016. Leaf litter decomposition in Atlantic islands is driven by microbes and depends on litter quality and environmental conditions. Pp. 306-307 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: São Miguel Island, Azores; *Taxa*: aquatic hyphomycetes and macroinvertebrates; *Other*: aquatic macroinvertebrates, dissolved nutrients, litter decomposition, litter quality, water temperature.

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Leaf litter decomposition is an important process in many streams. The flow of carbon and nutrients to higher trophic levels generally depends on litter characteristics and environmental conditions, and is mediated by the activities of detritivores and microbes. However, little is known about what drives litter decomposition in Atlantic islands, where invertebrate communities are species-poor. In this study we assessed the relative importance of litter quality (by using three leaf litter species with distinct chemical composition: *Acacia melanoxylon*, *Clethra arborea*, and *Pittosporum undulatum*) and environmental conditions (by using six Azorean streams over a gradient of nutrient concentration and temperature) on mass loss of litter exposed to and protected from macroinvertebrates (by using coarse and fine mesh bags, respectively). No significant differences in litter decomposition rates were found between coarse and fine mesh bags suggesting that in these streams microbes are the key players in litter decomposition. Litter decomposition rates were in the order *A. melanoxylon* < *C. arborea* < *P. undulatum* and were negatively related with initial lignin concentration. Litter decomposition rates differed among streams. There was a hump-shaped relationship between decomposition rates and nitrate concentration and a U-shaped relationship between decomposition rates and water temperature. These relationships are explained by the limitation of the potentially stimulatory effect of the highest nitrate concentration on microbial activity by low temperature and a stimulation of microbial activity at the lowest temperature by high nitrate concentration, respectively. Nutrient availability and water temperature thus interact to determine litter decomposition, which can have implication for stream management under environmental change.

## Allometric relationships, feeding preferences, growth and survival of the endemic stream shredder *Limnephilus atlanticus* (Trichoptera, Limnephilidae)

ANA BALIBREA, V. GONÇALVES, V. FERREIRA & P.M. RAPOSEIRO



Balibrea, A., V. Gonçalves, V. Ferreira & P.M. Raposeiro 2016. Allometric relationships, feeding preferences, growth and survival of the endemic stream shredder *Limnephilus atlanticus* (Trichoptera, Limnephilidae). Pp. 307 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: *Limnephilus atlanticus* (Trichoptera, Limnephilidae); *Other*: shredder, stream, allometric relationships, feeding preferences.

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Oceanic freshwater communities tend to be species poor but rich in endemism due to their physical isolation. The ecology of endemic freshwater species is, however, poorly known. This study assessed allometric relationships, feeding preferences, growth and survival of larvae of the endemic stream shredder *Limnephilus atlanticus* (Trichoptera, Limnephilidae) exposed to leaves of native (*Ilex perado* and *Morella faya*) and exotic (*Alnus glutinosa* and *Clethra arborea*) tree species in laboratory trials. All regression models used to estimate *L. atlanticus* dry mass from body and case dimensions and wet mass were significant. *L. atlanticus* consumed all the four leaf species offered, but when given a choice, shredders significantly preferred *A. glutinosa* over the other three leaf species. Relative larval growth rate was significantly higher when *L. atlanticus* fed on *A. glutinosa* and *I. perado* leaves in comparison with the other leaf species. Survival of 95% was found when individuals fed on *A. glutinosa* leaves while it decreased to 75% when they fed on the other leaf species. Our results suggest that *L. atlanticus* acts as an active shredder and that it exhibits the same basic patterns of food exploitation as its continental counterparts.

## Network analysis of tropical drainage basins: Habitat connectivity among migrating species

ALAN P. COVICH, T A. CROWL & O. PEREZ-REYES



Covich, A.P., T.A. Crowl & O. Perez-Reyes 2016. Network analysis of tropical drainage basins: Habitat connectivity among migrating species. Pp. 308 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Caribbean, Neotropics; *Taxa*: freshwater decapods; *Other*: connectivity, drought, waterfalls, upstream-downstream migrations.

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The widespread use of the River Continuum Concept for analysis of connections among different types of functional feeding groups includes some research on tropical rivers. However, this concept focuses on channel width as a predictor of how the major sources of energy shift from inputs of riparian leaf litter to inputs of solar energy. This switch from food webs dominated by detritivores to other downstream food webs dominated by herbivores and predators does often occur. However, recent studies indicate that this compartmentalization along a river continuum does not account for some species using algae as an important energy sources even in the shaded, upstream headwaters. Additional complexity exists that requires considerations of other geomorphological parameters beyond channel width. Longitudinal connectivity that influences species mobility and migratory pathways can alter species' use of different sources of energy. The number and locations of waterfalls, various outcrops of large boulders and other constrictions slow or completely limit the movements of many dominant species of fishes. Moreover, during prolonged drought, access is limited to numerous types of headwater habitats that are distributed widely within reticulate drainage networks. Lateral connectivity of the main channel with adjacent habitats is another important component that influences movement. Different lengths and complexities of migratory pathways occur in headwaters of streams in the Luquillo Experimental Forest, Puerto Rico. Some species of freshwater shrimp move long distances from coastal zones to more than 800 m in altitude while other species occupy lower coastal zone habitats. Determining the importance of the geomorphic template in restricting patterns of movement requires long-term studies of variable discharge because some "barriers" during periods of low flows are inundated during high flows; floods allow species to migrate along river banks. Comparative studies under different climate regimes are necessary to determine which species will likely continue to retain access to headwater habitats.

## Specialized Symposium 1

### (Ec2) Functional diversity on islands: Challenges and opportunities for future research

CHAIRS: FRANÇOIS RIGAL & PEDRO CARDOSO

## Functional diversity on islands: Challenges and opportunities for future research

FRANÇOIS RIGAL, J.C. CARVALHO & P. CARDOSO



Rigal, F., J.C. Carvalho & P. Cardoso. 2016. Functional diversity on islands: Challenges and opportunities for future research. Pp. 310 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: assembly rules, functional diversity, functional traits, island biogeography.

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Functional Diversity (FD) has recently emerged as an aspect of crucial importance in understanding community structure and ecosystem processes. FD-based approaches are now widely applied in community ecology, biogeography and conservation biology. Yet, FD has been largely overlooked in island research. Few formal tests have been carried out to study how FD covaries with classic island features such as area, elevation and isolation and, as a consequence, a comprehensive framework for island ecosystems integrating FD has not been yet explicitly formulated. All features that make islands model systems for studies of biogeographical patterns (distinct boundaries, simplified communities, varying ages) should also prevail for FD, making islands appropriate testing ground for trait-based research in general. We therefore advocate the need to extend our current research on islands to approaches incorporating functional diversity to further explore the ecological and evolutionary processes structuring communities on islands and elsewhere. This introductory talk will be an opportunity to summarize current research on FD for islands and to identify future research lines.

## Global patterns of functional diversity and assemblage structure of island parasitoid faunas

ANA M.C. SANTOS, M.V. CIANCARUSO & P. DE MARCO JR.



Santos, A.M.C., M.V. Cianciaruso & P. Marco Jr. 2016. Global patterns of functional diversity and assemblage structure of island parasitoid faunas. Pp. 311 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: Braconidae (Hymenoptera); *Other*: community assembly, habitat filters, hosts, island biogeography, species traits.

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The processes leading to the assembly of ecological communities can determine their functional structure. We assess the influence of biogeographical correlates associated with species diversity gradients on the global patterns of functional diversity of island parasitoid assemblages (Hymenoptera, Braconidae). We also evaluate whether island assemblages present a non-random functional structure. Traits related to morphology, attack strategy and development were used to measure functional diversity and determine the level of departure from randomness on trait diversity between islands and their corresponding species pool, through null models. We used generalized and partial regressions to determine the influence of different predictors (climate, regional and local island characteristics) on the functional diversity of island assemblages, comparing results with those obtained for species richness. We also evaluated whether any of the predictors or particular species traits were related to the patterns obtained when comparing island assemblages with null models. Our results indicate that most of the geographical variation in functional diversity was not explained by the predictors evaluated, while for species richness these explained over 70% of spatial variation. The abiotic characteristics of islands with functionally clustered parasitoid biotas (c. 40% of all islands) did not differ from those of other islands. Comparisons between functionally clustered assemblages and those expected randomly from the species pool indicated a higher percentage of that the former included proportionally fewer ectoparasitoid and idiobiont species, which attack fewer host orders and prefer the egg and larval stages of their hosts. To conclude, we show that the predictors correlated with functional diversity differ from those driving species richness patterns. We argue that biotic filters associated with the structure of the host communities may be important determinants of the assembly of many island parasitoid faunas, leading to assemblages dominated by species presenting particular ranges of trait values that differ from those in their pool of potential colonists.

## Functional island biogeography: Evaluating functional diversity patterns in fragmented landscapes

THOMAS J. MATTHEWS & R. J. WHITTAKER



Matthews, T.J. & R.J. Whittaker 2016. Functional island biogeography: evaluating functional diversity patterns in fragmented landscapes. Pp. 312 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: fragmentation, habitat islands, nestedness, species–area relationships, functional diversity, functional nestedness.

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The widespread fragmentation of natural habitats around the world creates a strong incentive to understand how ecological communities respond to such pressures. Habitat island biogeographical analyses of species incidence, nestedness and diversity have traditionally focused on species as the unit of analysis. Recent developments have allowed researchers to focus on functional diversity (FD) through analysis of species traits. However, global analyses of FD patterns in habitat islands are lacking. Here we examine FD patterns in forest fragments at a variety of different spatial scales and ecological contexts. We use a recently published functional nestedness metric in combination with 18 bird-habitat island datasets to show that many bird-habitat island communities are significantly functionally nested, although we discuss how our results were sensitive to the null model used. In addition, we examine a) the scaling of functional diversity with island area, both in terrestrial habitat islands and forest fragments within the Azorean archipelago, and b) the role of individual isolated trees in maintaining functional diversity in fragmented landscapes. Through these analyses we highlight the benefits of testing for ordered patterns of functional diversity in habitat island biogeography.



## Functional diversity and composition of bryophyte communities along an elevational gradient in Terceira Island, Azores

DÉBORA S.G. HENRIQUES, F. RIGAL, P.A.V. BORGES & R. GABRIEL



Henriques, D.S.G., F. Rigal, P.A.V. Borges & R. Gabriel 2016. Functional diversity and composition of bryophyte communities along an elevational gradient in Terceira Island, Azores. Pp. 313 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Terceira Island, Azores; *Taxa*: bryophytes; *Other*: beta diversity, liverworts, mosses, richness differences, traits, turnover.

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Spatial variation in abiotic variables along elevational gradients is known to influence plant functional traits related with performance, such as size or life form. For bryophytes, which are a group of ectohydric plants relying strongly on water and nutrient transport along their external surface, theory predicts that plant fitness should be strongly linked to desiccation avoidance and tolerance under conditions of water deficit. In this context, we investigate whether functional trait diversity and composition of water-related traits in Terceira Island's bryophytes relates to changes in elevation. Focusing on areas with a predominance of native vascular vegetation, we applied the standardized BRYOLAT sampling methodology to an elevational transect in the island, with two plots set up at 200 m elevational intervals from sea level to the island's summit. As a result, 94 bryophyte species were sampled and identified on six different types of substrates. We then characterized functional diversity using data on 25 morphological traits present in the BRYOFILE database (a trait database we compiled for the Azorean bryoflora) that relate to water dynamics. These functional traits represent a key spectrum of bryophyte ecology and are expected to drive compositional changes across elevations. Specifically, we want to know if these changes are due to: a) functional beta turnover ( $FB_{repl.}$ ) reflecting a substitution of some species by others performing different functions or b) differences in functional beta richness ( $FB_{rich}$ ) reflecting a loss (or gain) of species and their functions with changing elevation. Our study underlines the need to identify processes responsible for changes in trait composition in bryophyte assemblages in order to better understand current drivers of bryophyte diversity as well as determine how communities and ecosystems might respond to global change in the future.

## Patterns and drivers of functional diversity of epiphytic liverworts communities along an elevational transect in La Réunion (Mascarenes)

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& O. FLORES



Ah-Peng, C., S. Meek, T.A.J. Hedderson, N. Wilding, D. Strasberg & O. Flores 2016. Patterns and drivers of functional diversity of epiphytic liverworts communities along an elevational transect in La Réunion (Mascarenes). Pp. 314 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: La Réunion; *Taxa*: bryophytes; *Other*: competition, environmental filtering, functional traits, oceanic islands.

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Analysing functional traits along environmental gradients can improve our understanding of the mechanisms involved in plant community assembly. Elevational gradients as major environmental gradients provide model systems to study the factors that generate and structure biodiversity. While community-level trait responses to environmental changes for vascular plants have been largely studied, functional diversity and the role of functional traits of bryophytes in ecosystem services and processes remain largely unexplored. In this study, we measured species abundance and the distribution of 12 morpho-anatomical functional traits of epiphytic liverworts along an elevational gradient (350-2750 m) on the oceanic island of La Réunion. We use functional diversity indices to investigate processes implied in community assembly. Namely, we relate both community weighted means (CWM) and variances (CWV) to elevation and climatic variables along the gradient. We compared the observed patterns to random expectations based on a null model of species abundance, which allows to separated processes such as environmental filtering, competition and stochastic assembly. Functional richness increased linearly with species richness with a peak at mid elevations (cloud forest). We found 4 different patterns of CWM with elevation, different from random distribution for ten traits, with higher trait diversity than expected by chance. Vapour pressure deficit seasonality was the most significant climatic driver of these patterns in liverwort traits. Depending on the traits, CWV showed simultaneous divergence and filtering, indicating that different processes may co-occur to structure these liverwort communities. This work is embedded in a large- scale research program across tropical and subtropical islands (MOVECLIM) aiming at studying the different components of diversity (species richness, functional and phylogenetic diversity) to better understand the current and future distribution of bryophytes under a changing environment.

# Geological age and host polymorphism affect functional diversity and community composition in plant-insect interactions across a space-for-time chronosequence on the Hawaiian Islands

ELSKE K. TIELENS & D. S. GRUNER



Tielens, E.K. & D.S. Gruner 2016. Geological age and host polymorphism affect functional diversity and community composition in plant-insect interactions across a space-for-time chronosequence on the Hawaiian Islands. Pp. 315 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hawaii; *Taxa*: arboreal arthropods; *Other*: functional diversity, plant-insect interactions, species traits, arboreal arthropods.

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Oceanic islands have long been considered conducive places to examine biodiversity. Speciation and single island endemism frequently results in high species turnover between islands in an archipelago, despite similarity of habitats. Examining functional diversity and traits instead of taxonomic identity can be more insightful to examine biodiversity and shifts in community composition. To address turnover in functional diversity with increasing species richness and community succession, we study arthropod communities across a space for time chronosequence. We sampled arboreal arthropod communities in mesic forests across a chronosequence on the Hawaiian Islands spanning from historic to Pleistocene substrate age. Native mesic forests are dominated across geological age by a highly polymorphic tree species *Metrosideros polymorpha*, allowing us to compare arboreal phytophagous insect communities and plant-insect interactions across substrate age and community development. We make use of recent advances in model-based methods for analysis of multivariate abundance data to analyze the community composition and identify traits that drive species variation in environmental response. We perform this analysis both at the level of forest architecture and individual host plant traits. Preliminary results indicate that species richness and abundances peaks at intermediate age high productivity plots. Evenness and species turnover between trees on similar substrate ages was lowest at intermediate aged substrates, indicating that these forests may be dominated by a small number of species. Functional diversity is hypothesized to increase with forest structure as a function of substrate age, and peak early. Further, Hemiptera abundance and species composition is strongly associated with *M. polymorpha* morphotype. We predict that variation in polymorphic host plant traits across substrate age will drive shifts in species composition based on insect feeding traits. This will shed light on the stability of phytophagous insect communities across substrate age and polymorphic hosts on the Hawaiian Islands.

Island Biology 2016  
2nd International Conference on Island Evolution, Ecology and Conservation

## Specialized Symposium 16

### (Ec3) Network approaches to island biology

CHAIRS: ANNA TRAVESET, RÚBEN H. HELENO & MANUEL NOGALES

## Spatiotemporal stability of island endemic plant-pollinator interactions

JEFF OLLERTON



Ollerton, J. 2016. Spatiotemporal stability of island endemic plant-pollinator interactions. Pp. 317 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Tenerife, Canary Islands; *Taxa*: *Erysimum scoparium*, *Anthophora alluaudi*; *Other*: pollination, bees, Brassicaceae, endemism, mutualism, interactions.

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Endemic oceanic island plant-pollinator relationships have generated particular interest because there is a theoretical mismatch in the expectations of the outcomes of dispersal and establishment of biotically pollinated plants to islands. The ancestors of endemic plants should, in theory, be more likely to establish on an island if they are generalists capable being pollinated by a wide range of taxa. At the same time, island pollinator faunas tend to be of rather low diversity and abundance, and plant reproduction is often pollinator limited, making pollination niche segregation more likely via specialisation on a single pollinator or functional group of pollinators. The relative importance of specialist versus generalist strategies for biotic pollination are therefore unclear for island plants. At the moment, however, too few detailed studies of oceanic island plant-pollinator interactions have been conducted to properly assess the generality of any patterns and further case studies are required, particularly over a longer time scales and across multiple populations to assess spatiotemporal variation in the interactions between plants and their pollinators. Since 2003 I have been studying the pollination ecology of a Canary Island endemic plant species, the Canary Wallflower *Erysimum scoparium* (Brassicaceae), on Tenerife. *E. scoparium* employs a flower colour change strategy to manipulate its principal pollinators, which comprise a guild of medium sized bees, dominated by an endemic solitary bee *Anthophora alluaudi* (Apidae). The interaction between *E. scoparium* and *A. alluaudi* is stable over that time period and in multiple populations over an altitudinal range of almost 1000 m (range = 1300 to 2250 m.a.s.l). The period of study includes one of the driest winters recorded on Tenerife and I discuss the effect of changes in community composition on the ecology of this endemic plant-pollinator interaction, and the reproductive success of the plant.

## Spatiotemporal variation in pollinator species and functional diversity influences the structure of pollination networks in Japanese islands

ATUSHI USHIMARU & M. K. HIRAIWA



Ushimaru, A. & Masayoshi K. Hiraiwa 2016. Spatiotemporal variation in pollinator species and functional diversity influences the structure of pollination networks in Japanese islands. Pp. 318 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Honshu and Izu islands, Japan; *Taxa*: plants, Flowering plants and insects (pollinators); *Other*: continental and oceanic islands, functional diversity, plant-pollinator networks, species richness.

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Compared to mainlands and continental islands, oceanic islands generally have lower species richness (SR) of pollinators. In such species-poor island systems, reduced competition for floral resource is considered to promote high generalization of some pollinators. This hypothetical relationship between low pollinator richness and highly generalized network structure in oceanic islands had been supported in many papers by examining several network parameters, such as connectance, interaction diversity, nestedness and modularity. Oceanic islands are also known to lack larger pollinators with long proboscis (e.g., bumble bees and swallow-tailed butterflies). Long-tongued pollinators are often more specialized and competitive than others, lack or low density of the functional group (i.e. low functional diversity, FD) can increase generalization levels in oceanic networks. In the study, we test the relative importance of SR and FD of pollinators in structuring highly generalized networks of oceanic islands by examining the relationships of SR and FD with network parameters. We surveyed plant-pollinator networks in three sites in the continental island and in a single site for each of five oceanic islands for five times per year. SR and FD of pollinators were lower in oceanic islands than in continental islands and varied seasonally in each site. We found that SR had significant relationships with several network parameters but FD did not. Generalization level increased with decreasing SR, supporting the previous hypothesis and findings. Although FD was not correlated with any of the network parameters, it did influence a functional aspect of plant-pollinator networks. We discuss our results to understand characteristics of pollination networks in oceanic islands.

## Non-modular systems, dissimilarity and homogenization in Azorean pollinator communities

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Picanço, A., F. Rigal, T.J. Matthews, P. Cardoso, J.M. Olesen & P.A.V.Borges 2016. Non-modular systems, dissimilarity and homogenization in Azorean pollinator communities. Pp. 319 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Terceira Island, Azores; *Taxa*: Coleoptera, Diptera, Hymenoptera; Lepidoptera; *Other*: pollinator insects, island, nestedness, modularity, species abundance distribution (SADs).

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Understanding the impact of land-use intensification on island pollination networks and its structure pattern allows us to characterize community's dynamics and stability. The two most common and known network structures are nestedness and modularity. Here we discuss this subject by examining the distribution, abundance, richness and composition of the different floral visiting insects and investigate the structural organization of their respective networks, through five habitat types on Terceira Island. We found that the indigenous flower-visiting insects are dominant both in abundance and species richness across the entire range of habitat disturbance, being the native forest, as expected a favourable habitat. The high composition dissimilarity is between the native forest and intensively managed pasture. Beta diversity between native forest and the other habitats is mostly due to richness differences with a minor contribution of true turnover. Furthermore, these contrasting differences on insect species composition are highly correlated to the host plant species composition. In terms of abundance, the SAD patterns analysed through the habitats follow the same Poisson log normal model, where there are very few truly common regional flower-visiting species, with prevalence of species of intermediate abundance, being the rarest species mostly pseudo-rare. Concerning the flower-visiting network structures, they are basically very small nested networks and non-significantly modular, for which we have hypothesized the abundance as a major driver for the nestedness of the networks and not the evolution, which is expectable from a young and small oceanic island. Moreover, when gathering all habitat networks in one matrix, there's no evidence of modularity, suggesting that the habitat differences have not been able to make highly linked assemblies. In conclusion, our results reveal a homogeneous landscape in species and links, with small nested networks driven by the abundance.



## Habitat restoration improves functional resilience of plant-pollinator communities

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Kaiser-Bunbury, C.N., A.E. Whittington, J. Mougál, T. Valentin, R. Gabriel, J.M. Olesen & N. Blüthgen 2016. Habitat restoration improves functional resilience of plant-pollinator communities. Pp. 320 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Seychelles; *Taxa*: Plants and pollinators; *Other*: biodiversity conservation, ecological restoration, inselbergs, interaction networks, Western Indian Ocean.

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Habitat restoration is a common tool to mitigate the loss of species and habitats, aiming to restore ecosystem functioning. Large-scale experimental evidence is lacking, however, on whether standard management techniques indeed restore ecosystem functioning at the community level. One key ecosystem function is pollination. We used an experimental network approach to test two main hypotheses: 1) habitat restoration increases the robustness of plant-pollinator networks by increasing pollinator diversity and altering pollinator behaviour; and 2) the observed structural changes in the networks enhance the functional performance of pollinators and overall plant reproductive performance. We collected 64 monthly pollination networks from four restored and four unrestored woody plant communities (each 1-2 ha) on the island of Mahé, Seychelles, over a full flowering season of eight consecutive months. Habitat restoration resulted in a prompt and marked increase in pollinator and interaction diversity. Changes in network structure indicate improved plant-pollinator community robustness in restored compared to unrestored sites. These patterns had direct and positive effects on the functional performance of pollinator and total fruit production of native plants in restored sites. The main implications of our findings are: 1) Habitat restoration affects pollinators positively by changing their foraging behaviour, suggesting that degraded pollination processes are at least partly reversible; 2) Pollination network structure is directly related to the quality and robustness of pollination services; and 3) Increased relative and total fruit production in restored plant communities are encouraging indicators for a successful restoration trajectory towards self-sustaining native plant communities.

## The dispersal of native and exotic seeds by São Tomé forest birds

ANA P. COELHO, J. M. PALMEIRIM, R.H. HELENO & R. F. DE LIMA



Coelho, A.P., J.M. Palmeirim, R.H. Heleno & R.F. Lima 2016. The dispersal of native and exotic seeds by São Tomé forest birds. Pp. 321 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: São Tomé Island, São Tomé and Príncipe, central Africa; *Taxa*: birds, plants; *Other*: community ecology, networks, invasion, tropical montane forest, endemics, conservation.

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The island of São Tomé, in the Gulf of Guinea, is a biodiversity hotspot with a remarkable number of endemic species. While introduced species are generally perceived as a major threat to the conservation of native biota, their exact impacts on key ecosystem functions remain poorly understood. Animal-mediated seed dispersal, is one such functions, which is critical for vegetation dynamics. During three months we quantified the seeds found in the droppings of mist-netted birds in the Obô Natural Park to explore how avian seed dispersal might affect the future of São Tomé forests. We captured 15 bird species, all of which endemic, but only five were dispersing intact seeds, with the São Tomé speirops, *Speirops lugubris* being responsible for nearly 90 % of the recorded interactions. Over 6000 seeds of nearly 50 plant species were retrieved from the droppings. The most frequent seeds belonged to the native *Psydrax subcordata* and to the introduced roseleaf bramble, *Rubus rosifolius*. Our preliminary results suggest that in São Tomé, birds play a double role, likely facilitating the dispersal of introduced species and also the recolonization of degraded areas by native flora. These results pose a curious and difficult dilemma, since birds are simultaneously contributing to forest regeneration and invasion. This study provides a first assessment of the role of species interactions in maintaining ecosystem diversity and function in São Tomé.

## Frugivory networks of nonnative birds across Hawaiian forest communities

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Hruska, A., J.P. Kelley, J.M. Gleditsch, C.E. Tarwater, J.T. Foster, J.H. Sperry & D.R. Drake 2016. Frugivory networks of nonnative birds across Hawaiian forest communities. Pp. 322 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: O'ahu, Hawaii; *Taxa*: *Leiothrix lutea*, *Zosterops japonicus*, *Pycnonotus jocosus*, *Clidemia hirta*, *Schinus terebinthifolius*, *Pipturus albidus*; *Other*: novel ecosystems, seed dispersal.

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The Hawaiian Islands are renowned for their unique fauna and flora. Since human colonization, the islands have become imperiled by both the extinction of native species and invasion by nonnative species. On the island of O'ahu, most forests are dominated by nonnative flora, but native diversity increases with elevation. Many native Hawaiian flowering plants in these forests produce fleshy, bird-adapted fruits; however, the avifauna on O'ahu is dominated by nonnatives. A lack of native seed dispersers could limit the ability of native plants to disperse to sites suitable for regeneration. Our main objectives were to determine which nonnative birds are primarily frugivorous, which species of plants are most frequently eaten, and how diets vary by site. Fecal samples were collected across a variety of forest types on O'ahu, varying in elevation, precipitation, and forest diversity, to produce diet networks for nonnative birds. Red-billed Leiothrixes (*Leiothrix lutea*), Japanese White-eyes (*Zosterops japonicus*), and Red-whiskered bulbuls (*Pycnonotus jocosus*) were the most common frugivorous birds captured. Nonnative seeds, such as *Clidemia hirta* and *Schinus terebinthifolius*, were most frequently found in fecal samples. *Pipturus albidus*, a common native species, was also found in fecal samples from sites with high native diversity. Seeds most frequently found in fecal samples represent both some of the most common invasives and natives in O'ahu forests, suggesting that nonnative avian frugivores may be selecting fruits based on abundance. Our work represents the first documented insight into the role nonnative frugivores may have across a range of mixed native and nonnative plant communities in Hawai'i and suggests that the dispersal potential of native plants may be dependent on the abundance of reproductive individuals at a given site.

## Using the intact seed dispersal network of Aldabra Atoll as a baseline for the conservation of interactions in the Western Indian Ocean

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Falcón, W., C.N. Kaiser-Bunbury, N. Bunbury & D.M. Hansen 2016. Using the intact seed dispersal network of Aldabra Atoll as a baseline for the conservation of interactions in the Western Indian Ocean. Pp. 323 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Aldabra Atoll & Rodrigues, Western Indian Ocean; *Taxa*: frugivores and fleshy-fruited plants; *Other*: seed dispersal networks, Rodrigues, giant tortoises, conservation, rewilding.

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Recent studies have highlighted the importance of mutualistic interactions in shaping biodiversity, and have prompted calls to focus on the conservation of the network structure of species interactions. However, it remains unclear which attributes of a network to focus on, and how to define a useful baseline for conservation. Animal-mediated seed dispersal is an important ecological function in many ecosystems, and the community-level complexity of these interactions are good examples of such species interaction networks. Here, we evaluate the virtually intact seed dispersal network (SDN) of Aldabra Atoll, and compare its structure to that of Rodrigues Island; both in the Western Indian Ocean. Aldabra is one of the few islands with an almost intact vertebrate fauna, comprising lizards, birds, fruit bats, and giant tortoises. In contrast, Rodrigues has experienced many anthropogenic changes, which led to the extinction of the majority of its frugivores, as well as several plant species. To construct a robust SDN of Aldabra, we employed three field methodologies to sample plant-frugivore interactions: observations, camera traps, and faecal analysis. In addition, we surveyed the literature on plant-frugivore interactions for both Aldabra and Rodrigues to construct their SDNs. We investigated structural parameters and identified potential drivers and hub species of the SDNs. The Aldabra SDN is nested, has a high connectivity, and modularity. Blue pigeons and giant tortoises are the two most central species in the Aldabra SDN, and thus, potential drivers of its structure. Closely related species of these two hub species have gone extinct on Rodrigues, and we discuss conservation implications for the functional resurrection of the Rodrigues SDN. We further discuss opportunities and pitfalls in constructing robust SDNs from field-data versus from literature-derived information about plant-frugivore interactions. Overall, the Aldabra SDN has a great potential as a baseline to inform conservation and rewilding efforts on Rodrigues and other highly degraded islands in the Western Indian Ocean.

## Predicting the consequences of disperser extinction in the Galapagos Islands: Richness matters the most when abundance is low

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& R. H. HELENO



Rumeu, B., M. Devoto, A. Traveset, J.M. Olesen, P. Vargas, M. Nogales & R.H. Heleno 2016. Predicting the consequences of disperser extinction in the Galapagos Islands: Richness matters the most when abundance is low. Pp. 324 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Galapagos Islands; *Taxa*: fleshy-fruited plants, birds, reptiles; *Other*: biodiversity loss, biotic homogenization, ecological networks, ecosystem function, Galapagos Islands, secondary extinctions.

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The ongoing biodiversity crisis entails the loss of species and their ecological services. Defaunation, in particular, might negatively affect the seed dispersal of fleshy-fruited species, with an especially strong impact in simplified communities on oceanic islands. We applied a network approach to simulate the independent effects of decreasing the abundance and richness of seed dispersers on the dispersal of Galapagos plants. We found that both abundance and richness affect the full functionality of seed dispersal and that richness becomes increasingly important as disperser abundance declines. Extinction simulations revealed that the order of species loss has profound implications on community dynamics. On one hand, abundant generalist dispersers, like the Galapagos lizards, can, to a large extent, mitigate the loss of specialized dispersers. On the other hand, specific threats affecting key-dispersers, such as the effect of introduced predators on lizards and the giant tortoise, can rapidly cause the collapse of the seed dispersal service.

## Frugivory and seed dispersal networks: Should we look for a more realistic interpretation of interaction outcomes? Insights from an island community

AARÓN GONZÁLEZ-CASTRO, M. NOGALES & A. TRAVESET



González-Castro, A., M. Nogales & A. Traveset 2016. Frugivory and seed dispersal networks: Should we look for a more realistic interpretation of interaction outcomes? Insights from an island community. Pp. 325 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Canary Islands; *Taxa*: Different fleshy-fruited plants from thermophilous scrubland and fruit-eating vertebrates (*Gallotia galloti*, *Sylvia atricapilla*, *S. melanocephala*, *Erithacus rubecula* and *Turdus merula*); *Other*: frugivory, mutualistic networks, oceanic islands, seed dispersal.

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Mutualistic interactions, such as that between plants and seed dispersers, are very important for biodiversity maintenance worldwide. Since more than 10 years ago, network approach has been widely used to understand the structure and functioning of mutualistic interactions in communities as a whole, rather than focusing on isolated interactions. It has allowed us to understand the role of ecological and evolutionary processes in determining the structure of mutualistic communities and to know how such a structure influences coevolution of interacting species and the community robustness against disturbances. However, most of frugivory and seed dispersal networks are built with interaction frequency data (i.e., number of fruit consumed or seeds dispersed). But, we do not know, with empirical data, if interaction frequency is a good estimation of the animal effect on a given plant or vice versa. In this study we built a plant-disperser network based on number of seeds dispersed (interaction frequency network) and calculated some network parameters (e.g., nestedness, connectance and interaction evenness) and some species level parameters (species strength and species dependence for each interaction). We also created two additional networks: one based on the seed dispersal effectiveness provided by animals and another based on the energy supplied by fruits (estimated as amount of lipids and sugars). We calculated the same network and species level parameters for these two networks. Some network level parameters did not change across networks, suggesting that the community behavior as a whole is independent of the approach used. However, other network parameters and all species level parameters, such as species strength, drastically changed from one network to another. It has important consequences for island biodiversity management policies because species that appear important under an interaction frequency-based approach could not be so under an interaction effectiveness-based approach, and vice versa.

## Specialized Symposium 14

### (Ec4) Polar Islands

CHAIRS: INGER GREVE ALSOS



## Biogeography, isolation and evolution in the peri-Antarctic islands

PETER CONVEY



Convey, P. 2016. Biogeography, isolation and evolution in the peri-Antarctic islands. Pp. 327 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Antarctica and Southern Ocean; *Taxa*: multiple; invertebrates, lower and flowering plants; *Other*: biodiversity, dispersal, isolation, endemism, conservation, human impacts.

*Peter Convey (e-mail: pcon@bas.ac.uk) British Antarctic Survey, Biodiversity Evolution and Adaptation Team, Cambridge, CB3 0ET, UK.*

The mid- to high latitudes of the Southern Ocean and fringes of the Antarctic continent host an often overlooked series of islands and archipelagos. They have features in common such as extreme geographical isolation and chronically cool to frigid environmental conditions. They also differ strikingly in their age and geological origins, and their historical and current levels of glaciation. Many of these islands are strongly influenced by the circumpolar westerly winds and the oceanic Antarctic Circumpolar Current, providing both oceanic and atmospheric connectivity. Their terrestrial biotas are unique, with an almost complete absence of native terrestrial vertebrates and, rather, invertebrate-dominated ecosystems. Biodiversity patterns are varied, including single island endemics, species/groups restricted to particular oceanic provinces and linked with the nearest larger landmasses, to more circum-Antarctic distributions. Wind or bird-assisted dispersal is strongly implicated in the latter, although few explicit data exist. Modern molecular phylogeographic approaches are starting to be applied to the sub-Antarctic biota, and there is already evidence for early colonisation by contemporary species as opportunity became available, including on multi-million year pre-Pleistocene timescales even on islands long thought to have undergone periods of complete glaciation. These patterns are today being compromised by human activity, through transfer of non-native species into the region, the frequency of this far outweighing natural colonisation events, and the intra-regional transfer of native biota between previously isolated areas.

## Resilience of high latitude island ecosystems

INGIBJÖRG S. JÓNSDÓTTIR



Jónsdóttir, I.S. 2016. Resilience of high latitude island ecosystems. Pp. 328 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Svalbard, Iceland; *Taxa*: plants; *Other*: Arctic, climate change, herbivory, Iceland, plants.

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To be able to predict how different drivers of environmental change, such as climate change, affect ecosystems it is important to understand their resilience. There are several aspects that may affect ecosystem resilience, such as species diversity of biological communities and the size of the local and regional species pool. On a global scale the species richness of most organism groups declines with latitude. Such latitudinal gradient is even apparent within the Arctic biome: there are fewer species in regional floras and faunas of the high Arctic than the low Arctic. On a regional scale several species diversity gradients may cross-cut the global gradient. One such gradient is the difference in diversity between mainlands and islands. We would therefore expect ecosystem resilience to drop from the low to the high Arctic and from mainlands to islands within a bioclimatic zone. In this talk I will address the question whether high Arctic island plant communities are less resilient than low Arctic island communities and whether plant communities on Arctic islands are less resilient than on mainlands. I will present results from perturbation experiments and observational studies from two island ecosystems, in the high Arctic (Svalbard) and in the low and sub-Arctic (Iceland), with some comparisons with mainland studies.

## Dispersal and survival of disjunct arctic plant species

KRISTINE B. WESTERGAARD



Westergaard, K.B. 2016. Dispersal and survival of disjunct arctic plant species. Pp. 329 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Circumpolar region; *Taxa*: vascular plants; *Other*: Arctic-alpine plants, disjunctions, dispersal, survival, conservation genetics.

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The Arctic is a naturally fragmented biome, with many islands and archipelagos, and the frequent and dramatic glaciation-induced range shifts during the Quaternary led to large disjunctions in the distribution of many arctic-alpine plant species. The history of these disjunctions is challenging to unravel, since genetic structure results from a combination of demography, mutations, genetic drift, dispersal, and current and historical gene flow. In this talk, I will focus on how we use rare and extremely disjunctly distributed arctic-alpine plant species to study dispersal and survival in northern regions. Molecular studies have reported extensive postglacial long-distance dispersal, both trans-oceanic and trans-continental, for an increasing number of both common and rare arctic-alpine plant species, even species lacking obvious morphological adaptations to long-distance dispersal. We also have molecular results supporting *in situ* glacial survival in the North Atlantic region for several species, including Beringian/Atlantic and west-arctic disjuncts. These findings suggest that we no longer need to presume that long-distance dispersal abilities are conflicting with possible *in situ* glacial survival. Several of our study species are threatened by habitat loss, and are included in national Red Lists. Based on mainly neutral genetic markers, our results show that most species have several genetic groups, and populations within each genetic group represent large geographic and climatic gradients. It is highly likely that local adaptation has taken place since the last glaciation, and understanding the genetic basis of adaptation in response to environmental variation is essential for e.g. conservation. The application of genomics to species of conservation concern shows great promise, and I will end this talk by presenting results from a first step towards investigating both neutral and adaptive genetic composition in a highly disjunctly distributed northern sedge, *Carex scirpoidea*.

## North Atlantic island insect faunas, from palaeoecology to conservation

EVA PANAGIOTAKOPULU, ASHLEY BUCHAN & PAUL BUCKLAND



Panagiotakopulu, E., A. Buchan & P. Buckland 2016. North Atlantic island insect faunas, from palaeoecology to conservation. Pp. 330 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: North Atlantic; *Taxa*: Coleoptera; *Other*: fossil insects, extinctions, introductions, Holocene, North Atlantic islands.

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The origins of the North Atlantic island insect faunas have been the topic of debate for over a century, whether part of the fauna survived in refugia or immigrated at the end of the last glaciation and what were the pathways for the colonisation. The lack of endemics in the current fauna makes post glacial introduction, with ice rafting as the more probable mechanism, although more research is needed to provide detail for differing rates of colonisation on different islands. The fossil evidence for the early Holocene biota of the islands indicates sources in Scandinavia. In terms of the fossil insect record, the debate on endemics is centred around the Icelandic fauna, including the argument about survival of *Bembidion grapii* through glacials around areas of hot springs and nunataks. The early Faroese faunas included species such as *Calathus micropterus*, which would be associated with woodland, or riparian habitat, while the post glacial fauna of Greenland was restricted to cold tolerant species. During the last millennium, human impact has drastically altered the island faunas with a synanthropic package introduced during the medieval period and a further range of synanthropic species have become established during the post industrial period. Local extinctions, as for example *Hydraena britteni* in Iceland, have accompanied human colonisation, although separating any climate record from human impact is a difficult task. The fossil insect assemblages of the North Atlantic islands provide insights both into climate and human induced changes.

## The aquatic fauna of the North Atlantic islands with emphasis on Iceland

GÍSLI MÁR GÍSLASON



Gíslason, G.M. 2016. The aquatic fauna of the North Atlantic islands with emphasis on Iceland. Pp. 331 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Atlantic islands; *Taxa*: Crustacea, Trichoptera; *Other*: ice-age, aquatic insects, colonization.

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During the last glacial maximum, 25 Myr ago, ice sheet covered the North Atlantic Islands, Scandinavia into N-Europe and Britain north of London. During this time ice sheet extended as far as 100 nautical miles off the present coast of Iceland. Most likely no aquatic invertebrates survived, with the exception of newly discovered 2 species subterranean amphipods in the groundwater system of Iceland. It is evident from mitochondrial DNA that one of the species has been on the island for at least 5 million years. Other invertebrates have presumably colonized the islands after the Ice-Age, 10 Kyr ago. Their origin is Scandinavia and Britain and it has been possible to follow the colonization route of one Trichoptera species from Central-South Europe migrating along the W-Europe through Britain and Faroe Islands to Iceland, where as another parthenogenic Trichoptera originated near the Bearing Straight and one population migrated westward through N-Asia to Scandinavia to Iceland, where another population migrated eastward through N-America, Greenland to Iceland, where the populations meet without reproducing. The number of species on the North Atlantic Islands is a result of the distance these islands are from the larger regions of Western Europe rather than the sizes of the islands. For aquatic insects, about 5% of the Norwegian or British fauna is found on the Iceland, the island furthest away from these regions, whereas about 30% of the Cladocera (Crustacea) are found, but they have resting eggs which can be transported by waterfowl. Also, the North Atlantic islands have only a few of the species in common, indicating the stochastic nature of the colonization.

## Patterns of vascular plant endemism in high latitude islands

THÓRA ELLEN THÓRHALLSDÓTTIR



Thórhallsdóttir, T.E. 2016. Patterns of vascular plant endemism in high latitude islands. Pp.332 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: high latitudes in N & S hemispheres, Iceland; *Taxa*: vascular plants; *Other*: high-latitude islands, endemism, species richness, glaciation history.

*Thóra Ellen Thórhallsdóttir (e-mail: theth@hi.is), Institute of Life and Environmental Sciences, University of Iceland, Askja, IS-101 Reykjavik, Iceland.*

Endemism is a long established characteristic of island biotas, but most well known examples are from low latitudes. I investigated vascular plant endemism and species richness among high latitude islands in the north and south hemispheres and explored correlations with island area, isolation, climate, topography and glaciation history. The comparison included eight north hemisphere islands/archipelagoes: two in the northeast Atlantic, five in the Arctic Ocean or bordering the Atlantic and one in the Pacific. Of nine southern islands/archipelagoes, two are in the south Atlantic, three in the Indian Ocean and four in the Pacific. The mini-continent of Greenland was included for some comparisons. South hemisphere islands generally displayed much higher endemism than north hemisphere islands. Endemism is noticeably low in the NE Atlantic and Iceland, the largest island in the sample, has no vascular endemics at all. Evaluated in the context of the Arctic floristic province as a whole, Iceland also appears to be singularly poor in endemics. Neither area nor isolation is a good predictor of endemism in high-latitude islands. The most noticeable pattern relates to degree of Pleistocene glaciation. Glaciation was limited or absent in most of the south hemisphere islands but extensive or complete for most of the NE Atlantic and Arctic islands. The high-arctic Wrangel Island is exceptionally rich in endemics but it was part of the ice-free Beringia during the LGM. Species richness on the other hand, is correlated with island area and degree of isolation but unlike endemism it does not reflect degree of Pleistocene glaciation.

## The role of sea ice for vascular plant dispersal in the Arctic

INGER GREVE ALSOS, D. EHRLICH, M.-S. SEIDENKRANTZ, O. BENNIKE, A. KIRCHHEFER  
& A. GEIRSDOTTIR



Alsos, I.G., D. Ehrlich, M.-S. Seidenkrantz, O. Bennike, A. Kirchhefer & A. Geirsdottir 2016. The role of sea ice for vascular plant dispersal in the Arctic. Pp. 333 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Iceland, East Greenland, Svalbard, Jan Mayen, Faroe Islands; *Taxa*: all vascular plants in the region; *Other*: Arctic, dispersal vector, genetic, Holocene, long distance dispersal (LDD), plant colonization.

*Inger Greve Alsos (e-mail: inger.g.alsos@uit.no) and Dorothee Ehrlich, UiT – The Arctic University of Tromsø, Norway; Marit-Solveig Seidenkrantz, Centre for Past Climate Studies, and Arctic Research Centre, Department of Geoscience, Aarhus University, Denmark; Ole Bennike, GEUS, Copenhagen, Denmark; Andreas Kirchhefer, Dendroökologen, Tromsø, Norway; Aslaug Geirsdottir, University of Iceland, Askja, IS-101 Reykjavik, Iceland.*

Sea ice has been suggested to be an important factor for dispersal of vascular plants in the Arctic. To assess its role for postglacial colonisation in the North Atlantic region, we compiled data on the first Late Glacial to Holocene occurrence of vascular plant species in East Greenland, Iceland, the Faroe Islands and Svalbard. For each record, we reconstructed likely past dispersal events using data on species distributions and genetics. We compared these data to sea-ice reconstructions to evaluate the potential role of sea ice in these past colonisation events and finally evaluated these results using a compilation of driftwood records as an independent source of evidence that sea ice can disperse biological material. Our results show that sea ice was in general more prevalent along the most likely dispersal routes at times of assumed first colonisation than along other possible routes. Also, driftwood is frequently dispersed in regions that have sea ice today. Thus, sea ice may act as an important dispersal agent. Melting sea ice may hamper future dispersal of Arctic plants and thereby cause more genetic differentiation. It may also limit the northwards expansion of competing boreal species, and hence favour the persistence of Arctic species.



## Specialized Symposium 11

(Ec5) Similarities and dissimilarities of biodiversity patterns on oceanic, terrestrial and experimental islands

CHAIRS: TEJA TSCHARNTKE & HOLGER KREFT

## Oceanic and terrestrial islands: Biophysical similarities and differences and implications for theory

HOLGER KREFT



Kreft, H. 2016. Oceanic and terrestrial islands: Biophysical similarities and differences and implications for theory. Pp. 335 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: -; *Other*: island theory, mountains, lakes, habitat fragments.

*Holger Kreft (e-mail: hkreft@gwdg.de), Biodiversity, Macroecology & Conservation Biogeography, University of Göttingen, Büsgenweg 1, 37077 Göttingen, Germany.*

Research on ‘true’ islands has stimulated great interest to study other insular systems including mountain tops, caves, habitat fragments and many more. A central tenet in island biology seems to be that research insights gained from the study of one system can also be transferred and applied to other insular systems. Transferability and generality of island theory is often complicated by strong biophysical differences that exist among different insular systems and by the different spatial and temporal scales at which relevant processes for a given insular systems might be at work or not. In this talk, I review studies of insular systems and provide a systematic overview of the biophysical similarities and differences of different systems. I will further discuss implications for island theory and beyond.

## Toward a mechanistic understanding of edge effects in fragmented systems

RAPHAEL K. DIDHAM



Didham, R. 2016. Toward a mechanistic understanding of edge effects in fragmented systems. Pp. 336 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: various; *Other*: drivers, edge effects, habitat fragmentation, matrix, mechanisms, spatial configuration.

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There has been considerable debate over the relevance of island biogeography theory to habitat fragments embedded in a terrestrial land-use mosaic. Can studies of islands really illuminate the dominant mechanistic processes operating in habitat fragments? At face value, it would seem intuitive that relatively low matrix hostility and high edge influence should greatly moderate any classical island-area or isolation-by-distance effects on the biota of recently-formed habitat fragments. Yet strong patch area and isolation effects are still frequently observed in fragments. Perhaps, then, the same suite of mechanisms do operate in all types of patchy systems, but with differing relative magnitudes of effect in habitat fragments vs oceanic islands? If so, it is likely that fragment studies can also reciprocally illuminate mechanistic processes that are frequently ignored in island systems. For instance, edge effects are not absent in oceanic island systems (such as variation in habitat types and disturbance regimes at island edges vs island interiors) and nor are matrix effects (such as varying productivity of surrounding seascapes and nutrient spillover across the marine-terrestrial interface), despite the fact that they are rarely considered as potential determinants of 'island' effects on biota. Development of a common template for interdependence among mechanistic drivers of habitat configuration effects would help a great deal in integrating findings across seemingly disparate study systems. The problem is that the mechanistic basis for habitat configuration effects has been extremely weakly developed (and is commonly ignored) in most studies, leading to limited capacity to compare the direction and magnitude of effects across systems. In this talk, I discuss mechanistic discrimination of the direct and indirect drivers of habitat configuration effects, focusing in particular on examples from the edge effects literature.

## Revisiting species-area-relationships: The case of German barrier islands

HAGEN ANDERT, C. SCHERBER & T. TSCHARNTKE



Andert, H., C. Scherber & T. Tschardtke 2016. Revisiting species-area-relationships: The case of German barrier islands. Pp. 337 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: East Frisian Islands, Germany; *Taxa*: Acari, Amphibia, Araneae, Auchenorrhyncha, Aves, Bivalvia, Bryophyta, Coleoptera, Crustacea, Diptera, Embryophyta, Fungi, Gastropoda, Heteroptera, Hymenoptera, Lepidoptera, Mammalia, Odonata, Pisces, Saltatoria, Trichoptera; *Other*: barrier islands, generalized boosted regression trees, species-area relationship, Wadden Sea, natural conservation.

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Around 20,783 kilometers of worldwide shoreline are occupied by 2,149 barrier islands. Since they are shaped by offshore sedimentation processes and annually occurring storm tide events, the appearance of these islands may vary between years if they are not protected by dykes. Barrier islands have been ignored by classical island biogeographic analysis until now. To close this knowledge gap, we analyzed more than 8,600 taxa across 37 organism groups (including vertebrates, invertebrates and land plants) on the German barrier islands, also referred to as East Frisian Islands. We tested for classical relationships between species and island area (SAR) and for effects of island habitat heterogeneity (SHH), and further island parameters using Generalized Linear Mixed-Effects Models. Only few taxa such as mammals (27 species) and bugs (277 species) showed a SAR. SHH was more important for small-sized insects such as Aculeata (339 species), Auchenorrhyncha (193 species) or Saltatoria (13 species). All other taxonomic groups responded to particular island parameters such as the degree of island isolation and the amount of annually deposited marine sediments. Surprisingly, the annual sediment deposition – calculated from 1650 A.C. to 2008 A.C. – had strong positive effects across all taxonomic groups from lichens to mammals. Seven of the 11 islands have permanent dykes, thereby protecting islands from sediment loss. Diked islands have the largest amount of species. We conclude that enhanced annual sediment deposition, promoted by dykes, increases overall biodiversity across taxa on barrier islands.

## Effects of habitat fragmentation on plant and animal diversity: Research in a land-bridge island system

JIAJIA LIU, X. SI, G. HU, Y. WANG, P. DING & M. YU



Liu, J., X. Si, G. Hu, Y. Wang, P. Ding & M. Yu 2016. Effects of habitat fragmentation on plant and animal diversity: Research in a land-bridge island system. Pp. 338 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Thousand Island Lake, China; *Taxa*: plants and animals; *Other*: habitat fragmentation, biodiversity, multiple taxa, traits.

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Habitat fragmentation is widely recognized as one of the leading threats to biodiversity. However, few tested how habitat fragmentation effect on biodiversity varies among different biological groups. Land-bridge islands, especially as formed by dam construction and subsequent inundation, are considered model or "experimental" systems for researching habitat fragmentation effect on multiple biological groups. In the past ten years, we and our group have been conducting habitat fragmentation effect research on land-bridge islands in the Thousand Island Lake — a man-made reservoir with over 1000 islands formed by the damming of a river in 1959 in Zhejiang province, East China. We have been monitoring *bird communities* on 42 islands since 2006. We then have been sampling *plant richness* on 156 islands and using forest dynamics plots to monitor community dynamics on 29 islands and the mainland. We have also investigated *small mammals* on 14 islands, several taxa of *reptiles and amphibians* on 23-48 islands, and *arthropods* on 35 islands. In addition, we have surveyed *butterflies and dragonfly*, and monitored mammals and ground-dwelling birds using camera traps on 32 islands. Through these approaches, methods and additional experiments, we have been studying the effects of habitat fragmentation on community assembly of plant and animal communities, and the mechanisms driving biodiversity dynamics and forming metacommunity patterns in this context. In addition, we collaborate with colleagues studying molecular, community, ecosystem and landscape ecology, for researching phylogenetic, functional, and genetic diversity in this fragmented landscape. Our results demonstrated that habitat fragmentation has significant negative effect on biodiversity, but these relationships may differ among biological groups due to their specific traits.

## Taxonomic and functional diversity of birds on subtropical fragment islands in China

XINGFENG SI & P. DING



Si, X. & P. Ding 2016. Taxonomic and functional diversity of birds on subtropical fragment islands in China. Pp. 339 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Thousand Island Lake, Zhejiang Province, China; *Taxa*: birds; *Other*: beta diversity, biodiversity conservation, environmental filtering, functional trait, habitat fragmentation, island biogeography.

*Xingfeng Si (e-mail: xingfengsi@gmail.com) and Ping Ding, College of Life Sciences, Zhejiang University, Hangzhou, Zhejiang 310058, China.*

Land-bridge islands created by construction of dams, such as the Thousand Island Lake (TIL) in China, can be viewed as particularly effective systems to explore patterns of species diversity and community assembly in fragmented habitats. Formed in 1959, TIL is a large man-made lake with > 1000 land-bridge islands in eastern China. Since 2006, our group have been monitoring breeding bird communities on 37 islands in TIL, and found high species turnover on these islands. On species level, taxonomic and functional alpha diversity of birds have clear relationships with island area, but not isolation. By partitioning beta diversity, we found low levels of overall taxonomic and functional beta diversity. The functional nestedness-resultant component dominates overall functional beta diversity, whereas taxonomic turnover is the dominant component for taxonomic beta diversity. Our assessment of island bird assemblages validated the dynamic species composition and area effects, but not distance effects as proposed by the theory of island biogeography. This is probably because of the relatively small scale (c. 580 km<sup>2</sup>) of our research system, and the strong dispersal ability of most birds. The contrasting turnover and nestedness-resultant components of taxonomic and functional beta diversity demonstrate the importance of considering the multifaceted nature of biodiversity when examining community assembly.

## Springs: Geographical isolates for the groundwater meiofauna?

SIMONE FATTORINI, B. FIASCA, A. DI CIOCCIO, T. DI LORENZO & D.M.P. GALASSI



Fattorini, S., B. Fiasca, A. Cioccio, T. Lorenzo & D.M.P. Galassi 2016. Springs: Geographical isolates for the groundwater meiofauna?. Pp. 340 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Central Italy; *Taxa*: Crustacea Copepoda; *Other*: groundwater, springs, island biogeography.

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As a consequence of reduced temporal variation in physicochemistry, springs are stable environments usually characterized by a high degree of endemism. The aim of this study was to assess whether groundwater-fed springs may be considered as biogeographical isolates with regards their surface-water and groundwater meiofauna. As a possible model system, we analysed a total of 30 springs fed by contiguous aquifers in Central Apennines (Italy). As factors affecting species richness, we considered spring area, discharge and elevation. We conducted separate analyses for the total number of species, and for stygobiotic, non-stygobiotic, cold stenotherm and non-cold-stenotherm species alone. A multimodel selection procedure based on the AIC was used to select the best fit models, with percentages of explained variances ranging from 62 to 86%. For both the total number of species and the non-stygobites, the best models included discharge (positively) and elevation (negatively). For stygobites, the best model included only area. Both discharge and area were included in the best model for cold-stenotherms, whereas area (positively) and elevation (negatively) were included in the best model for non-cold stenotherms. Thus, small-sized, high-altitude springs tend to harbour less species than basal and larger springs. Also, cold-stenotherms seem to be particularly sensitive to the low thermal regime of small springs. The strong relationship between stygobiotic richness and spring area (which followed a Gleason model) can be explained in relation with the low dispersal ability and poor potential for competition of stygobites when compared with epigean species. Due to these traits, stygobites are virtually unable to cross the less stable downstream freshwater environments and the surrounding terrestrial landscape. Therefore they tend to be mainly confined to the springs where they drifted out and trapped by springbed sediments. From this perspective, springs can be considered “water islands” and open windows to the aquifers.



## Islands within islands: Arthropod diversity within a volcanically fragmented landscape on Hawaii island

DANIEL S. GRUNER



Gruner, D.S. 2016. Islands within islands: Arthropod diversity within a volcanically fragmented landscape on Hawaii island. Pp. 341 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hawaii; *Taxa*: Arthropoda; *Other*: fragmentation; biodiversity; species composition; matrix habitat; *Metrosideros polymorpha*.

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Oceanic islands are characterized by high biotic endemism, but also by high rates and impacts of biological invasion. Habitat fragmentation therein, a major component of anthropogenic global change, creates islands within islands thought to accelerate both evolutionary and ecological change. A recent synthesis of fragmentation experiments up to 35 years in duration demonstrated biodiversity reductions by 13 to 75%, with intensification of negative effects over the passage of time. Yet the duration of the majority of studies are limited to decadal scales. We used the volcanic landscape of the island of Hawaii, where continuous old growth forest was dissected by a series of lava flows 135-160 years ago, as a natural, centennial-scale habitat fragmentation experiment. We studied canopy arthropod communities in fragments varying in area 100-fold from 0.1 to 12 hectares and separated by a recovering matrix of once-sterile basalt. This early successional matrix habitat is severe abiotically but still provides habitat for the dominant tree species in native forest. Arthropod community abundance, biomass, and richness increases with area of forest fragments; however, when corrected for higher abundance in large fragments, richness did not differ on the spectrum of fragment size. Along transects up to 100 meters into the matrix, richness and species diversity was invariant. However, evenness declined and species composition shifted strongly with increasing distance into the matrix. The matrix habitat was dominated by a small subset of species that were rare in closed forest, and the totality of successional habitats contributed to greater diversity on the landscape-level. Matrix habitat also was more highly invaded by introduced arthropod species. Such studies on centennial scales and longer are needed to predict the persistence of biodiversity after habitat fragmentation and recovery.

## Colonization of experimental islands in the Wadden Sea, Germany

MICHAEL KLEYER, T. BALKE & K. LOMUS



Kleyer, M., T. Balke & K. Lomus 2016. Colonization of experimental islands in the Wadden Sea, Germany. Pp. 342 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Spiekeroog, Germany; *Taxa*: plants; *Other*: Wadden Sea, experimental islands, dispersal, priority effects.

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On new islands, the initial assembly of plant communities will not only be based on niche requirements, but also on the ability to disperse, depending on distance to the mainland. Niche and dispersal processes may jointly determine priority effects in the colonization sequence. To disentangle and predict the effects of dispersal and niche requirements on the assembly of salt marsh communities we set up a field experiment in the Wadden Sea of Germany. Twelve islands were constructed on the tidal flats approx. 500 m offshore from the salt marsh. Each island consists of three heights, corresponding to the lowest, intermediate and upper level of the adjacent salt marsh. Six islands display bare sediment. The other six were planted with sods from lower salt marsh, where only the intermediate elevation of the islands corresponds to the realized niche of this lower salt marsh community. Planted islands are expected to show lower successional speed due to competition by unpaid extinction debts as compared to islands with bare soil. The set up was mirrored in the existing salt marsh where dispersal limitation is absent. Dispersal limitation had a strong effect on the colonization of the bare plots, with significantly less individuals colonizing the islands than the bare plots within the salt marsh. Species colonized plots at all elevations although they were absent in the natural salt marsh community at the lowest and highest elevation. Species were sorted according to their tolerances to salinity and inundation after the first season indicating that abiotic filtering leads to rapid payment of extinction debts. The island experiment allows addressing the dynamics of community and functional assembly in coastal meta-ecosystems where strong gradients of non-consumable environmental factors such as salinity govern the distribution of species.

## Non-convergent mammal community diversity and assembly in shared ecoregions: A test in Madagascar and Australia

KATHERINE H. BANNAR-MARTIN



Bannar-Martin, K.H. 2016. Non-convergent mammal community diversity and assembly in shared ecoregions: A test in Madagascar and Australia. Pp. 343 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Madagascar and Australia; *Taxa*: Nonvolant terrestrial mammals; *Other*: diversity, community assembly, ecoregion, biogeography.

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Island assemblages provide ideal groups for studying diversity and community assembly processes because they are discrete, bounded, and quantifiable. However, island mammal communities, such as those in Madagascar, often appear as outliers when compared to other regions. Islands or landmasses with shared biogeographic and evolutionary histories may be more appropriate choices for comparison, and consequently exhibit shared patterns. Madagascar and Australia share similar biogeographic histories, patterns of insular mammal evolution, ecoregion types, and convergent niches in Australian possums and Malagasy lemurs. Consequently, I tested whether the mammal communities of Madagascar and Australia have similar diversity patterns and are explained by similar assembly processes. I compiled a database of terrestrial nonvolant mammal occurrences, traits and phylogenies for 34 Malagasy and 51 Australian protected areas. I calculated 12 measures of taxonomic, functional, and phylogenetic diversity. I partitioned the explained variation for each diversity measure due to environmental variables (testing the contribution of environmental sorting), spatial variables (constructed with principal coordinates of neighbour matrices and testing the contribution of dispersal limitation), and biogeographic variables (measures of site isolation due to biogeographic dispersal barriers). Patterns in nonvolant mammal diversity and community assembly in Madagascar and Australia were inter- and intra-regionally variable. Arboreal mammals had convergent functional richness values but did not share patterns of assembly. Overall, patterns of mammal diversity in Madagascar and Australia were the result of environmental sorting, dispersal limitation, and evolutionary processes. This analysis calls into question the search for overarching explanations for patterns of diversity or assembly when significant environmental heterogeneity and variations in diversity characterize mammal communities. Broad-scale inter-regional descriptions of community assembly patterns may be unrealistic even for regions with comparable histories.

## Biodiversity patterns and processes in fragmented landscapes

TEJA TSCHARNTKE



Tscharntke, T. 2016. Biodiversity patterns and processes in fragmented landscapes. Pp. 344 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: habitat fragmentation, beta diversity hypothesis, dilution hypothesis, intermediate landscape-complexity hypothesis.

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Understanding how landscape structure affect local biodiversity patterns and ecological processes is critical for mitigating effects of global environmental change. In this talk, I use knowledge gained from human-modified, fragmented landscapes to suggest hypotheses, which I hope will encourage more systematic research on the role of composition and configuration of fragmented mosaic landscapes in determining the structure of ecological communities, ecosystem functioning and services. These include the dominance of beta diversity hypothesis (landscape-moderated dissimilarity of local communities determines landscape-wide biodiversity and overrides negative local effects of habitat fragmentation on biodiversity), the landscape-moderated concentration and dilution hypothesis (spatial and temporal changes in landscape composition can cause transient concentration or dilution of populations with functional consequences) and the intermediate landscape-complexity hypothesis (landscape-moderated effectiveness of local conservation management is highest in structurally simple, rather than in cleared, i.e. extremely simplified, or in complex landscapes). Shifting our research focus from local to landscape-moderated effects on biodiversity will be critical to developing solutions for future biodiversity and ecosystem service management.

## Fragmentation effects depend on biodiversity measure applied: Examples on grassland plants and insects

PETER BATÁRY, V. RÖSCH & T. TSCHARNTKE



Batáry, P., V. Rösch & T. Tscharnkte 2016. Fragmentation effects depend on biodiversity measure applied: Examples on grassland plants and insects. Pp. 345 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Central Germany; *Taxa*: plants, leafhoppers; *Other*: food web.

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Habitat fragmentation studies usually consider island (or fragment) size, connectivity or isolation of islands (fragments) and in terrestrial islands often the matrix (its amount and/or permeability) around habitat fragments. In this study we focus on different biodiversity measures from terrestrial habitat fragments in order to see, whether those react to the above major fragmentation effects on a similar way. In 2010 we surveyed leafhoppers and plants on 14 small (0.1-0.6 ha) and 14 large (1.2-8.8 ha) semi-natural calcareous grasslands in Germany, differing in isolation from other calcareous grasslands and in arable land % of surrounding landscape (from simple to complex landscapes). Beside calculating frequently used biodiversity measures, such as leafhopper species richness, specialist-generalist species richness ratio and Shannon evenness, we also quantified weighted trophic links between plants and their phytophagous leafhoppers for each grassland fragment (here we used only the interaction diversity). We showed that the three fragmentation effects (size, connectivity and landscape complexity) never acted alone, but in interesting interactions. Connectivity increased leafhopper richness in simple landscapes, but not in complex ones due to higher matrix permeability there. Leafhopper specialist ratio decreased in small, but increased in large fragments with increasing connectivity, but with the opposite effect on food web interaction diversity and Shannon evenness. This implies the prevalence of generalist (oligophagous and polyphagous) species in better connected small fragments, whereas better connected large fragments appeared to be dominated by specialist (monophagous) species. In summary, our results show that in the remaining protected calcareous grassland fragments, herbivore communities and their food webs are moderated by several interacting variables of landscape structure. Considering only one biodiversity measure might bias conservation actions, whereas considering several measures provides a more holistic view. However, given that different biodiversity measures are sensitive to different environmental variables; it also makes conservation decisions more difficult.

Island Biology 2016  
2nd International Conference on Island Evolution, Ecology and Conservation

## SPECIALIZED SYMPOSIA – EVOLUTION



Terrestrial gastropods are particularly diverse in Azores, with a high proportion of endemic species  
(Photo: Paulo A. V. Borges)



### Specialized Symposium 3

(Ev1) Diversification, colonisation and ecological limits  
on islands: A macroevolutionary perspective

CHAIRS: LUÍS VALENTE & JOSSELIN CORNUAULT

## Dynamic assembly of island biota through speciation, immigration and extinction

RAMPAL S. ETIENNE, L.M. VALENTE, A. B. PHILLIMORE & B. HAEGEMAN



Etienne, R.S., L.M. Valente, A.B. Phillimore & B. Haegeman 2016. Dynamic assembly of island biota through speciation, immigration and extinction. Pp. 349 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: multiple islands and archipelagos; *Taxa*: all; *Other*: speciation, extinction, colonisation, equilibrium, phylogeny, modelling.

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Island biotas emerge from the interplay between immigration, speciation and extinction and are often the scene of spectacular adaptive radiations. A common assumption is that insular diversity is at a dynamic equilibrium, but for remote islands, such as Hawaii or Galapagos, this idea remains untested. Here, I detail a new approach to test this idea: the R package DAISIE. This package is based on a dynamic model of island community assembly through the three abovementioned processes, and allows inference of the rates of these processes from phylogenetic data. With these rates predictions can be made on whether the island is at equilibrium, whether radiations are exceptional, and how the dynamics respond to sudden disturbance such as mass extinction.

## Equilibrium and non-equilibrium dynamics on islands: Insights from birds and bats

LUÍS M. VALENTE, J.C. ILLERA, L. DÁVALOS, A. B. PHILLIMORE, K. HAVENSTEIN,  
R. TIEDEMANN & R.S. ETIENNE



Valente, L.M., J.C. Illera, L. Dávalos, A.B. Phillimore, K. Havenstein, R. Tiedemann & R.S. Etienne 2016. Equilibrium and non-equilibrium dynamics on islands: Insights from birds and bats. Pp. 350 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Caribbean, Galápagos, Macaronesia; *Taxa*: birds, bats; *Other*: phylogeny, equilibrium, radiation, diversification, macroevolution.

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Do islands tend towards an equilibrium number of species over evolutionary time scales? This question is notoriously difficult to address, because it requires reconstructing processes and events that took place in the distant past. Using a combination of molecular phylogenetic data, fossil information and dynamic stochastic process-based modelling, we assess whether the number of species on islands is at equilibrium, tends towards equilibrium or is fundamentally non-equilibrial. As case studies, we use the land birds of the Galápagos and Macaronesia archipelagos and the noctilionoid bats of the Caribbean.

## Isolated islands untangle universal patterns at the nexus of macroevolution and macroecology

ANDREW J. ROMINGER, J.Y. LIM, K.R. GOODMAN, J. HARTE, D. GRUNER  
& R. G. GILLESPIE



Rominger, A.J., J.Y. Lim, K.R. Goodman, J. Harte, D. Gruner & R.G. Gillespie 2016. Isolated islands untangle universal patterns at the nexus of macroevolution and macroecology. Pp. 351 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Hawaii; *Taxa*: arthropods; *Other*: chronosequence, maximum information entropy, macroecology, bipartite network.

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Applying static ecological theories in rapidly evolving ecosystems can highlight what about the evolutionary process drives communities away from statistical idealizations. Using the chronosequence afforded by the Hawaiian Islands to capture snapshots of arthropod communities at different evolutionary ages and stages of ecological assembly, we have tested static ecological theories of herbivory network structure and the distributions of abundances and metabolic rates across species. We use the maximum entropy theory of ecology to build statistical idealization of how communities should partition resources and populations across species in equilibrium. This framework seeks to predict distributions of interest, such as abundance distributions, without invoking any specific mechanistic assumptions but instead by finding the solution that an ideal system would reach in equilibrium. Thus deviations from this theory can reveal the nature of unique mechanisms behind the observed structure of biodiversity. Our studies of network linkage, abundance and metabolic distributions indicate that rapid assembly from immigration and speciation in young ecosystems and extinction in old ecosystems could drive observed patterns.

## Disentangling the drivers of species richness in island floras

JONATHAN P. PRICE, M.K. BORREGAARD, R.J. WHITTAKER, H. KREFT, P. WEIGELT, L.M. VALENTE & BIG WORKING GROUP



Price, J.P., M.K. Borregaard, R.H. Whittaker, H. Kreft, P. Weigelt, L.M. Valente & BIG working group 2016. Disentangling the drivers of species richness in island floras. Pp. 352 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: 25 tropical and subtropical archipelagos; *Taxa*: flowering plants; *Other*: biogeography, colonization, speciation, species area relationship.

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The floras of oceanic islands are formed by an equilibrium among three processes: immigration, speciation and extinction. Although some speciation may take place within an individual island, many speciation events occur when populations become separated on nearby islands. Species also frequently disperse within an archipelago after speciation, such that tracing speciation events to a single island is problematic. Thus, the diversity dynamics of island plants are best characterized at the archipelago scale, at which colonizing species form endemic radiations. Here, we present a global analysis of the relative contribution of the main processes of immigration and speciation to island plant diversity for 25 archipelagos, representing a majority of the world's oceanic archipelagos within the subtropical and tropical climate zones. We estimate the number of colonization events based on the phylogenetic relationships among species on 12 archipelagos that have numerous, well-resolved phylogenies. For an additional 13 archipelagos, we develop a heuristic sampling tool that generates a probability distribution for the estimated number of colonization events, based on the taxonomic status of endemic species and genera in published checklists. The heuristic is parameterized using checklists and phylogenies for the 12 well-resolved archipelagos. The number of speciation events is then determined as the total number of species minus the number of colonization events. The results reveal that the well-known species-area relationship for archipelagos is driven most strongly by differences in within-archipelago rates of speciation. Colonization is predicted by both isolation and archipelago area, which may be an indirect effect of differential extinction. Archipelago age, although difficult to characterize, appears to have a net positive effect on both colonization and speciation. This confirms the central tenets in island theory, and demonstrates that we can disentangle the drivers of species richness at the regional scale.

## Comparing the accumulation of species across multiple lineages and islands

JOSSELIN CORNUAULT & C. THÉBAUD



Cornuault, J. & C. Thébaud 2016. Comparing the accumulation of species across multiple lineages and islands. Pp. 353 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: diversification, colonization, phylogeny, hierarchical Bayesian models.

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Factors determining the accumulation of lineages on islands, through colonization and in-situ diversification are still the subject of much debate. The importance of ecological processes and geography in triggering or limiting diversification or the establishment of new colonists is still widely unknown. Discovering general trends regarding the evolutionary processes that shape diversity on islands is facilitated by macroevolutionary studies carried out across a large taxonomic range. Comparative phylogenetic studies are particularly useful to obtain an insight into the history of multiple island lineages. However, inferring evolutionary processes from phylogenetic data for a large number of taxa and islands is impaired by multiple sources of uncertainty. These notably include uncertainty in phylogenetic data (time-calibration and topology, incomplete taxon sampling) and in inferred rates of colonization/diversification which need to be accounted for to not produce over-confident estimates of evolutionary parameters. In this context, we design a hierarchical Bayesian framework aimed for comparative phylogenetic studies that accounts for these sources of uncertainty. This basic framework can be adapted to consider varying sets of evolutionary models and/or explicative variables, facilitating the analysis of the eco-evolutionary dynamics of island taxa.

## Late Quaternary climate change shapes island biodiversity

PATRICK WEIGELT, M.J. STEINBAUER, J. S. CABRAL & H. KREFT



Weigelt, P., M.J. Steinbauer, J.S. Cabral & H. Kreft 2016. Late Quaternary climate change shapes island biodiversity. Pp. 354 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: flowering plants; *Other*: endemism, extinction debt, island biogeography, non-equilibrium.

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Present biogeographical models regard islands either as 1) geologically static with biodiversity resulting from neutral immigration-extinction dynamics or 2) geologically dynamic with changes in area and habitat heterogeneity and biodiversity resulting from immigration-speciation-extinction dynamics over millions of years. Compared to most of the late Quaternary with recurrent and much longer, cooler and drier glacial periods, however, the climate and spatial arrangement of islands observed today is rather exceptional. These shallow-time dynamics act orders of magnitude faster than the relatively slow deep-time geological processes of island formation and erosion considered in biogeographical theory. Recurrent fluctuations in sea level and associated changes in island area, isolation and connectivity thus provide ideal opportunities to assess the effect of shallow-time environmental changes on present biodiversity. Here, we analysed the effects of present and last glacial maximum island area, isolation and climate on angiosperm diversity on islands (species richness, endemic richness, and proportion of endemic species). We found past island characteristics, especially changes in area, to have strong effects on present number and proportion of endemic species, while species richness was more strongly related to present island characteristics. Specifically, the number and proportion of endemic species was higher on islands that were larger during glacial maxima and lower on islands that were repeatedly connected with other islands. We conclude that, while species richness seems to be closer to equilibrium with present environments, environmental conditions of the last glacial maximum and effects of sea-level changes are essential to understand patterns of island endemism and its underlying evolutionary dynamics. Island biogeographical theory should hence be expanded to accommodate the effects of shallow-time environmental changes on the origin and distribution of endemic species.



## An ecological and evolutionary framework for the analysis of insular biomes

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Emerson, B.C., H. López, A. Perez-Delgado, P. Oromí, J.M. Fernández-Palacios, J. Caujapé-Castells, P. Cardoso, D. Strasberg, C. Thébaud & P.A.V. Borges 2016. An ecological and evolutionary framework for the analysis of insular biomes. Pp. 355 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores, Canary Islands, Mascarene Islands; *Taxa*: arthropods; *Other*: community structure, genetic connectivity, colonization, diversification, forest, arthropod.

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In this talk I will present results from an on going collaborative project to characterise community structure within forest biomes of the Azores, Mascarene Islands and the Canary Islands. Standardised inventories have been carried out for plant communities within forests, and community composition for three arthropod groups is been quantified using a combination of ecological and molecular sampling protocols. Invertebrates have been sampled from 10 biodiversity plots distributed across historically continuous forest within single islands within each of the three archipelagos. Spiders and beetles have been chosen for the analysis of arthropods primarily associated with above-ground habitat, and DNA sequencing has been employed to facilitate both the delineation of probable biological species, and the estimation of genetic connectivity within species. Collembola have been chosen for the analysis of arthropods primarily associated with soils, using mitochondrial metagenomics to quantify species richness and diversity. A selection of recently obtained data will be used to demonstrate the practical and applied utility of this approach for the analysis and understanding of biological communities.

## Geology and ecology interact to drive evolutionary radiations and declines on Hawaii

JUN YING LIM & C. M. MARSHALL



Lim, J.Y. & C.M. Marshall 2016. Geology and ecology interact to drive evolutionary radiations and declines on Hawaii. Pp. 356 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hawaii; *Taxa*: endemic plant and animal clades; *Other*: diversity dependence, island ontogeny, diversification.

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Determining the drivers of species richness change through time remains a central challenge in evolution and ecology. Oceanic islands such as Hawaii, however, are ideal systems for examining the interplay between diversification dynamics and landscape dynamism. Firstly, the islands of hotspot archipelagoes such as Hawaii are formed in sequence, and thus capture a record of evolutionary radiations at different stages of their unfolding. Secondly, the physical environment of the islands changes dramatically over short geologic time spans, directly influencing their biota. Here, by using a geologically-informed diversification model that takes into account island-specific geological histories, we explain current diversity patterns across the Hawaiian archipelago for 15 endemic groups of animals and plants. This island ontogeny model predicts current species richnesses better than do ontogeny-independent models, suggesting the importance of geologic history in the diversification (and decline) of island clades. The model enables us to infer the temporal diversification trajectories for each group examined – most of the endemic clades show rises and then falls in species richness that are coupled to the growth and decay of the islands. In fact, just over half the clades are no longer radiating on the older islands, and (even ignoring human impacts) are in evolutionary decline on these islands. Less commonly we see some clades continuing to diversify, albeit slowly, on even the oldest islands, with species richnesses that are below their inferred island-specific carrying capacities. Our results show how large-scale landscape dynamism can drive evolutionary dynamics on islands on broad time scales.

## Island is the limit: Observing species turnover in bat species record from Siberut Island, Indonesia

SABHRINA G. ANINTA, S. NOERFAHMY, S. Wiantoro & D. T. ISKANDAR



Aninta, S.G., S. Noerfahmy, S. Wiantoro & D.T. Iskandar 2016. Island is the limit: Observing species turnover in bat species record from Siberut Island, Indonesia. Pp. 357 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Siberut Island, Indonesia; *Taxa*: Chiroptera; *Other*: species turnover, species records, biodiversity, biogeography, island bats.

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Due to their limited space and vulnerability to both immigration and extinction, islands have a unique species assemblage. The species number of an island over a period of time thus may provide important insights on processes affecting biodiversity. In our study, we collected bat species records from Siberut Island from the early 20th century to 2013 to see the pattern of bat diversity over time. We found that bat species assemblage is not consistent over time with a cumulative number of 22 species. However, this number is unlikely to be a fixed point for Siberut bat species richness. Overestimation is possible due to the possibility of species turnover. We assumed that species turnover is the cause of different yearly species assemblages as the number of new records found per year does not vary much (average species richness = 4.33 species/year, standard deviation = 1.84 species/year). This was corroborated by the consistent proportion of functional groups throughout the year with different species assemblages for each sampling year in both functional groups. Furthermore, we may infer turnover possibility from the similarity of bat species composition between Siberut and the Sundaland islands (Sumatra, Borneo, Java, and Malaya Peninsular) that confirmed the tendency of bats to be opportunistic dispersers. Underestimation is nevertheless possible due to the unavailability of standardized species presence data from the museum and the lack of systematic long term monitoring. Despite its homogenous nature, Siberut ecosystems consists of five major ecosystem types with a variety of microhabitat which are worth to consider to record additional bat species. Hence, our study has demonstrated the importance of species records completeness for assessing the pattern of species richness of a tropical island and long term monitoring for perceiving biodiversity in a broader sense.

## Testing landscape effects on the evolution of island arthropod assemblages

ANTONIA SALCES CASTELLANO, H. LÓPEZ, A. PEREZ-DELGADO, P. OROMÍ  
& B.C. EMERSON

Salces Castellano, A., H. López, A. Perez-Delgado, P. Oromí & B.C. Emerson 2016. Testing landscape effects on the evolution of island arthropod assemblages. Pp. 358 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Tenerife (Canary Islands); *Taxa*: Coleoptera; *Other*: geographic isolation, ecological isolation, speciation, oceanic island, arthropods.

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Geographic isolation is a recognised driver of speciation within oceanic island archipelagos, with the chance colonisation and establishment of species from one island to another being a cornerstone for the origin of new evolutionary lineages. The importance of geographic isolation within islands is less clear, as current distributions of closely related species may not be reflective of the geography of their shared ancestors. It may also be that physical geographic distance has been less important than ecological distance for the initiation of the speciation process within islands. We are addressing this information gap by testing for geographical and ecological isolation effects through the sampling of whole arthropod communities within insular forest biomes. We combine standardised ecological sampling with DNA sequencing and apply both traditional (FST-based) and novel (Bayesian MCMC) analyses of molecular data. In this presentation I will outline our study system and our methodological approach for the investigation of geographic effects on genetic differentiation among the Coleoptera fauna sampled within a topographically complex insular forest biome. I will illustrate our approach with some preliminary results and discuss their significance.

Specialized Symposium 21  
(Ev2) Dynamics of speciation and diversification in island  
birds

CHAIRS: BORJA MILÁ & CHRISTOPHE THÉBAUD

## Taxon cycles and diversification of Lesser Antillean birds

ROBERT E. RICKLEFS



Ricklefs, R.E. 2016. Taxon cycles and diversification of Lesser Antillean birds. Pp. 360 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Lesser Antillean; *Taxa*: birds; *Other*: clade diversification, population expansions, coevolutionary relationships, pathogens.

*Robert E. Ricklefs (e-mail: ricklefs@umsl.edu) Department of Biology, University of Missouri-St. Louis, USA.*

Species formation and clade diversification are nowhere more apparent than in archipelagoes, where the geography of speciation is spread across discrete land masses in close proximity. However, the causes of population expansions across archipelagoes to start the speciation process are poorly understood. Analyses of genetic differentiation among species and populations of birds in the West Indies shed light on temporal and spatial aspects of these population processes, suggesting that phases of expansion occur independently of such external drivers as climate change and might instead reflect intrinsic, coevolutionary relationships between species and their pathogens.

## Microevolution in white-eyes of southwest Pacific islands

SONYA M. CLEGG, G. OATLEY & B.C. ROBERTSON



Clegg, S.M., G. Oatley & B.C. Robertson 2016. Microevolution in white-eyes of southwest Pacific islands. Pp. 361 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: southwest Pacific; *Taxa*: Zosterops; *Other*: natural selection, drift, phenotypic evolution, dispersal.

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Biologists have a good understanding of the evolutionary processes required to generate divergence between populations. But why do some populations diverge rapidly from one another, while others do not? White-eyes are excellent island colonisers and one of the great speciators, with numerous forms at different stages of divergence across the southwest Pacific region. I discuss the relative roles of selection and drift in generating patterns of divergence in white-eyes and give a summary of current work investigating changes in dispersal, and divergence in the presence and absence of gene flow.



## Montane bird speciation and conservation across oceanic sky islands

CHRISTOPHER E. FILARDI, M. J. ANDERSEN & R.G. MOYLE



Filardi, C.E., M.J. Andersen & R.G. Moyle 2016. Montane bird speciation and conservation across oceanic sky islands. Pp. 362 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: southwestern Pacific Islands; *Taxa*: island birds; *Other*: sky island, conservation, montane, endemic, bird.

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Montane areas across southwest Pacific Islands, though poorly known, are characterized by a limited number of bird lineages with high levels of endemism. Because of their unique faunas, largely intact ecological states, and importance to local people for cultural and ecosystem service values, these oceanic *sky islands* are of interest to both evolutionary biologists and conservation. From an evolutionary perspective, the origins of these faunas remain largely unknown. In this paper, we present some of the first multi-island analyses revealing the assembly of montane bird communities. Through regional analyses of Honeyeaters (Meliphagidae), White-eyes (Zosteropidae), Whistlers (Pachycephalidae), Monarchs (Monarchidae), and Kingfishers (Alcedinidae), we investigate the evolutionary history of montane endemics across primary oceanic sky islands in the western Pacific. Unlike other vertebrate groups such as frogs and lizards, which show strong evidence of extensive *in situ* genesis of montane endemism, most avian endemics are either relicts within regional radiations or recent colonizers. These results are placed in the context of community assembly and broader conservation strategy for oceanic sky islands across the western Pacific.

## Genomic insights into speciation in widespread Pacific island bird lineages

ROBERT G. MOYLE, J. D. MANTHEY, M. J. ANDERSEN, C. H. OLIVEROS & C. E. FILARDI



Moyle, R.G., J.D. Manthey, M.J. Andersen, C.H. Oliveros & C.E. Filardi 2016. Genomic insights into speciation in widespread Pacific island bird lineages. Pp. 363 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Pacific Islands; *Taxa*: birds; *Other*: islands.

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The archipelagos of the SW Pacific are among the world's great natural laboratories, with diverse island sizes and degrees of isolation that support high species diversity and endemism. Phylogenetic relationships among island bird taxa are being clarified at a rapid pace with DNA sequence data, but aspects about the speciation process, such as the tempo of speciation and occurrence of gene flow, remain unclear. White-eyes (Aves: Zosteropidae) are one of the most rapid radiations among birds and have a complex speciation history in the SW Pacific. We used two methods of reduced-representation genomic sequencing to assess the relationships among species and populations of white-eyes (Aves: Zosteropidae) in the Solomon Islands. Data from both methods reveal two notable patterns: 1) gene flow among well-differentiated species and 2) no discernable genetic difference between morphologically and behaviorally distinct populations. These data support that diversification can be rapid and may occur without complete isolation of incipient species.

## What are we learning about speciation and extinction from the Canary Islands?

JUAN CARLOS ILLERA



Illera, J.C. 2016. What are we learning about speciation and extinction from the Canary Islands?. Pp. 364 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: The Canary Islands; *Taxa*: birds; *Other*: island evolution, island diversification, island phylogeography, Macaronesia, oceanic islands, island quaternary fossil record.

*Juan Carlos Illera (e-mail: jcillera3@hotmail.com), Research Unit of Biodiversity, Oviedo University, Mieres, Asturias, Spain.*

Oceanic islands are excellent systems for allowing biologists to test evolutionary hypotheses due to their relative simplicity of habitats, naturally replicated study design, and high levels of endemic taxa with conspicuous variation in form, colour and behaviour. Over the last two decades the Canary Islands archipelago has proved an ideal system for evolutionary biologists who seek to unravel how biodiversity arises and disappears. In this review we have evaluated the contribution of the study of Canarian birds to our understanding of how and why species occurs and change over time. We focus our attention on both extant and extinct Canarian taxa, and describe how research on these species has filled gaps in our understanding of avian speciation and extinction. In addition, we discuss the necessity of revising the current taxonomy in the Canarian avian taxa, especially the status of the endemic subspecies, some of which might be better treated as full species. An accurate classification of Canarian birds is not only crucial for testing evolutionary, biogeographic and ecological hypotheses, but also for effective decision making about conservation and environmental management. Finally we introduce future avenues of research that we feel will yield the most exciting and promising findings on island evolution in the coming years.

## Genetic and morphological differentiation in an island bird, the Azorean Woodpigeon (*Columba palumbus azorica*)

PEDRO A.M. ANDRADE, T.M. RODRIGUES, R. FONTAINE, V.R.C. NEVES, A. FONSECA, P.C. ALVES, M.J.P. CARNEIRO & D. GONÇALVES



Andrade, P.A.M., T.M. Rodrigues, R. Fontaine, V.R.C. Neves, A. Fonseca, P.C. Alves, M.J.P. Carneiro & D. Gonçalves 2016. Genetic and morphological differentiation in an island bird, the Azorean Woodpigeon (*Columba palumbus azorica*). Pp. 365-366 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Azores; *Taxa*: *Columba palumbus*; *Other*: population genetics, ecomorphology.

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The colonization of novel environments, such as islands, is recognized as a strong driving force for evolutionary change: populations usually undergo detectable differentiation, either through adaptation or isolation from the source populations. For some taxa, however, doubts still persist on whether insular populations are actually separate evolutionary entities. The Azorean Woodpigeon (*Columba palumbus azorica*) may be one example of this, as this island form has only been recognized as separate based on external characters, and contemporary genetic studies are inconclusive. To understand the extent to which colonization of the Azores archipelago has resulted in differentiation of insular Woodpigeon populations we assessed patterns of genetic and morphological divergence from continental populations. We sampled genome-wide single nucleotide polymorphisms (SNP) with genotyping-by-sequencing (GBS) and looked at specific patterns of morphological differentiation at several functional complexes of the Woodpigeon body (whole body structural size and shape, as well as feeding and locomotory complexes). Analysis of population structure (based on 64 individuals from seven Azorean islands and 12 individuals from four European sites) indicate that the Azorean Woodpigeon has already undergone slight differentiation from the continental subspecies, as birds from each of the two geographical domains cluster separately. Interestingly, populations from each island of the Azores seem to have higher diversity and lower values of inbreeding than our group of continental birds. Concurrently with genetic differentiation, some morphological divergence is also recovered with our data, particularly differences in bill morphology (the bill of Azorean birds is

thicker than that of continental specimens). This suggests a possible role of ecological adaptation in the evolution of this island taxon. These preliminary results highlight the usefulness of the Woodpigeon as a model to study the evolution of birds in islands, as well as the need for integrated approaches to better understand the evolutionary history of island taxa.

## Genomic approaches to assess phylogeny and adaptation in the Hawaiian honeycreeper radiation

ROBERT C. FLEISCHER, L.C. SACKETT, T.E. CALLICRATE, M.G. CAMPANA & H. F. JAMES



Fleischer, R.C., L.C. Sackett, T.E. Callicrate, M.G. Campana & H.F. James 2016. Genomic approaches to assess phylogeny and adaptation in the Hawaiian honeycreeper radiation. Pp. 367 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hawaii; *Taxa*: Hawaiian honeycreepers (Drepanidinae); *Other*: genomics, phylogeny, disease, rate calibration.

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The Hawaiian Islands are often cited as a unique natural laboratory for evolution, and as unparalleled for studies of insular evolution and adaptive radiation. One of the best examples of adaptive radiation is the Hawaiian honeycreepers (Drepanidinae), which show tremendous morphological and ecological diversity that evolved over an estimated 5-6 my timespan. The Hawaiian Islands are generated by plate migration over a mostly stationary volcanic hotspot, setting up a temporally stratified series of islands of known age and a useful system for assessing evolutionary rates. The radiation is also known for an excessively high rate of recent extinction, mostly due to impacts of introduced organisms, including predatory mammals and mosquito-vectored diseases. We are applying next generation sequencing and genomic approaches to gain an understanding of the phylogenetic relationships and pattern and tempo of the honeycreeper radiation, and also to understand the basis of differential responses of honeycreeper species to infection by an introduced avian malaria lineage. We have assembled genome sequences for two honeycreeper species from the island of Hawaii – the common and ecologically generalized Hawaii amakihi (*Loxops virens*), and the endangered and specialized akiapolaau (*Hemignathus wilsoni*) - and these show expected quantitative differences in their population histories. We are using SNP capture arrays generated from the amakihi genome to estimate a phylogeny for the extant and a set of extinct taxa, and in concert with island ages to temporally calibrate the honeycreeper phylogeny and estimate dates for other nodes. We are also using the SNP capture arrays to assess genetic structure of amakihi on Hawaii and across the islands, and to document variants that appear associated with resistance or tolerance of malaria infection.

## The genetic basis and genomic consequences of plumage divergence in incipient flycatcher species of the Solomon Islands

JOHN ALBERT C. UY



Uy, J.A.C. 2016. The genetic basis and genomic consequences of plumage divergence in incipient flycatcher species of the Solomon Islands. Pp. 368 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Solomon Islands; *Taxa*: *Monarcha castaneiventris*, chestnut-bellied flycatcher; *Other*: speciation, genomics, melanism.

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Speciation, the evolutionary process by which new species originate, is responsible for the amazing diversity we see in nature. Despite decades of active research, many fundamental questions remain unresolved, including the genetic basis of reproductive isolation. We explore the genetic basis, genomic consequences and ecology of diversification using the variable *Monarcha castaneiventris* flycatcher of the Solomon Islands. This complex is composed of populations that vary in plumage color, which represent different stages of speciation. We focus on island populations that have convergently evolved entirely black plumage and are sister to chestnut birds that inhabit adjacent or the same islands. Combining field experiments with genomic approaches, our results thus far indicate that simple point mutations predict parallel melanism, that directional selection keeps the color forms distinct despite gene flow, and that the differences in color are used in conspecific recognition. We discuss the implications of our results in our understanding of speciation on islands.



## Eastern Polynesian landbirds did not follow hotspot diversification models

ALICE CIBOIS & J.-C. THIBAULT



Cibois, A. & J.-C. Thibault 2016. Eastern Polynesian landbirds did not follow hotspot diversification models. Pp. 369 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Pacific Ocean; *Taxa*: birds; *Other*: oceanic hotspot archipelago, phylogeography, multiple colonization, insular terrestrial avifauna.

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Eastern Polynesia is composed of several linear hotspot archipelagos on the Pacific Plate. Because they were all formed *de novo* by volcanism, their biotas were assembled entirely via long-distance dispersal, followed by in-situ diversification. In this context, comprehensive phylogenies are necessary to decipher the complexity of the colonizations that took place over large distances and a multitude of islands. Recent studies on the avifauna of Eastern Polynesia, in addition to knowledge on recent anthropogenic extinctions, provide new elements for testing conceptual models of colonization and diversification applied to other well-studied archipelagos, like Hawaii. Phylogenetic studies based on molecular data showed that Polynesian landbirds originated mainly from East Asia and Melanesia, and only marginally from the Holarctic region. Although several genera have colonized Australia from smaller islands, present knowledge suggests that Eastern Polynesia constituted a “sink”, from which birds did not come back to recolonize western islands. Colonizations may be unique among a lineage (as in kingfishers), or, more commonly, correspond to multiple independent events (for instance in fruit doves, reed warblers, swiftlets etc.): interestingly, these patterns differ for each group, highlighting the unpredictability of colonization routes and tempos among diverse groups of birds. Colonization time estimates obtained with genetic analyses date from the Holocene for the most recent, to the Oligocene for the oldest. Most genera are as old as (monarchs, fruit doves), or younger than (reed warblers, kingfishers, swiftlets), the island they had colonized, except for the endemic sandpipers that are considerably older than the last emergence of the atolls they inhabit today, suggesting that they colonized other islands initially. Globally we found little support for the “progression rule”, and no common pattern in the timing and routes that led to the endemic landbirds in Eastern Polynesia.

## Sympatric speciation in an island giant involves isolation, hybridization and selection

MARTIN STERVANDER, M. MELO, P. JONES & B. HANSSON

Stervander, M., M. Melo, P. Jones & B. Hansson 2016. Sympatric speciation in an island giant involves isolation, hybridization and selection. Pp. 370 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Gulf of Guinea, West Africa; *Taxa*: seedeaters (*Aves*: *Passeriformes*: *Fringillidae*: *Crithagra* spp.); *Other*: colonization, birds, character displacement, ecological speciation, bill morphology, adaptation.

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Closely related species on small, isolated islands offer unique opportunities to gain insights into the role of ecology and gene flow in the speciation process. Here we report on the evolution of two sister species of birds occurring in full sympatry on the same oceanic island, São Tomé: the enigmatic and gigantic São Tomé grosbeak *Neospiza concolor* and the Príncipe seedeater *Crithagra rufobrunnea*. The latter species also occurs on two neighbouring islands in the Gulf of Guinea. With a genome-wide panel of SNPs, we clarified the evolutionary history of the sister species by showing (i) a genome-wide phylogenetic signal that is unique to the grosbeak, with alleles that are different from all seedeater populations, and (ii) that the genome of the seedeater on São Tomé is a mosaic created by introgression from the grosbeak, following secondary hybridization. Moreover, the genomic segments that are unique to the grosbeak, and have been preserved from introgression in any direction, are situated significantly more closely to genes than are introgressed segments, and overlap with several genes that determine bill morphology in birds. These results strongly suggest the occurrence of disruptive selection during divergence in sympatry. We conclude that although an important part of their evolutionary history and progression to speciation occurred in sympatry, there was an early period of allopatry during which genetic and phenotypic conditions that facilitated the divergence process upon secondary contact evolved. After initial hybridization, it is likely that resource-driven selection on bill size and body size drove the evolution of gigantism in the grosbeak. The result of such asymmetrical ecological character displacement would also have created an effective reproductive barrier between the two incipient species.

## Intra-island variation in the Réunion grey white-eye: What we know 50 years after Frank Gill's classic study?

CHRISTOPHE THÉBAUD & B. MILÁ



Thébaud, C. & B. Milá 2016. Intra-island variation in the Réunion grey white-eye: What we know 50 years after Frank Gill's classic study?. Pp. 371 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Mascarene Islands, southwestern Indian Ocean; *Taxa*: *Zosterops borbonicus*; *Other*: bird, speciation, population divergence, *Zosterops*, hybrid zones.

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Most birds are highly mobile, and thus unlikely to speciate allopatrically within islands of small to moderate size. The Réunion white-eye (*Zosterops borbonicus*) represents one of two possible exceptions to this view, with not less than five distinct plumage colour variants distributed across the small and remote island of Réunion (Mascarene archipelago). This five variants can be grouped into four geographical forms: three monomorphic forms occupy discrete regions in the lowlands; and the fourth form comprises two morphs that occur at high altitudes in complete sympatry and which, rather unexpectedly, do not show any assortative mating regarding plumage colour. Extremely narrow hybrid zones arise where the different forms come into contact, both between parapatric lowland forms and between lowland and highland forms. Building upon this unusual context, Frank Gill in the 1960s conducted a thorough investigation of morphological variation in *Z. borbonicus*, which led him to propose a series of hypotheses relative to the origin and evolution of such diversity. Here we revisit Gill's study in the light of new genomic and phenotypic data to explain the divergence of the different phenotypic forms of white-eyes. Our results provide support for the existence of reproductive isolation between these forms and strongly suggest *in situ* divergence in allopatric conditions.

## Diverse evolutionary histories of endemic avian taxa on Guadalupe Island, Mexico

BORJA MILÁ & J. HERNÁNDEZ-MONTOYA



Milá, B. & J. Hernández-Montoya 2016. Diverse evolutionary histories of endemic avian taxa on Guadalupe Island, Mexico. Pp. 372 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Guadalupe Island, Pacific Ocean, Mexico; *Taxa*: Island junco (*Junco insularis*), Guadalupe house finch (*Haemorhous mexicanus amplus*), Anna's hummingbird (*Calypte anna*); *Other*: phylogeography, natural selection, sexual selection, speciation, hybridization, ecomorphology.

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Oceanic islands provide unique selective scenarios in which to study the evolution of fitness traits and their role in population divergence and speciation. On Guadalupe Island, in the Mexican Pacific, we are studying the evolutionary history of three endemic taxa: the island junco (*Junco insularis*), the Guadalupe house finch (*Haemorhous mexicanus amplus*), and Anna's hummingbird (*Calypte anna*). Juncos colonized the island over half a million years ago and have become smaller and longer-beaked than continental relatives, yet have converged in plumage color with some continental forms. House finches colonized less than 20,000 years ago, yet show a massively enlarged bill, and a marked reduction in sexual dimorphism and secondary sexual characters, including a reduction of colored areas and a predominance of yellows over reds. The hummingbirds also show a reduction of sexual characters (gorgette size, rectrix modification) and genetic data reveal a complex history of long-term isolation followed by frequent bouts of recent hybridization with Costa's hummingbird (*Calypte costae*) from the mainland. Ongoing research on these unique taxa include ecological, ecomorphological and genome-wide analyses to investigate patterns of resource use, modes of selection, and the genetic basis of fitness traits.

## Specialized Symposium 22

### (Ev3) Evolutionary Processes in the Macaronesian Island Flora

CHAIR: HANNO SCHAEFER

## Speciation processes in the Macaronesian fern flora

FREDERICK J. RUMSEY



Rumsey, F.J. 2016. Speciation processes in the Macaronesian fern flora. Pp. 374 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Macaronesia; *Taxa*: pteridophytes; *Other*: allopolyploidy, dispersal, extinction.

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Pteridophytes form a conspicuous component of Macaronesian vegetation and more than any other floral group form a distinctive Macaronesian element. In stark contrast to the angiosperm floras narrow endemism and speciation through adaptive radiation are virtually absent and where they occur they are at an archipelagic level. The paramount role that propagule dispersability and the cohesive action of gene-flow in shaping and maintaining the flora is considered. Speciation has primarily proceeded through allopolyploidy, facilitated and perhaps explained in part by the greater incidence of multiple lineage colonisations, a rarer feature in the less vagile angiosperms. Ploidy-level distinctions occur in some lineages, however, autopolyploidy, a less frequent but still significant speciation mechanism in continental areas, is not a local feature and the reasons for this are discussed. Complex patterns of some allopolyploid endemics in relation to their progenitors poses interesting questions as to the roles of local extinction versus dispersal and the possibility of polytopic origins.

## Why do different oceanic archipelagos harbour contrasting levels of species diversity? Diversification processes in the Macaronesian archipelago floras

MARK CARINE



Carine, M. 2016. Why do different oceanic archipelagos harbour contrasting levels of species diversity?. Diversification processes in the Macaronesian archipelago floras. Pp. 375 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Macaronesia; *Taxa*: *Pericallis*; *Other*: single island endemics, diversity patterns.

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In a letter to Joseph Hooker dated Christmas Day, 1844, Charles Darwin commented on a recent enumeration of the Azores flora and noted “*Watson’s Paper on [the] Azores has surprised me much; do you not think it odd, the fewness of peculiar species?*” More than 160 years later, the distinctiveness of the Azorean flora – specifically the low number of single island endemics (SIEs) and limited intra-archipelago diversification in comparison with other archipelagos in Macaronesia – remains to be satisfactorily explained. We are investigating diversification patterns across Macaronesia in a number of groups and this talk provides an overview of diversification patterns evident from our work. Focusing on *Pericallis*, a Macaronesian endemic genus which exemplifies the distinctiveness of the Azorean flora (one endemic species (with two multi-island endemic subspecies) is recognised in the Azores whereas the Canarian members of the genus are numerous and are largely SIEs) and integrating morphometric, genetic and bioclimatic data for Azorean and Canarian lineages, this talk highlights the contribution of isolation, habitat shifts and reticulation in generating the diversity patterns evident across the region.



## Homoploid hybrid speciation in *Argyranthemum* (Asteraceae)

OLIVER WHITE, M. CARINE & M. CHAPMAN



Carine, M. 2016. Homoploid hybrid speciation in *Argyranthemum* (Asteraceae). Diversification processes in the Macaronesian archipelago floras. Pp. 376 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Macaronesia; *Taxa*: *Argyranthemum*; *Other*: homoploid hybrid speciation, Simple Sequence Repeats (SSR), population genetics.

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The genus *Argyranthemum* is an exemplary evolutionary radiation of flowering plants endemic to archipelagos of the North Atlantic including Madeira, Selvagens and the Canary Islands. This group of plants is also noteworthy as a rare example of Homoploid Hybrid Speciation (HHS), the origin a new species via hybridisation without a change in chromosome number. This mode of hybrid speciation is particularly rare in nature, with only 20-30 well documented cases cited in the literature. Examples of HHS also present ideal biological scenarios to study the intersection between a number of evolutionary phenomena such as hybridisation, reproductive isolation, adaptation and speciation. On Tenerife in the Canary Islands, hybridisation between the montane laurel forest species *A. broussonetii* and the coastal xerophytic species *A. frutescens* is implicated in the origin of two other species: *A. sundingii* and *A. lemsii*. Both *A. lemsii* and *A. sundingii* are found in novel intermediate ecological habitats, are morphologically and genetically distinct with respect to their putative parents, supporting the view that these species have originated via HHS. Using a combination of nuclear and chloroplast Simple Sequence Repeat (SSR) markers, we assess the genetic diversity across multiple populations to investigate (1) whether HHS taken place and (2) if *A. sundingii* and *A. lemsii* are the result of a single or multiple hybridisation events.

## Hybridization to explain the diversification pattern of island taxa: Using codominant markers to investigate the “surfing syngameon” and alternative hypotheses in *Micromeria*

HARALD MEIMBERG, M. CURTO & P. PUPPO



Meimberg, H., M. Curto & P. Puppo 2016. Hybridization to explain the diversification pattern of island taxa: Using codominant markers to investigate the “surfing syngameon” and alternative hypotheses in *Micromeria*. Pp. x-xx in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Canary Islands; *Taxa*: *Micromeria*; *Other*: hybridization; surfing syngameon; genetic diversity; microsatellites.

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Continuous colonization of islands from the mainland might lead to introduction of high levels of genetic diversity that might facilitate adaptability and be sorted in different lineages during further expansion across the archipelago. This had been recently formulated as the „surfing syngameon” hypothesis. The model implies that genetic diversity decreases with distance from the islands receiving migrants from the mainland. Nevertheless, the hypothesis might also apply to inter island exchange in species that are already reproductively isolated from mainland progenitors. We study the genus *Micromeria* a group of species that can be clearly delimited but produce hybrids between most species that naturally can occur together. In several studies we investigated phylogeny and genetic structure and constructed one joint codominant dataset using Microsatellites that incorporate all species from all islands. Even though genetic structure indicates a genetic differentiation for most species, we found gene flow between species within islands and between islands. Contrary to expectations, diversity within populations increases with decreasing island age. Between-population differentiation shows an opposite pattern, with young islands having lower among population differentiation than old islands. Our results support a scenario of inter-island colonization with continuous gene-flow: Every time a new island emerges it is colonized from multiple sources, leading to single populations that contain a high number of alleles but are similar to each other. In older islands differentiation might occur explaining lower within population diversity and higher among population differentiation. Our results support some conclusions of the “surfing syngameon” hypothesis. Nevertheless, it is indicated that the syngameon is more dynamic and that it expands with the colonization-front thus preventing loss of genetic diversity through founder effects. In this example colonization does not necessarily lead to a decrease in genetic diversity due to founder effects, ecological filters or other sorting out processes.

## Postzygotic isolating barriers, divergence and speciation in Macaronesian *Tolpis*

DANIEL J. CRAWFORD, D. P. HAUBER, L.B. SILVA, M.M. SEQUEIRA, M. MOURA, A. SANTOS-GUERRA, J. K. KELLY ET AL.



Crawford, D.J., D.P. Hauber, L.B. Silva, M.M. Sequeira, M. Moura, A. Santos-Guerra, J.K. Kelly, M.E. Mort, B. Kerbs, J. Ressler & M.J. S. Gibson 2016. Postzygotic isolating barriers, divergence and speciation in Macaronesian *Tolpis*. Pp. 378-279 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Macaronesia; *Taxa*: *Tolpis*; *Other*: chromosomal mutations, postzygotic barriers, prezygotic barriers.

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The prevailing paradigm for plant speciation, especially in oceanic archipelagos, is that prezygotic barriers are most important in early stages of speciation. Ecogeographic factors are considered most effective in reducing gene flow and promoting divergence, with postzygotic factors evolving after geographic isolation. The occurrence of natural hybrids when species come into contact, and the ability to synthesize viable, fertile  $F_1$  hybrids argue against postzygotic factors. However, recent and ongoing biosystematic studies in *Tolpis* demonstrate postzygotic isolating barriers, namely, reduced  $F_1$  pollen fertility. The observed reduction in pollen fertility correlates with phylogenetic distance, suggesting that pollen sterility factors accumulate subsequent to divergence of lineages into archipelagos. At the other extreme, progeny of individual maternal plants vary in fertility, and crosses between populations on the same island may have very reduced fertility. Some highly sterile plants exhibit meiotic irregularities indicating chromosomal mutations (translocations and inversions). In other cases, meiosis showed the expected 9 bivalents. These observations indicate that genic/chromosomal factors could facilitate initial divergence rather than having accumulated subsequent to divergence. The synthesis of advanced generation hybrids ( $F_3$ ) between two species of *Tolpis* reveals hybrid breakdown in a number of traits such as pollen fertility, time to germination, malformed embryos, etc., indicating negative epistatic interactions at loci affecting fitness. These

results demonstrate a variety of postzygotic isolating barriers in Macaronesian *Tolpis*. Postzygotic isolating factors may be more important in island lineages than is currently recognized. The challenge of doing experimental work, especially in long-lived plants so frequent in islands, likely accounts for the paucity of postzygotic data for insular lineages.

## The utility of Multiplexed-Shotgun-Genotyping (MSG) for resolving phylogenetic relationships within and among oceanic archipelagos: An example from Macaronesian *Tolpis* (Asteraceae)

MARK E. MORT, J.K. ARCHIBALD, M.J.S. GIBSON, H.L. BONTRAGER, D. P. HAUBER, L.B. SILVA, M.M. SEQUEIRA ET AL.



Mort, M.E., J.K. Archibald, M.J. S. Gibson, H.L. Bontrager, D.P. Hauber, L.B. Silva, M.M. Sequeira, M. Moura, A. Santos-Guerra, J.K. Kelly, M. Gruenstaeudl, J. Caujapé-Castells & D.J. Crawford 2016. The utility of Multiplexed-Shotgun-Genotyping (MSG) for resolving phylogenetic relationships within and among oceanic archipelagos: An example from Macaronesian *Tolpis* (Asteraceae). Pp. 380-381 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Macaronesia; *Taxa*: *Tolpis*; *Other*: inter-island dispersal, intra-island diversification, multiple shotgun genotyping.

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Plants endemic to oceanic islands are well known models for studying patterns and processes of evolution. However, resolving phylogenetic relationships within insular lineages is often difficult due to decoupling of molecular and ecological/morphological diversity. Low molecular divergence leads to poorly resolved phylogenies with limited utility for interpreting patterns of evolution. Macaronesian *Tolpis* (Asteraceae) is present in the Canary Islands (CI), Madeira, Azores, and Cape Verde (CV). Prior molecular phylogenetic studies have resolved several clades reflecting geography, including a CI-CV clade. Members from CI-CV are distributed across the five westernmost CIs and CV on substrates of broad geologic age, and vary in morphology, reproductive biology, and ecology. A new

species in CI-CV was recently named, and studies suggest additional cryptic diversity. However, despite extensive efforts, prior estimates of phylogeny based on analyses of rapidly-evolving cpDNA regions and nrDNA ITS/ETS for *Tolpis* have lacked the resolution and sampling necessary to provide a robust framework for evolutionary studies. Furthermore, the relationships between species from the Azores and Madeira to each other or to the CI-CV clade remain uncertain. Analyses of MSG data were employed to provide the first robust estimate of phylogeny for *Tolpis*, including multiple individuals from over 50 populations from all archipelagoes in which the genus occurs. At the deepest levels of the phylogeny, relationships among archipelagos was strongly supported, providing new and somewhat unexpected insights into species relationships within and between the Azores and Madeira. These data provide unprecedented resolution among populations within each of the archipelagos. The phylogeny suggests that both inter-island dispersal as well as intra-island diversification have played roles in the ongoing diversification of the genus in the Canaries.

## From single lineages to entire floras: What are the main evolutionary processes forming the Macaronesian flora?

HANNO SCHAEFER



Schaefer, H. 2016. From single lineages to entire floras: What are the main evolutionary processes forming the Macaronesian flora?. Pp. 382 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Macaronesia; *Taxa*: Apiaceae, Euphorbiaceae; *Other*: Azores, *Angelica*, Euphorbia, radiation.

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How and when the species-rich flora of the mid-Atlantic islands evolved is focus of many research projects but the results so far give us a relatively complex picture. Looking at two widespread plant families, the Apiaceae and the Euphorbiaceae, I analyze the contribution of geographic isolation, divergence time and habitat heterogeneity on genetic and morphological diversity within and between endemic taxa. Both families are represented by c. 65 species in Macaronesia, half of which are probably indigenous. Apiaceae colonized the Azores min. nine times independently before the arrival of the first human settlers, Madeira and the Canaries 10-14 times, and Cape Verde just once or twice. In Euphorbiaceae, we find evidence for just two successful colonizations of the Azores and about four of Madeira, the Canaries, and Cape Verdes respectively. Diaspore morphology suggests, for both families, a rather limited dispersal ability and therefore a high potential for allopatric speciation. In contrast, radiations (cladogenesis) are rare in both families: two cases in the Azores, two in the Cape Verdes and six in Madeira and Canaries. Only in the latter two archipelagos, these radiations also coincided with significant morphological diversification. For Apiaceae and Euphorbiaceae there is no significant effect of isolation or divergence time on genetic diversification but habitat heterogeneity seems to have led to higher morphological diversity in the Canaries and Madeira. I will discuss these findings in the broader context of all Macaronesian flowering plant lineages.



## Specialized Symposium 15

### (Ev4) Invertebrate Evolution on Islands

CHAIRS: BRENT EMERSON, HERIBERTO LÓPEZ & CHRISTINE PARENT

## Linking macro- and microevolutionary perspectives to evaluate the role of Pleistocene sea-level oscillations in driving island diversification patterns

ANNA PAPADOPOULOU & L.L. KNOWLES



Papadopoulou, A. & L.L. Knowles 2016. Linking macro- and microevolutionary perspectives to evaluate the role of Pleistocene sea-level oscillations in driving island diversification patterns. Pp. 384 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Puerto Rico Bank (Caribbean); *Taxa*: *Amphiacusta* ground crickets; *Other*: sea-level change, island connectivity cycles, comparative phylogeography, diversification.

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Island connectivity cycles caused by Pleistocene sea-level oscillations are expected to impact not only population demographic processes, but also the patterns of species diversity that accumulate over longer evolutionary time-scales. In this study we conduct side-by-side comparisons between flightless ground cricket species from two island areas of equivalent size, which differ with respect to their exposure to sea-level oscillations, as well as their diversity patterns. Specifically, we generated a genome-wide dataset of 150,000 SNPs for a clade of seven *Amphiacusta* species endemic to the Puerto Rico Bank, sampled at both inter- and intraspecific levels. By linking micro- and macroevolutionary perspectives we aimed to gain insights into the particular evolutionary dynamics associated with changes in island area and isolation. We found consistently deeper interspecific divergences and higher population differentiation across mainland Puerto Rico and the isolated island of Mona, in comparison to Virgin Islands, Vieques and Culebra, which have experienced severe changes in island area and connectivity during the Pleistocene. We evaluate alternative hypotheses for extinction and migration rates during periods of high and low sea levels to explain the lower levels of population divergence and lack of speciation across the Virgin Islands. We further use demographic simulations to assess how microevolutionary responses to island connectivity cycles, and consequently diversification patterns, may vary across organisms depending on taxon-specific ecological traits. Our study highlights how consideration of the underlying microevolutionary processes is critical to current efforts for a Pleistocene-sensitive model of island biogeography and more broadly to studies of island diversification.

## Adaptive radiation and parallel evolution in the sheet-weaving spiders (Linyphiidae) of the south Pacific Archipelago of Juan Fernández

MIQUEL A. ARNEDO & G. HORMIGA



Arnedo, M. & G. Hormiga 2016. Adaptive radiation and parallel evolution in the sheet-weaving spiders (Linyphiidae) of the south Pacific Archipelago of Juan Fernández. Pp. 385 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Juan Fernandez Archipelago, southern Pacific Ocean; *Taxa*: Linyphiidae spiders (Araneae, Linyphiidae); *Other*: convergent evolution, independent colonization, ballooning, sanger sequencing, ecological shift, molecular dating.

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Oceanic islands have provided some of the most striking examples of rapid evolution of divergent phenotypes. On the other hand, distantly related species sometimes convergently evolve similar phenotypic characteristics upon insular colonization. Here we report on a newly discovered species radiation on the oceanic archipelago of Juan Fernández, off the coast of Chile. A multi-locus phylogeny revealed four independent colonizations of Juan Fernández by sheet-weaving spiders (Linyphiidae) that have resulted in local speciation events. In situ diversification was more prevalent in Robison Crusoe Island than in Alejandro Selkirk Island. We identified only a single case of between island dispersal. Three of the island lineages produced species with bizarre morphologies, including cases of island gigantism and extreme appendage elongation. Additionally, we document major ecological shifts in the endemic species of Robinson Crusoe Island, including the evolution of diverse atypical foraging webs and the likely abandonment of web building. We have generated a timeframe for the colonization and the evolution of these island endemics using relaxed Bayesian approaches. The radiation of sheet-weaving spider in the Juan Fernández Islands represents one of the most remarkable examples of insular adaptive radiation so far reported, not only within spiders but probably in terrestrial arthropods. This model system offers unparalleled opportunities to investigate the external drivers and the genomic changes associated with major morphological and ecological transitions in rapid diversification events.

## The role of allele sorting in a parallel speciation gradient of *Calosoma* beetles in the Galápagos archipelago

CARL VANGESTEL & F. HENDRICKX



Vangestel, C. & F. Hendrickx 2016. The role of allele sorting in a parallel speciation gradient of *Calosoma* beetles in the Galápagos archipelago. Pp. 386 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Galápagos; *Taxa*: *Calosoma*; *Other*: adaptive radiation, speciation genomics, introgression, speciation continuum.

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A most intriguing feature of adaptive radiation within islands is that phenotypic similar species evolve independently along repeated environmental gradients. It remains a contentious issue whether each island community has reached similar endpoints either by i) true independent parallel evolution, ii) a single evolution event followed by immigration into similar habitat on different islands ('species sorting') or iii) infiltration of adaptive alleles from one species into another ('allele sorting'). In an attempt to tackle this long-standing evolutionary puzzle, we studied an adaptive radiation of caterpillar hunters within the Galápagos islands. Here, representatives of this genus radiated along an altitudinal gradient resulting in the repetitive occurrence of highland and lowland ecotypes on each island. The combination of chronological variation in island age and replication of environmental gradients across islands has created a unique and rare example of a speciation continuum, allowing us to study the full range of different stages in an evolutionary trajectory within a single taxon. In an attempt to unravel the evolutionary history of this adaptive radiation, genetic variation was quantified by mapping Restriction-Associated DNA tags against a newly assembled reference draft genome. Our results suggest that the repeated evolution of these ecotypes (partly) involves the same alleles and that "allele sorting" is a potential and important process in this radiation. As such, we believe our results offer a fertile ground for further research on the underlying molecular mechanisms of adaptive radiations in islands.

## Near and far: Contrasting remote and near continent island radiations

DIANE M. PERCY



Percy, D.M. 2016. Near and far: Contrasting remote and near continent island radiations. Pp. 387 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Atlantic and Pacific Ocean islands; *Taxa*: Psylloidea, Fabaceae, Myrtaceae; *Other*: host plant, species radiation, psyllid.

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Comparing radiations that take place on islands near and far from continental source areas reveals the role that immigrants have played in shaping and directing radiations over time. A higher frequency of immigrants does not necessarily disrupt ongoing insular radiations, but may shift the trajectory of a radiation in different ways. I will review examples in plants and insects that reflect responses to immigration during processes of radiation and speciation. Examples from invasive species in historical time can also serve to illustrate responses expected over evolutionary time.

## Galapagos land snail's metabolic rate: A relationship of shell morphology and environment

YANNIK E. ROELL, J. VOYLES & C.E. PARENT



Roell, Y.E., J. Voyles & C.E. Parent 2016. Galapagos land snail's metabolic rate: A relationship of shell morphology and environment. Pp. 388 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Galapagos Islands; *Taxa*: Naesiotus; *Other*: metabolic, morphology, physiology, environment, snails.

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Adaptive radiation studies mainly focus on morphological characters and often overlook the physiological consequences to these adaptations. The link between morphological and physiological changes with environmental variation would allow for the understanding of why an adaptation would arise and why a lineage has diversified. The endemic land snails of the genus *Naesiotus* form the most species rich adaptive radiation of the Galapagos Islands with over 60 species described. These snails inhabit most islands from low elevations that are hot and arid to higher elevations that are cool and humid. Along this climatic gradient, *Naesiotus* species present a diverse spectrum of shell size, shape, and color. We predict that snails in hot and arid climates have lower basal metabolic rates and smaller shell apertures which would minimize water loss. We quantified the metabolic rate (calculated from oxygen consumption and carbon dioxide production) and water loss of 13 species distributed along two Galapagos elevational transects using a Sable Systems International FoxBox. We measured spatial and temporal variation in temperature and humidity along the transects and tested whether species metabolic rate changes due to morphology or environment or both. This research work will help establish how snail physiology differs along elevational gradients and whether snail shell morphology represents an adaptation to these differences.

## Flightless vs Winged: How dispersal ability shapes colonization and speciation processes of grasshoppers on the Canary Islands

AXEL HOCHKIRCH



Hochkirch, A. 2016. Flightless vs Winged: How dispersal ability shapes colonization and speciation processes of grasshoppers on the Canary Islands. Pp. 389 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Canary Islands; *Taxa*: Orthoptera; *Other*: colonization, speciation, differentiation, radiation, island biogeography.

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The Canary Islands are a well-known model system for the study of colonization and speciation processes. Situated in the Atlantic Ocean with a distance of ca. 100 km from the African continent and being of volcanic origin, they are an ideal region for evolutionary studies. Approximately 90 species of Orthoptera occur on the Canary Islands, 40% of them being endemic. Two third of these endemics belong to the genera *Calliphona*, *Acrostira/Purpuraria*, *Arminda* and *Sphingonotus*. We studied the phylogeny of the latter two genera by sequencing mitochondrial and nuclear genes. While the flightless genus *Arminda* showed the typical stepwise colonization pattern from the east to the west, following the direction of the prevailing wind and ocean currents as well as the geological history of island formation, the alate genus *Sphingonotus* shows a complex pattern of multiple independent colonization events. Only two out of nine *Sphingonotus* species occurring on the Canary Islands turned out to be sister species. The others either represented isolated old lineages (*S. guanchus*, *S. picteti*, *S. rugosus*) or young relatives to species from the African mainland (*S. willemsei*, *S. sublaevis*, *S. fuerteventurae*, *S. pachecoi*). We conclude that active dispersal ability in most *Sphingonotus* species is not large enough to colonize other islands and that initial colonization from the African mainland was supported by sand storms, resulting in the unique pattern of multiple colonization without subsequent radiation. Contrary, for the genus *Arminda* we suggest that dispersal usually takes place by passive transport of egg material with the ocean currents.



## What are we losing? The ecomorphology of decline in Galápagos land snails

ANDY C. KRAEMER & C.E. PARENT



Kraemer, A.C. & Christine E. Parent 2016. What are we losing? The ecomorphology of decline in Galápagos land snails. Pp. 390 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Galapagos Islands, Ecuador; *Taxa*: Naesiotus; *Other*: conservation, biogeography, extinction, adaptive radiation, land snails.

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Most research on modern extinctions focuses on the numbers, such as the number of species on the IUCN Red List, the rate of extinction, and the correlation between these numbers and human activity. Few studies, however, compare the ecology and morphology of species that are healthy to those in decline. Pacific Island fauna have endured a crisis of extinction in recent years owing to habitat destruction, introduced species, and unsustainable harvesting by humans. Each species' risk of extinction depends on how it interacts with its environment (including these new threats introduced by humans). We assessed the risk of extinction for 80 Galápagos endemic land snails (genus *Naesiotus*). We then compared extinction risk to several estimates of diversity (including ecology, morphology, native range, and phylogeny) to identify 1) what aspects of snail diversity are being lost through the collapse of this spectacular radiation, and 2) whether we can predict future declines using this information. By considering the ecology of species and how each constellation of threats places them at risk, we may be able to move from extinction triage to extinction prevention.

## The role of morphological evolution and prey specialization in adaptive radiations: The spider genus *Dysdera* in the Canary Islands

NURIA MACÍAS-HERNÁNDEZ, O.S. WANGENSTEEN, S. TOFT & M.A. ARNEO



Macías-Hernández, N., O.S. Wangenstein, S. Toft & M. Arnedo 2016. The role of morphological evolution and prey specialization in adaptive radiations: The spider genus *Dysdera* in the Canary Islands. Pp. 391 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Canary Islands, Ecuador; *Taxa*: *Dysdera* (Dysderidae, Araneae); *Other*: diversification, morphology, prey specialization, metabarcoding.

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The genus *Dysdera* is remarkable among spider genera in showing a wide range of variation in body size and mouthpart size and shape. The genus has been traditionally considered a specialised predator on woodlice, but recent studies have revealed the existence of different levels of prey specialisation among the species. *Dysdera* has undergone a remarkable diversification in the Canary Islands, where more than 50 endemic species have been recorded. It has been hypothesized that trophic segregation among co-occurring species was a major driver of morphological diversification in Canarian *Dysdera* and hence that prey specialisation might lie behind its outstanding richness of species. In the present study we test prey specialization and resource partitioning in several species of Canarian *Dysdera* by combining prey preference experiments, with nutritional adaptation and molecular prey detection methods. We took advantage of DNA-based methods, which offer the ability to identify prey where prey hard parts do not survive the digestion process, as is the case for spiders and other terrestrial invertebrates. Specifically, we used a metabarcoding approach to characterize dietary preferences in the wild in several co-occurring species of Canarian *Dysdera*. Our preliminary experimental results showed that cheliceral morphology is a predictor of the level of prey specialisation. Additionally, species with different cheliceral types also showed differential use and assimilation of nutrients. Those findings reveal the relationship between morphology, prey preference and food specialization, which may ultimately lead to the generation of biodiversity.

## The thin line between *in-situ* radiation and among island dispersal in the genesis of replicated species assemblages on the Galapagos

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& C. VANGESTEL



Hendrickx, F., C. Busschere, S.M van Belleghem, Z. Corte & C. Vangestel 2016. The thin line between *in-situ* radiation and among island dispersal in the genesis of replicated species assemblages on the Galapagos. Pp. 392 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Galapagos, Ecuador; *Taxa*: wolf spiders, ground beetles; *Other*: adaptive radiation, population genomics, parallel radiation.

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Species radiations on island archipelagos can result in a particular set of phenotypically divergent species that is repeatedly found on the different islands. When species from the same island are more closely related to each other compared to ecologically equivalent species residing on different islands, it is often suggested that parallel evolution repeatedly resulted in a similar set of species on each island separately. Recent genetic studies of such presumed parallel radiations of spiders and beetles from the Galapagos show that substantial historic and contemporary gene exchange within as well as between islands may strongly drive the genetic relationships among these species, rendering it difficult to make sound inferences about their evolutionary history. Importantly, identifying the genomic regions associated with adaptation to different environments showed that repeated adaptation on different islands often involves repeated fixation of the same alleles or alleles that have a shared ancestry. Hence, for genes involved in ecotypic differentiation, a different picture arises wherein species cluster by ecotype rather than by their geographic distribution. This demonstrates that recurrent adaptive differentiation is at least partly based on introgression of adaptive alleles among islands or even through species dispersal between islands followed by extensive gene flow within islands. These findings not only relax the use of neutral gene genealogies to reconstruct the evolutionary history island radiations, but moreover suggests that interspecific gene exchange within as well as among islands makes the distinction between niche occupancy through adaptive radiation and species dispersal less clear-cut as often assumed.

## Community assembly over evolutionary time: Application of next generation sequencing for high throughput assessment of Hawaiian arthropod diversity

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& R.G. GILLESPIE



Krehenwinkel, H., S. Kennedy, J. Henderson, J. Russack, B. Simison & R.G. Gillespie 2016. Community assembly over evolutionary time: Application of next generation sequencing for high throughput assessment of Hawaiian arthropod diversity. Pp. 393 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hawaii; *Taxa*: Arthropoda; *Other*: evolution, arthropod communities

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Home to impressive and diverse adaptive radiations, the Hawaiian Archipelago is a biodiversity hotspot of global importance. In conjunction with its geographic isolation and well known geology, the island chain is also considered a natural laboratory for the study of island biogeography, with the geological chronology providing an opportunity to study changes in ecological interactions over evolutionary time. Although much of the Hawaiian biodiversity is comprised of arthropods, very little is known about diversification and assembly of Hawaiian arthropod communities. In a collaborative project, we currently aim to understand the processes underlying Hawaiian arthropod community assembly. The emerging technologies of next generation sequencing now allow for unprecedented insights into the contribution of species interactions, abiotic factors and island geology, in shaping Hawaii's diversity. We have developed next generation sequencing based tools for rapid, cost efficient and large scale analysis of taxonomy, biogeography and species interactions. Here, we present results from the application of Illumina sequencing to: 1. Multi-locus phylogenetic and taxonomic analyses. By simple amplicon sequencing, we are building a comprehensive barcode reference library for Hawaiian arthropod taxa. 2. Metabarcoding of mixed arthropod samples. We have optimized barcoding protocols for qualitative and quantitative analyses of the species composition in communities. 3. Gut content analyses of predatory arthropods. We have developed a protocol to enrich prey DNA from whole body extractions of predatory arthropods, enabling high throughput analysis of food webs without the need for predator specific blocking primers. 4. Large scale population genetic studies across multiple species. We present an Illumina sequencing protocol for these markers and a simple software solution for data analysis. Together, these data will provide insights into changes in species diversity, patterns of abundance, and food web interactions, over the island chronology.

## Island colonisation: Do species jump, or are they pushed?

BRENT C. EMERSON, V.G. OLIVARES, H. LÓPEZ, J. PATIÑO, A. MACHADO & N. ALVAREZ



Emerson, B.C., V. García Olivares, H. López, J. Patiño, A. Machado & N. Alvarez 2016. Island colonisation: Do species jump, or are they pushed? Pp. 394 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Canary Islands; *Taxa*: Coleoptera, Curculionidae; *Other*: phylogeography, mtDNA, dispersal, genetic admixture

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Colonisation of species from one island to another is a fundamental process for the establishment of island biotas within oceanic archipelagos, but exactly how species arrive is a little understood question. Phylogenies can tell us approximately when a colonisation event may have occurred, but not how. Sexually reproducing arthropods, particularly flightless species are interesting in this context. Excluding secondary transport by birds, which is likely important for ectoparasitic and perhaps in some cases non-ectoparasitic taxa, colonisation must be either windborne or waterborne. Windborne colonisation most probably involves single gravid females, as it is unlikely that wind-transported individuals would arrive within the geographic proximity of each other required for subsequent mating. Even allowing for a multiply mated female, successful establishment of a windborne colonist will be challenging due to low genetic variation and inbreeding. On the other hand, colonisation by oceanic rafting can potentially result in multiple individuals arriving within geographic proximity of each other. In this case subsequent mating among unrelated individuals may limit the negative genetic consequences of a founder event. To date we are not aware of any study that has been able to distinguish between these two mechanisms to explain the origin of flightless island arthropod species. Here we present evidence from a weevil radiation in the Canary Islands for oceanic rafting between islands, mediated by a novel mechanism, and discuss the implications for island biogeographic theory.

## A bottom up approach to understand the origins of an island super-radiation

VÍCTOR GARCÍA OLIVARES, H. LÓPEZ, J. PATIÑO, U.L. DE HERREDIA, M. BÁEZ, A. MACHADO, M. SEPPY, N. ALVAREZ & B. C. EMERSON



García Olivares, V., H. López, J. Patiño, U. Lopez de Herredia, M. Báez, A. Machado, M. Seppy, N. Alvarez & B.C. Emerson 2016. A bottom up approach to understand the origins of an island super-radiation. Pp. 395 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Canary Islands; *Taxa*: Coleoptera, Curculionidae; *Other*: evolution, speciation, diversification, genomic.

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Species radiations provide fertile ground for the investigation of the drivers of speciation on oceanic islands, and have been the focus of many molecular phylogenetic studies. This top down phylogenetic approach has been very informative to understand the timing and geography of speciation (intra-island versus inter-island), but has typically been less informative regarding the detail of speciation itself. However, diversification is a dynamic process, with both speciation and extinction playing out over the full geological timescale of island ontogeny. Thus a bottom up approach, where the focus is on broad geographical sampling of closely related species complexes within radiations, can provide a more direct approach to the study of the speciation process. In this presentation I will outline how we are taking such a genome-focused bottom-up approach within the genus *Laparocerus*, the largest arthropod radiation on the Canary Islands.



## Relation between wing development and diversification in the Macaronesian *Rhopalomesites* beetles (Coleoptera: Curculionidae)

DAVID HERNÁNDEZ-TEIXIDOR, H. LÓPEZ, V.G. OLIVARES & P. OROMÍ



Hernández-Teixidor, D., H. López, V.G. Olivares & P. Oromí 2016. Relation between wing development and diversification in the Macaronesian *Rhopalomesites* beetles (Coleoptera: Curculionidae). Pp. 396 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Macaronesian Islands; *Taxa*: *Rhopalomesites*, Coleoptera, Curculionidae; *Other*: colonisation, geographical isolation, phylogeny, geometric morphometrics, wing reduction.

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The phytophagous weevils of the genus *Rhopalomesites* constitute a lineage endemic to Macaronesia, occurring in the Canary, Madeira and Azores archipelagos. Recently, we have studied the importance of geographical versus ecological barriers in the diversification of this genus, and evidence was found for two *Rhopalomesites* monophyletic lineages. A lineage associated with *Euphorbia* host plants has vicariant species in the Madeira and Canary archipelagos. In this lineage, an ancestral association with *Euphorbia mellifera* in the two island groups was deduced, which has subsequently undergone shifts to related host plants in marginal areas. A second, ecologically generalist lineage exploiting decaying wood from Lauraceae and other forest trees, is also present on such islands along with the Azores and part of Atlantic Europe. These results point to a quasi-parallel colonization of Macaronesia by the two lineages dating to the early Pliocene, followed by allopatric isolation in more recent times according to the presence of suitable habitats on particular islands. The flight ability of different species is a determining factor for dispersion; could the wing development degree have played a decisive role in the diversification of this genus and *Rhopalomesites*? Here we present the preliminary results of a study to establish relationships among the genetic structure of the different species of these two *Rhopalomesites* lineages and the characteristics of their wings. For this, we perform a geometric morphometric analysis with specimens of each species, using landmarks on the wing venation. The preliminary results shown that both species lineages are separated by the characteristics of their wings, one of them including the species with fully development wings (functional), and the other one the species with different wings reduction grade (not functional).



## Specialized Symposium 18

### (Ev5) Patterns of adaptation on islands and the Insularity Syndrome

CHAIRS: RITA COVAS & CLAIRE DOUTRELANT

## Life-history and morphological evolution in island birds

RITA COVAS, P.-A. CROCHET & C. DOUTRELANT



Covas, R., P.-A. Crochet & C. Doutrelant 2016. Life-history and morphological evolution in island birds. Pp. 398 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: birds; *Other*: insularity syndrome, island rule, life-history evolution, morphological evolution, parallel evolution, parental care.

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The shared characteristics of island environments, such as impoverished biotas and less-seasonal climates, are thought to trigger specific adaptations by organisms. Birds make very good island colonisers, and are among the best studied groups. However, few broad-scale systematic analyses have examined patterns of evolution in island birds and has a result our understanding of which traits are affected by the ‘insularity syndrome’ remains weak. We have been studying patterns of adaptation in reproductive life histories and morphology in island birds worldwide. Results show that insularity favours a slower pace of life in birds, with reduced fecundity, extended developmental periods, and an increase in the frequency of cooperative breeding. Reduced species diversity on islands (including the reduced number of predators and parasites) and reduced seasonality appear to play a prominent role in life history change. Parallel changes in morphological traits include changes in wing and leg shape, (broader wings and longer tarsi) and larger skull size relative to body mass. Last, we found support for the ‘island rule’ in island birds, but the effect was not pronounced, which might be due in part to the high number of extinct large flightless birds that were not included in our analyses. While changes in body shape appear to arise from a more sedentary lifestyle, the factors underlying changes in body size are more complex, probably arising from an interaction of different ecological factors such as competition, predator release, energetics and niche shifts, which require further field study.

## Worldwide patterns of bird colouration on islands

CLAIRE DOUTRELANT, M. PAQUET, E. LOBATO, J.P. RENOULT, C. LOISEAU, A. GRÉGOIRE, M. MELO, P.-A. CROCHET & R. COVAS



Doutrelant, C., M. Paquet, E. Lobato, J.P. Renoult, C. Loiseau, A. Grégoire, M. Melo, P.-A. Crochet & R. Covas 2016. Worldwide patterns of bird colouration on islands. Pp. 399 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: birds; *Other*: insularity syndrome, insularity syndrome, island rule, life-history evolution, parasite pressure, spectrophotometry.

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Island environments share distinctive characteristics that offer unique opportunities to investigate parallel evolution. Previous research has produced evidence of an island syndrome for morphological traits, life-history strategies and ecological niches, but little is known about the response to insularity of other important traits such as animal signals. Here, we tested whether birds' plumage colouration is part of the island syndrome. We analysed with spectrophotometry the colouration of 116 species endemic to islands and their 116 closest mainland relatives. We found a pattern of reduced brightness and colourfulness for both sexes on islands. Additionally, we found a decrease in the number of colour patches on islands that was associated, in males, with a decrease in the number of same-family sympatric species. These results demonstrate a worldwide pattern of parallel colour changes on islands and suggest that a relaxation of selection on species recognition may be one of the driving mechanisms. In a separate study, we started investigating the potential role of parasites in the observed reduced colouration on islands. We quantified both parasites and colouration for about 300 individuals belonging to 7 pairs of insular and mainland species of birds breeding in the islands of São Tomé and Gabon. We found that species were less parasited on islands than mainland and that more parasited species have more saturated pigmentary colours as predicted by Hamilton Zuk hypothesis. Thus a reduction in parasites pressure on islands may play a role in the overall reduction in colour intensity in island birds and a wider study is needed to fully examine the role of this selective force.

## Island syndromes: What do we think we know

SHAI MEIRI



Meiri, S. 2016. Island syndromes: What do we think we know. Pp. 400 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: terrestrial vertebrates; *Other*: body size, density, evolution, island syndrome, life history, lizards.

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Island biogeography theory posits that evolution on islands is rapid, drastic, multifaceted – and predictable. Island vertebrates are thought to differ from mainland relatives – and the magnitude of these differences increases as islands become smaller and more isolated. Insular animals are thought to be members of communities enjoying relaxed predation and competition pressures. They are thus thought to evolve unique sizes as “dragons” or dwarfs”. Their dense populations force them to expand their niches. Island vertebrates are also thought to be slow: they have short limbs, and slow life histories. They should be generally dull (coloured), ‘naïve’ (unafraid of predators and not aggressive), and dumb (or at least small brained). I will show, giving examples from my own studies on insular lizards and carnivores, and from the literature in general, that these perceptions are often very poorly supported, taxon or archipelago specific, anecdote masquerading as generalities, or simply false. While evolution on islands is indeed drastic, and probably fast, island area and isolation are poor predictors of animal traits, because the relationships between species numbers and animal traits are anything but straightforward. Islands are not the resource poor but otherwise benign habitats they are often portrayed as. Different islands force their biota to face a wide array of selection pressures that are often contingent on history and geography and do not easily lend themselves to overarching generalizations. Furthermore, the high population densities of many insular animals bring about fierce intraspecific competition that make the island environment a much less relaxed place than it is often perceived, with fascinating consequences for evolution and ecology.

## Immune function and the island syndrome

KEVIN D. MATSON

Matson, K.D. 2016. Immune function and the island syndrome. Pp. 401 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: oceanic islands; *Taxa*: diverse hosts and parasites; *Other*: ecological immunology, disease ecology, hosts, parasites, pathogens.

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Life on isolated oceanic islands often means life in the absence of (or at least with fewer) top predators and large herbivores. Such a change in prey-predator and plant-herbivore interactions likely translates into slackened natural selection on the animals and plants that are normally being eaten. One consequence is that over evolutionary time island organisms lose their defenses against predation and herbivory. The extent to which similar dynamics underlie changes in host defenses against parasites (i.e., immune function) is less clear. The host-parasite interaction can be seen as ecologically analogous to prey-predator and plant-herbivore interactions, and some instances of island animals being hard hit by infectious diseases have been described. If the selective pressures imposed by parasites are reduced on islands compared to on continents and if immune defenses incur costs, then the immune system architecture is expected to differ between animal hosts on living on islands and continents. In this presentation, I will explore this hypothesis by reviewing current literature and examining the breadth and consistency of results. If the hypothesis is well supported, then changes in the immune system might be appropriately recognized as physiological aspect of the island syndrome.

## Transcriptome analysis to infer about the Reversed Island Syndrome

MARTINA TRAPANESE, V. MASELLI, M. BUGLIONE, S. PETRELLI, V. MARESCA  
& D. FULGIONE



Trapanese, M., V. Maselli, M. Buglione, S. Petrelli, V. Maresca & D. Fulgione 2016. Transcriptome analysis to infer about the Reversed Island Syndrome. Pp. 402 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Italy; *Taxa*: Lacertidae; *Other*: Italian wall lizard, transcriptome analysis.

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Differently from those described by Adler and Levins for Island Syndrome, in some insular populations environmental uncertainty and unpredictable mortality schemes will select for a new suite of characteristics. These reflect increased energy allocation towards reproduction because of life-history trade-offs. We named this suite of traits Reverse Island Syndrome (RIS). Under RIS, available energy is diverted from body growth and maintenance to early reproduction because mortality risk is high and unpredictable. In particular, males exhibit increased levels of aggressiveness and sexual activity; females allocate more energy towards reproduction increasing clutch mass. We demonstrated that the RIS in lizard population is driven by an increased activity of the melanocortin system, as also demonstrated by a melanism in the populations from islets. In this work we expose the first results of transcriptome analysis conducted on the island-mainland system where it was described for the first time. In this way we can have a wider framework of the genes, with different relevance, related to phenotypic traits involved in specific adaptations to island life. More than 110 millions of paired-end reads were used for *de novo* assembly. The results obtained with Trinity and Transabyss showed that these reads were assembled into 275310 transcripts via short overlaps. The mean contig size was 1036 bp with lengths ranging from 200 bp to more than 18000 bp. More than 140000 peptides were predicted from the assembled transcriptome and to more than 40000 a Gene Ontology annotation was assigned. Here we are interested in understanding how lizards use their genomes to respond to environmental and evolutionary pressures, considering that in our model the island broke away from the mainland not more than 4000 years ago (Island of Licosia from Mediterranean sea).

## The evolutionary shift from herbaceous towards woody flowering plants: A remarkable case of convergent evolution

FREDERIC LENS, L.C. DÓRIA & M. DEL ARCO



Lens, F., L. Chacon Doria & M. del Arco 2016. The evolutionary shift from herbaceous towards woody flowering plants: a remarkable case of convergent evolution. Pp. 403 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Canary Islands; *Taxa*: angiosperms; *Other*: convergent evolution, embolism resistance, drought stress, flowering plants, insular woodiness.

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Insular floras typically harbour species with a remarkable degree of woodiness. This so-called insular woodiness was described and interpreted correctly by Darwin, but many years later we still do not have a global overview in which plant groups the shift from herbaceousness towards derived woodiness has taken place and why this evolutionary transition has happened. Therefore, we are working on a review of derived woodiness within angiosperms using molecular phylogenies, revisions, and floras. Based on preliminary data, it is evident that derived woodiness is concentrated in the later diverging lineages of angiosperms (mainly Asteraceae), and many of these woody taxa are native to islands or island-like regions such as tropical mountain peaks. Surprisingly, the shift towards derived woodiness has occurred much more on continents than expected, especially in dry continental regions facing at least a number of consecutive dry months per year, such as savannas or (semi-)deserts. This suggests that increasing wood development and increasing drought stress resistance may go hand in hand, an observation that has also been found on the Canary Islands. Drought stress has never been associated with wood formation before, but we have already obtained experimental evidence in *Arabidopsis* and Canary Island daisies, showing that woody species are able to better avoid air bubble formation in their conductive xylem conduits due to drought stress than their closely related herbaceous relatives. To obtain more evidence for this link, we are performing water transport measures in stems of derived woody species and closely related herbaceous relatives in different plant groups to estimate the stem pressure at which plants loose 50% of their hydraulic conductivity (P50), which is considered as a good proxy for drought stress resistance.



## Tracking the effect of isolation time on morphological variation: Brandt's hedgehog (*Paraechinus hypomelas*) in Persian Gulf islands as a case study

GHOLAM HOSEIN YUSEFI, B.H. KIABI & N.M. MONTEIRO



Yusefi, G.H., B.H. Kiabi & N.M. Monteiro 2016. Tracking the effect of isolation time on morphological variation: Brandt's hedgehog (*Paraechinus hypomelas*) in Persian Gulf islands as a case study. Pp. 404 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Persian Gulf; *Taxa*: Brandt's hedgehog *Paraechinus hypomelas*; *Other*: island rule, degree of isolation, pleistocene glaciations, sea level rise, historical isolation, mammals.

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Insular mammals frequently differ in morphology from their continental counterparts. The mechanisms behind the generation of these differences, resulting from local adaptation and independent evolutionary processes, have the potential to strongly influence the patterns of body size variation among insulars. As such, small mammals tend to evolve towards a larger size in islands, while large mammals tend to reduce body size. This phenomenon, known as the “island rule”, has been recurrently challenged and still instigates heated discussions. Although the potential action of various selective forces capable of influencing body size evolution in island mammals have been repeatedly addressed, less is known about the effects of time in isolation. Here, in order to evaluate the effects of isolation time on the morphological variation among populations inhabiting Persian Gulf islands, we used the Brandt's hedgehog *Paraechinus hypomelas* (Brandt, 1836) as our model species. The results highlight a clinal variation along the sampled locations, closely reflecting the progressive historical isolation of the islands from the mainland and complying with what could be expected from the island rule. The observed levels of morphological differentiation translate the timing of the hypothetical last faunal exchanges between Larak, Qeshm and Hengam islands and the mainland. In the absence of any habitat, climate or size differences between the islands, and given the apparent absence of interspecific competition, we believe that the observed hedgehog size clines can be attributable to the degree of isolation (time of isolation).

## Evolution of island life histories in lizards: Evidence from Mediterranean islands

JOHANNES FOUFOPoulos, P. PAFILIS, E. VALAKOS, C. DONIHUE & K. BROCK



Foufopoulos, J., P. Pafilis, E. Valakos, C. Donihue & K. Brock 2016. Evolution of island life histories in lizards: Evidence from Mediterranean islands. Pp. 405 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Aegean Sea, Greece; *Taxa*: Bran Lizards of the genus *Podarcis*; *Other*: life history, predation, evolution, morphology.

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The life histories of island species have been the focus of evolutionary studies ever since Darwin visited the Galapagos. While much progress has been made in understanding the drivers of these patterns, comparatively little is known on the corresponding patterns in Lacertid lizards. Here we summarize and review the results of more than 30 years of investigations on the model system of the Aegean wall lizard genus *Podarcis*. We describe how the interactions between predation, parasitism and availability of natural resources shape the behavior, reproduction and morphology of insular populations based on data from dozens of islands from the Aegean Sea Region (Greece) and discuss how different drivers affect distinct aspects of life history.

## EVOLUTIONARY PATTERNS IN DEER ON MEDITERRANEAN ISLANDS

LEILA C. D'SOUZA, A.M. LISTER & D.A. RICHARDS



D'Souza, L., A.M. Lister & D.A. Richards 2016. Evolutionary patterns in deer on Mediterranean islands. Pp. 406 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Central Mediterranean: Malta and Sicily; *Taxa*: Cervidae: red, fallow and giant deer species; *Other*: insular dwarfism, Pleistocene, morphology.

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Malta's endemic dwarf deer are a remarkable example of insular body size evolution recovered from Mediterranean Quaternary deposits. The fossils show exceptional diversity in size and form that deviates from any likely European mainland ancestors. It is hypothesized that they migrated to Malta from Italy via Sicily, where they diversified into at least four size classes; this contrasts with the single size category found on the considerably larger island of Sicily. Antler, tooth and bone measurements and morphological characters - established to separate red, fallow and giant deer (the most plausible mainland ancestors) - are used to determine whether changes in size and shape signify taxonomic diversity. Early findings indicate that Maltese deer are not simply smaller, isometrically-scaled versions of larger modern species; some possess the reduced and robust distal limb proportions commonly seen in island dwarfs. Dental mesowear analyses suggest that all size groups contain both browsing and grazing individuals, but mixed feeders remain restricted to smaller size classes. This talk will focus on preliminary findings from comparative analyses with modern and with European Pleistocene deer species to illustrate the extent of morphological variation observed in the Maltese populations.

## Specialized Symposium 19

### (Ev6) The role of topography and elevation in diversification on islands

CHAIR: LAWRENCE R. HEANEY

## The role of topography and elevation in biological diversification on islands

LAWRENCE R. HEANEY



Heaney, L.R. 2016. The role of topography and elevation in biological diversification on islands. Pp. 408 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: islands, topography, speciation, biodiversity.

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In recent years, the predominant conceptual approach to the dynamics of biodiversity on islands has shifted from one in which colonization and extinction were the focal processes and islands were assumed to be static entities, to one in which speciation is incorporated as a primary process and islands are assumed to be dynamic entities on which changes in elevation and topography play a major role in impacting all of the biological processes. Simultaneously, a conceptual shift has occurred from assuming that most biodiversity occurs in lowland areas, to recognizing that much biodiversity occurs at moderate to high elevation, with many taxa absent from lowland areas. In this symposium, we explore the ways in which the extent of topography and elevation variation, and the dynamic history of changes in these variables, impact diversification in islands with a range of geological histories and degrees of isolation. We consider how organisms that differ in biological features (such as vagility and biomass) are impacted by differing island topographies and histories, and use all of these data and analyses to recommend topics for further research that will allow us to continue to build, test, and expand current models of biodiversity dynamics on islands.

## The role of topography in speciation by mammals within a complex plate-margin island

LAWRENCE R. HEANEY, D.S. BALETE, S.A. JANSA, E.A. RICKART & S. STEPPAN



Heaney, L.R., D.S. Balete, S.A. Jansa, E.A. Rickart & S. Stepan 2016. The role of topography in speciation by mammals within a complex plate-margin island. Pp. 409 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Luzon Island, Philippines; *Taxa*: Mammalia, Rodentia; *Other*: diversification, endemism, geological history, volcanism, climate, island radiations.

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Recent evidence has demonstrated that non-volant small mammals of the Philippines typically have low diversity in lowlands, greatly increase in diversity up to ca. 2,500 meters, and show a decline above that elevation. Using Luzon Island as an example of a species-rich oceanic island in SE Asia, we show that rare colonization events over the past ca. 14 my, followed by extensive diversification over long periods of time, has produced ca. 90% of the 54 small mammal species that are present, nearly all of which are endemic to Luzon. We present evidence that this diversification has taken place simultaneously with long-term volcanic and other tectonic activity associated with persistent subduction zones. This tectonic activity has increased the extent and height of mountains and the number of islands that subsequently merge into larger islands, producing increasingly complex topographic circumstances. Most speciation in the old endemic clades has taken place in allopatry at high elevation on the isolated mountains. Subsequent extensive secondary sympatry results in species-rich, ecologically diverse local communities of small mammals. As a result, both species richness and percent endemism on a given mountain are strongly positively correlated with the height of the mountain. Overall, these data show that most species richness among small mammals on Luzon has been generated by *in situ* speciation at high elevation, with the multiple mountain ranges providing a topographically diverse landscape in which progressive, long-term accumulation of species in endemic clades continues indefinitely. We postulate that organisms on other plate-margin oceanic islands, which have been inadequately studied, should show similar patterns of progressively increasing biodiversity correlated with progressively increasing island age, area, and topographic complexity. This is in stark contrast to the biotas of comparatively well-studied hot-spot islands that typically show an erosion/decline/extinction phase.

## Islands within islands: A global perspective on within-island isolation and its effect on diversification

MANUEL J. STEINBAUER



Steinbauer, M.J. 2016. Islands within islands: A global perspective on within-island isolation and its effect on diversification. Pp. 410 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global, local examples using the Canary Islands; *Taxa*: plants; *Other*: colonization, dispersal, isolation, probabilistic species pool models, speciation, within-island patterns, topography.

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I will present a strong, globally consistent empirical relationship between elevation and endemism on islands, indicating an effect of topography-driven isolation on speciation whose generality has hitherto been unrecognized. Isolation is locally more important than temperature, biotic interactions and area in influencing speciation rate on mountainous islands and strongly determines the spatial patterns of evolutionary dynamics within islands. This finding is further refined analysing species-specific dispersal characteristics. Environmental pre-adaptation, dispersal traits as well as directional dispersal vectors (wind current systems, bird migration routs etc.) cause colonisation rates to differ between species resulting in distinct, observable spatial patterns of isolation within islands that may vary with time. Again, differences in isolation are directly reflected in evolutionary dynamics. These findings, together with mounting evidence for species-specific evolutionary pathways gained from phylogenetic studies, urge us to acknowledge species characteristics and interactions in the environmental context within islands. The findings thus suggest the quantitative implementation of probabilistic species pool models that acknowledge both species-specific characteristics, as well as within-island environmental and topographic heterogeneity.



## Patterns of plant endemism on a high elevation island: The role of climate and topography

SEVERIN D.H. IRL, D.E.V. HARTER & C. BEIERKUHNLEIN



Irl, S.D.H., D.E.V. Harter & C. Beierkuhnlein 2016. Patterns of plant endemism on a high elevation island: The role of climate and topography. Pp. 411 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: La Palma, Canary Islands; *Taxa*: plants; *Other*: endemism, diversity, spatial pattern, topographic complexity.

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Climate and topography are among the most fundamental drivers of plant diversity. High elevation islands offer a diverse setting of climatic and topographic conditions (so-called climatic *mini-continents*), enabling us to study the influence of both factors on spatial patterns of endemism. Islands in general, and high elevation islands in particular, are famed for being excellent study objects of drivers of diversity and speciation processes. Therefore, we use the high elevation island of La Palma (Canary Islands) to test the relative importance of climate and topography on the spatial pattern of plant endemism using a large number of plots ( $n = 890$ ) covering all major environmental gradients of the island. Surprisingly, the relative importance of climate strongly differs depending on which response variables we focus on, i.e. endemic richness (a measure of biodiversity) or speciation-related endemism (percentage of endemics). Topography best predicts endemic richness, while climate is most important for endemism. The hotspots of endemic richness in topographically complex and steep regions are likely a combined result of evolutionary processes (preadaptation to rupicolous conditions, micro-refugia, dispersal limitations) and human-induced influences (introduced herbivores, fire, land use). In contrast, the hotspots of endemism at the highest elevations on the island are likely driven by specialization to local conditions and large-scale isolation effects (topography-driven isolation). The spatial incongruence in hotspots of endemic richness and endemism emphasizes the need for an integrated conservation approach acknowledging different diversity measures to protect the complete spectrum of diversity.

## Island ontogeny, environmental heterogeneity, and the build-up of island diversity

JOAQUIN HORTAL, J.S. CABRAL, S. MEIRI, A.B. PHILLIMORE, A.M.C. SANTOS  
& C. VIOLLE



Hortal, J., J.S. Cabral, S. Meiri, A.B. Phillimore, A.M.C. Santos & C. Violle 2016. Island ontogeny, environmental heterogeneity, and the build-up of island diversity. Pp. 412 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: theoretical models, topography, community structure, island radiations, trophic theory of island biogeography, trait diversity, phylogenetic diversity.

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Oceanic islands vary in area, elevation and environmental heterogeneity throughout their ontogeny. These geophysical factors produce variations in the carrying capacity and complexity of the islands, thereby determining the ecological space available for colonization and radiation. Islands typically receive a relatively constant flow of propagules of phylogenetically distinct lineages with different ecological traits, at rates that depend on their isolation and the dispersal abilities of the colonizers. Given that the environmental conditions, genotypes, and phenotypes present on an island vary with time, both the overall ecological space and the part of it that is available for colonization vary throughout its history. We present advances on a general model that predicts the diversity of lineages and traits in different types of oceanic islands, showing how island isolation interacts with ontogenetic changes to determine the complexity of island biotas. We discuss the model's implications for current theory on island biodiversity.

## Arthropod diversity across gradients of elevation on Society and Hawaiian islands: Environmental and anthropogenic effects

GEORGE K. RODERICK, N. DAVIES, S. CHARLAT, C.P. EWING, P.T.OBOYSKI, J.DECK ET AL.



Roderick, G.K., N. Davies, S. Charlat, C.P. Ewing, P.T. Oboyski, J. Deck, A.J. Rominger, L. Cayetano, N.R. Graham, H. Krehenwinkel, T. Ramage, D.S. Gruner, R.G. Gillespie 2016. Arthropod diversity across gradients of elevation on Society and Hawaiian islands: Environmental and anthropogenic effects. Pp. 413-414 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Pacific Islands, Society Islands, Hawaiian Islands; *Taxa*: arthropods, insects, spiders; *Other*: species diversity, invasive species, cloud forest, topography.

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Recent community-wide surveys of arthropods illustrate the role of local topography in species diversity, especially related to variation in elevation and precipitation, but also to the impact of human disturbance and associated invasive species. The Moorea BioCode Project (<http://mooreabiocode.org>) based on Moorea, French Polynesia, is an island-wide all taxon survey involving collection of specimen vouchers including DNA. The Hawaii-based Dimensions in Biodiversity (<https://nature.berkeley.edu/hawaiidimensions>) is sampling arthropods along a geological chronosequence of ecological communities across the main Hawaiian Islands. These sets of islands have similar taxonomic representatives and similar histories of human colonization. Here, we investigate the topographical patterns of diversity of arthropod taxa. Both sets of islands are dominated by non-indigenous species at low elevations with more indigenous and endemic species at higher elevations. In Hawaii, higher elevations are largely indigenous. Precipitation is critically important, with large differences between communities on windward and leeward sides of the islands, but also in association with cloud forest at higher elevations. Intact forest is also associated with arthropod species diversity. Species turnover associated with elevation and also other environmental variables is significant on both sets of islands, even across small geographical scales. In particular, the shift from almost entirely non-indigenous to indigenous-dominated systems occurs over relatively narrow gradients. Key questions remain, including the extent to which this non-indigenous/indigenous gradient is determined by environmental and/or anthropogenic variables, the role of some species to

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facilitate the invasion of others, and the importance of species diversity in resisting invasion. Answers to these questions are critical in designing strategies to protect these vulnerable island ecosystems in the face of global change.

## POSTER SESSIONS



Capelinhos volcano, Faial Island, Azores (Photo: Paulo A.V. Borges)

POSTER SESSION 1  
18 JULY 2016

BIODIVERSITY AND ECOLOGY

## First record of aquatic hyphomycetes associated with decomposing leaf litter in Azorean streams

VERÓNICA FERREIRA, A. PEREIRA, P.M. RAPOSEIRO & V. GONÇALVES



Ferreira, V., A. Pereira, P.M. Raposeiro & V. Gonçalves. 2016. First record of aquatic hyphomycetes associated with decomposing leaf litter in Azorean streams. Pp. 417 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: São Miguel Island, Azores; *Taxa*: aquatic hyphomycetes; *Other*: decomposing litter, oceanic islands.

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The decomposition of terrestrial derived litter is a fundamental ecosystem process in forest streams. The transfer of carbon and nutrients from litter into higher trophic levels is highly dependent on the activity of microbes, in particular aquatic hyphomycetes. Aquatic hyphomycetes are a phylogenetically heterogeneous group of fungi, composed mainly by the asexual forms of ascomycetes and basidiomycetes. These fungi, among other activities, incorporate carbon and nutrients in biomass (mycelia and conidia): the conidia will colonize new substrates locally and downstream and the mycelia penetrate the litter matrix increasing its nutritional quality that makes it more palatable to detritivores. Despite their importance, little is known about aquatic hyphomycetes in island systems. Here we present the first record of aquatic hyphomycetes associated with decomposing leaf litter in Azorean streams. Leaf litter of three species with distinct characteristics (*Acacia melanoxylon*, *Clethra arborea* and *Pittosporum undulatum*) was incubated in six streams in São Miguel Island, Azores, for 7 – 56 days, between June and August 2014. The litter was then incubated in the laboratory for 48h to induce conidia production and the conidia were identified and counted under a microscope. The number of aquatic hyphomycete species across litter species and streams varied between 8 and 15; a total of 31 species were recorded. *Lunulospora curvula* dominated in most streams. Depending on litter species and stream, *Anguillospora pseudolonguissima*, *Clavariopsis aquatica*, *Cylindrocarpon* sp., *Dimorphospora foliicola*, *Tricladium chaetocladium*, *Triperspermum myrti* and *Triscelophorus monosporus* were also important species. Community structure varied across litter species and streams. Thus, the aquatic hyphomycete community in island streams can be diverse and these organisms may have an important role on litter decomposition in these systems as they have on continental forest streams.



## Biodiversity Ecology Function across marine and terrestrial ecosystems (BEFmate): Linking microbial diversity and dispersal with function

SIMONE HANEKAMP, B. WEMHEUER & R. DANIEL



Hanekamp, S., B. Wemheuer & R. Daniel. 2016. Biodiversity Ecology Function across marine and terrestrial ecosystems (BEFmate): Linking microbial diversity and dispersal with function. Pp. 418 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Spiekeroog, Germany; *Taxa*: Bacteria, Archaea; *Other*: biodiversity, microorganisms, sediment, succession, metagenomics.

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Microorganisms are key players in almost all ecosystem processes in both marine and terrestrial realms. Although frequently studied, little is known on how ecosystem processes are linked to changes in the composition of microbial communities. The aim of this project was to assess archaeal and bacterial community structure and diversity on artificial islands to provide novel insights into island development. We hypothesized that microbial communities undergo a distinct succession from marine to more terrestrial communities. For this purpose, sediment samples were collected on artificial islands close to the German island Spiekeroog thrice a year. Islands were constructed from mud flat. Control plots were established at the shores of Spiekeroog. Total and active bacterial and archaeal community were investigated by MiSeq-based analysis of 16S rRNA amplicons generated from environmental DNA and RNA, respectively. The genomic potential of the microbial communities was exploited by metagenomic shotgun sequencing. *Proteobacteria* and *Woesearchaeota* dominated bacterial and archaeal communities, respectively. Furthermore, communities in oxic sediment layers exhibited a strong variation in structure and diversity reflecting the dynamics of the habitat itself. Moreover, bacterial richness increased towards the water realm being highest in the pioneer zone. The influence of certain microbial key species correlating to the distinct plant cover were visible on planted and unplanted islands. Additionally, obtained data showed that microbial community structure and diversity in artificial islands and control plots treated in the same manner were highly similar indicating a likewise microbial succession. The results of this study enable us to understand the dispersal of marine microbes and their dynamics at the land water interface and shed new light into natural succession processes on developing islands.

## Positive relationship between genetic- and species diversity on a mainland archipelago

ANNA M. CSERGŐ, L. HUFNAGEL & M. HÖHN



Csergő, A.M., L. Hufnagel & M. Höhn 2016. Positive relationship between genetic- and species diversity on a mainland archipelago. Pp. 419 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Carpathian Mountains, Romania; *Taxa*: *Saponaria bellidifolia*; *Other*: mainland islands, intraspecific diversity, interspecific diversity, dynamic equilibrial processes, landscape matrix, diversity hotspots.

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Evidence for dynamic equilibrial processes of both genes and species has often been expected from oceanic islands, because of the sharp ecological contrast with the landscape matrix. Whether ecological islands on mainland show similar patterns is still subject to debate, and probably dependent on the extent of habitat isolation. Rocky outcrops are good candidates for ecological islands because they may differ substantially from the landscape matrix of valleys, forests and flat areas in age, geomorphology, geology, soil types and vegetation history. We asked if the genetic diversity of *Saponaria bellidifolia*, a habitat specialist plant, and the species diversity of its habitat are driven by parallel landscape level processes in an island-like system of limestone outcrops in the Carpathian Mountains. We tested the relationship of these two diversity levels at local and regional geographic scales. Local genetic and species diversity showed parallel patterns influenced by the number of plant communities. Likewise, at regional level there was strong evidence for parallel equilibrial dynamics of genotypes and species. However, a superimposed matrix effect enhanced the regional species diversity only. Genetic diversity of habitat specialist organisms and species diversity of these limestone outcrop islands on mainland are modulated by parallel landscape-level processes detectable at different geographic scales and at very high spatial resolutions. Limestone outcrops have a pronounced ecological individuality and may functionally be similar to oceanic islands. Recognizing this fact may help conservation practitioners to detect islands that represent both hotspots of species diversity and important evolutionary laboratories of habitat specialist species.

## Isolation, production and maintenance of axenic cultures of freshwater species of *Cyanobacteria* from the Azorean Islands

RÚBEN LUZ, R. CORDEIRO, A. FONSECA & V. GONÇALVES



Luz, R., R. Cordeiro, A. Fonseca & V. Gonçalves 2016. Isolation, production and maintenance of axenic cultures of freshwater species of *Cyanobacteria* from the Azorean Islands. Pp. 420 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores, Portugal; *Taxa*: Cyanobacteria; *Other*: culture bank, bioprospecting, lakes.

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The Azorean islands are rich in freshwaters, such as springs, streams, wetlands and lakes, which are hotspots of biodiversity. Cyanobacteria are amongst the most diverse group of microorganisms that inhabit these ecosystems. Especially in lakes, as result of eutrophication, cyanobacteria have become the dominant group. They produce a wide diversity of secondary metabolites, some toxic (cyanotoxins), but others with possible uses as biocide, antifungal, antibiotic and anticancer substances, thus the isolation of cyanobacteria for their biochemical and genetic characterization are of great interest. The aim of this study is to create a culture bank of Azorean cyanobacteria strains, which allows genetic characterization and bioprospecting of cyanobacteria from the Azorean Islands. Samples from 24 lakes in São Miguel, Pico, Flores and Corvo islands (Azores Archipelago) are being collected seasonally (winter, spring, summer and autumn) since 2015 and the cyanobacteria present isolated and maintained in axenic cultures. Several technics were used for isolation, such as dilution and inverted microscope direct pipetting, and culturing, using three different mediums (BG-11, BG-11(N) and TFI+M) and temperatures and light conditions. Standard isolation and culture techniques were adapted according to the characteristics of the isolated strains or the desired taxa to isolate. At the moment we have successfully isolated and produced 15 axenic cultures of cyanobacteria strains belonging to the following taxa: *Anabaena* sp., *Aphanizomenon gracile*, *Aphanothece* sp., *Microcystis flos-aquae*, *Microcystis aeruginosa*, *Oscillatoria tenuis*, *Planktolyngbya* sp. and *Pseudanabaena* sp.. This bank will allow the first studies ever made in Azores with pure cultures of cyanobacteria, giving the chance to study these species genetically, but also the possibility to study their secondary metabolites as sources for new valuable products and applications.

## A new combination and status in *Andryala* (Asteraceae) from Madeira Island (Portugal)

MARIA ZITA FERREIRA, R. JARDIM, I.A. FERNÁNDEZ & M.M. SEQUEIRA



Ferreira, M.Z., R. Jardim, I.A. Fernández & M.M. Sequeira 2016. A new combination and status in *Andryala* (Asteraceae) from Madeira Island (Portugal). Pp. 421 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Madeira archipelago, Portugal; *Taxa*: *Andryala* L. (Asteraceae); *Other*: *Andryala glandulosa* subsp. *cheiranthifolia*, biometry, nomenclature, taxonomy.

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Lowe (1868) recognised two *Andryala* L. species for Madeira: *A. cheiranthifolia* L. Hér. and *A. crithmifolia* Aiton, the first including *A. cheiranthifolia* var. *congesta* Lowe and *A. cheiranthifolia* var. *sparsiflora* Lowe. Years before, De Candolle (1838) had included all Madeiran *Andryala* taxa in *A. varia* Lowe ex DC. Later Lowe (op. cit.) preferred the name *A. cheiranthifolia* over *A. varia* probably because it is an earlier name. Nonetheless, the earliest validly published name is *A. glandulosa* Lam. Hence, both names are illegitimate due to superfluity. De Candolle (1838) based on the observation of *A. cheiranthifolia* specimens from the L' Héritier collection, included the latter and *A. glandulosa* in a single taxon: *A. varia* var. *cheiranthifolia* (L'Hér.) DC. However, Lowe (1868) considered *A. cheiranthifolia* as a synonym of his *A. cheiranthifolia* var. *sparsiflora* subv. *runcinata* Lowe and included *A. glandulosa* in *A. cheiranthifolia* var. *congesta*. Curiously, the protologues of *A. glandulosa* and *A. cheiranthifolia* share an interesting feature: numerous involucre bracts arranged in several rows, the inner chaffy-like and glabrous. Lowe (1868) also highlighted this aspect to distinguish *A. cheiranthifolia* var. *congesta* from *A. cheiranthifolia* var. *sparsiflora*. Thus, *A. glandulosa* and *A. cheiranthifolia* correspond to the same taxon, which is distinct from *A. cheiranthifolia* var. *sparsiflora*. Fernandes (1959) restored the earliest validly published name (*A. glandulosa*), recognising the typical subspecies and *A. glandulosa* subsp. *varia* (Lowe ex DC.) Fern. Although stressing that the observation of herbarium specimens could support the distinction of two species, *A. glandulosa* and *A. cheiranthifolia* L'Hér., Fernandes (1959) included both entities in one species. Greuter (2003) proposed a new combination, *A. glandulosa* subsp. *cheiranthifolia* (L'Hér.) Greuter, misapplying *A. cheiranthifolia*. Considering the above and based on a biometry study, a new combination and status is proposed: *Andryala sparsiflora* (Lowe) M. Z. Ferreira, R. Jardim, Alv. Fern. & M. Seq..

## Mangroves of São Tomé Island: A preliminary assessment

RICARDO FAUSTINO DE LIMA, P. CHAINHO, P.M. FÉLIX, J.L. COSTA, A.J. ALMEIDA, I. DOMINGOS, T. SILVA ET AL.



Lima, R.F., P. Chainho, P.M. Félix, J.L. Costa, A.J. Almeida, I. Domingos, T. Silva, C. Beltrán, F. Carvalho, G. Oquiongo, E. Soares, M. Gonçalves & A.C. Brito 2016. Mangroves of São Tomé Island: A preliminary assessment. Pp. 422-423 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

**Key words:** *Location:* São Tomé Island, São Tomé and Príncipe, central Africa; *Taxa:* phytoplankton, terrestrial plants, benthic macrofauna, fish and birds; *Other:* estuarine ecosystems, land-use mapping, biodiversity, ecosystem services, threats, São Tomé Obô Natural Park.

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Mangroves are tropical estuarine forests, well-known for providing key ecosystem services. We conducted the first survey of mangroves in island nation of São Tomé and Príncipe, focusing on the biodiversity, ecosystem services and threats in two areas of São Tomé Island's Obô Natural Park. Praia das Conchas' land vertebrate assemblage was typical of degraded areas, but Malanza had many endemics, including two vulnerable bird species. The vegetation was poor in species, as expected from the mangrove's stressful conditions, small size and insularity. Nevertheless these are relevant in the national context, given that most plant species recorded are restricted to this habitat. Phytoplankton biomass was low, suggesting limited aquatic productivity linked to low availability of nutrients. Benthic macrofauna showed low diversity, with only 16 different taxa identified in both mangroves, most of which stress-tolerant species, such as decapods, oligochaetes and insect larvae. We identified 26 fish species, including four new to the country, three threatened and seven data deficient. These included resident species, but also opportunistic feeders, juvenile and larvae, several

of which important for coastal fisheries. Both mangrove areas were small and seemed to have only a marginal contribution to human subsistence and livelihoods, with few activities being detected. Nevertheless, besides their conservation value, these ecosystems proved to be relevant for some people and a mark on the cultural identity of nearby coastal communities. They also provide key indirect benefits to all Santomeans, such as maintaining fish stocks, fighting erosion and regulating biogeochemical cycles. Current threats include the existence of barriers constraining the link between terrestrial and marine environments, overexploitation, introduced species and land-use intensification. Finding ways to promote the sustainable use of these ecosystems is particularly relevant, given the vulnerability of biodiversity and human well-being in the context of insularity.

## The dragonflies of the Azores and Madeira

VIRGÍLIO VIEIRA & A. CORDERO-RIVERA



Vieira, V. & A. Cordero-Rivera 2016. The dragonflies of the Azores and Madeira. Pp. 424 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores and Madeira; *Taxa*: Odonata (Insecta); *Other*: biodiversity, *Ischnura hastata*, island, conservation

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Literature and personal information on the distribution of the Odonata species from Azores and Madeira islands is reported. The Zygoptera are represented by the Coenagrionidae family and the Anisoptera by the families Aeshnidae and Libellulidae, including the following species: (i) *Anax imperator*, *Ischnura hastata*, *I. pumilio*, *Sympetrum fonscolombii*, and a migrant species *Pantala flavescens* (Açores archipelago), and (ii) *Anax ephippiger*, *A. imperator*, *A. parthenope*, *I. pumilio*, *S. fonscolombii* e *S. nigrifemur* (Madeira archipelago, including Selvagens islands). The comprehensive information provided includes the relationship between dragonflies and the freshwater ecosystems of the Azores and Madeira (lakes, ponds and rivers), and highlights the relevance of odonates for human society, as agents of biological control of insect pests, and its role in conservation biology and evolution. The damselfly *I. hastata* is presented as a gemstone of the Azorean islands, because it is the only case known of parthenogenesis in the order Odonata (its Azorean populations are formed by only females). The dispersal ability of this species and the possible origin of parthenogenesis after its colonization of the Azores are briefly discussed. The potential causes of threat are identified and the need for conservation measures is outlined. Furthermore, we are also interested to promote the book «As Libélulas dos Açores e Madeira», which is a contribution to the knowledge to biodiversity and natural history of the two Atlantic archipelagos.



## Freshwater diatoms from Desertas Islands (Madeira, Portugal)

VÍTOR GONÇALVES, H.S. MARQUES, D. TEIXEIRA & P.M. RAPOSEIRO



Gonçalves, V., H.S. Marques, D. Teixeira & P.M. Raposeiro 2016. Freshwater diatoms from Desertas Islands (Madeira, Portugal). Pp. 425 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Desertas Islands (Madeira, Portugal); *Taxa*: Diatoms; *Other*: biodiversity, ecology, biogeography

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Desertas islands are three uninhabited small islets belonging to the Madeira Archipelago located 20 km Southeast of Madeira. Deserta Grande is the largest of the three islets, with an area of approximately 10 km<sup>2</sup> and a maximum altitude of 479 m. The Deserta Grande geomorphology is mostly rugged, with very steep slopes, ridges and peaks. The climate is temperate oceanic and the predominant habitats are rocky slopes and small arid flatlands, with sparse vegetation. Although fauna and flora of Desertas Islands are regarded as interesting and with high conservation value, freshwater biota was never study. Freshwater habitats are reduced to temporary streams in Vale da Castanheira and very small, also temporary, natural pools or artificial tanks. To study the biodiversity associated with these ecosystems, several freshwater habitats were sampled during two field campaigns in Deserta Grande, in 2012 and 2014. The analysis of those samples revealed a large diversity of diatoms (Bacillariophyceae). More than 30 species were found, all of them from benthic habitat. The majority of the species are strictly associated with freshwaters but several others are typically found in brackish environments revealing the influence of sea spray in inland surface water bodies of Deserta Grande, especially at lower altitudes. Taxonomical characterization of the observed diatoms, distribution and main ecological preferences will be presented and discussed.

## Preliminary study of bryophytes from Azorean wetlands I: Bryophytes from “Paul do Belo Jardim” (Praia da Vitória, Terceira Island, Azores)

CECÍLIA SÉRGIO, D. CLARO, J.D. CASTILLO & R. GABRIEL



Sérgio, C., D. Claro, J. Diaz Castillo & R. Gabriel 2016. Preliminary study of bryophytes from Azorean wetlands I: Bryophytes from “Paul do Belo Jardim” (Praia da Vitória, Terceira Island, Azores). Pp. 426 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Terceira Island, Azores; *Taxa*: bryophytes, liverworts, hornworts, mosses; *Other*: wetlands, LIFE CWR, *Bryum klinggraeffii*, life strategies, colonists

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The LIFE project “Ecological Restoration and Conservation of Praia da Vitória Coastal Wet Green Infrastructure” aims to recover and restore a network of wetlands in the coastal area of Praia da Vitória. One of the specific goals of the Project is to make an inventory of the local biodiversity, including bryophytes. Since these species respond quickly to environmental change, they are also going to be used as monitors over time. Prior to the LIFE CWR fieldwork, there were only five species of bryophytes (three mosses and two liverworts) recorded for Paul do Belo Jardim. In November 2014, it was possible to analyse two 300 m’ transects, resulting in a collection of 60 samples (10 cm x 5 cm). This inventory included 15 bryophyte species: 13 mosses (six *Pottiaceae*, five *Bryaceae*, one *Brachytheciaceae* and one *Grimmiaceae*), one liverwort and one hornwort. The moss *Bryum klinggraeffii* Schimp. was recorded new to the Azores (and Macaronesia). Concerning life strategies of the 15 bryophyte species, there are mainly colonists (seven colonists and three ephemeral colonists), such as *Bryum capillare* Hedw. and *B. subapiculatum* s.l., the two species with the highest frequency in Paul do Belo Jardim. The diversity of bryophytes found in Paul do Belo Jardim was lowest than expected, although it roughly doubled the known bryophytes for the location. The low diversity and the predominance of colonist species may be the result of high environmental disturbance, probably due to anthropogenic activities.

## Preliminary study of bryophytes from Azorean wetlands II: Bryophytes from “Paul da Pedreira do Cabo da Praia” (Praia da Vitória, Terceira Island, Azores)

ROSALINA GABRIEL, C. PIMENTEL, M.R. BRITO & C. SÉRGIO



Gabriel, R., C. Pimentel, M.R. Brito & C. Sérgio 2016. Preliminary study of bryophytes from Azorean wetlands II: Bryophytes from “Paul da Pedreira do Cabo da Praia” (Praia da Vitória, Terceira Island, Azores). Pp. 427 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Terceira Island, Azores; *Taxa*: bryophytes, liverworts, mosses; *Other*: wetlands, LIFE CWR, *Fissidens crispus*, *Trichostomum crispulum*, life strategies, colonists.

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Bryophytes are able to occupy a large spectrum of ecological conditions - from the lowlands to the mountain tops, including wetlands and present many qualities associated with effective biological indicators. However, due to their small size, challenging taxonomy and lack of trained taxonomists, they are often overlooked in conservation projects. However the LIFE project “Ecological Restoration and Conservation of Praia da Vitória Coastal Wet Green Infrastructure”, includes bryophytes in its biodiversity inventory. Before the fieldwork of LIFE CWR, there were no species of bryophytes recorded for Paul da Pedreira do Cabo da Praia. In February 2016, it was possible to analyse two 300 m<sup>2</sup> transects, resulting in a collection of 24 samples (microplots; 10 cm x 5 cm). This inventory included 13 bryophyte species: 10 mosses from seven families (three *Pottiaceae*, three *Bryaceae*, one *Brachytheciaceae*, one *Grimmiaceae*, one *Dicranaceae*, one *Ditrichaceae* and one *Fissidentaceae*) and three liverworts from three families (one *Ricciaceae*, one *Fossombroniaceae* and one *Frullaniaceae*). Concerning life strategies of the 13 bryophyte species, there are mainly colonists, such as *Bryum capillare* Hedw. and *Trichostomum brachydontium*, the two species with the highest frequency in Paul da Pedreira do Cabo da Praia, occurring in half of the collected samples. The moss *Trichostomum crispulum* was found for the first time in Terceira (although known from six other islands of the archipelago); besides, for two species, *Fissidens crispus* and *Riccia huebeneriana*, this was only the second record for Terceira Island, and the moss species had been observed by the Allorge couple in 1937! The diversity of bryophytes found in Paul da Pedreira do Cabo da Praia is similar to diversity found in Paul do Belo Jardim, and rather low, probably due to the high environmental disturbance that affects wetlands in the Azores and other places. However, the presence of rare species should be noted and further monitoring studies should proceed in the area.

## Preliminary study of bryophytes from Azorean wetlands III: Bryophytes from “Paul da Praia da Vitória” (Praia da Vitória, Terceira Island, Azores)

CÉSAR PIMENTEL, R. GABRIEL, M.R. BRITO & C. SÉRGIO



Pimentel, C., R. Gabriel, M.R. Brito & C. Sérgio 2016. Preliminary study of bryophytes from Azorean wetlands III: Bryophytes from “Paul da Praia da Vitória” (Praia da Vitória, Terceira Island, Azores). Pp. 428 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Terceira Island, Azores; *Taxa*: bryophytes, liverworts, mosses; *Other*: wetlands, LIFE CWR, Wetlands, LIFE CWR, *Bryum bornholmense*, restoration.

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The coastal wetland “Paul da Praia da Vitória”, is the largest and most well-known wetland of Terceira Island (Azores). Through the years, this area was studied by different biologists and its inventory is more complete than those of the neighbouring coastal wetlands, e.g. “Paul do Belo Jardim” and “Paul da Pedreira do Cabo da Praia”. Nevertheless, the changes in land use have been extreme through time, and in the 80’s it was actually transformed into a lawn. In the late 90’s, a process of re-naturalization began. This process resulted in the return of some species to the area – which is particularly observable with wintering birds. Presently, the LIFE project “Ecological Restoration and Conservation of Praia da Vitória Coastal Wet Green Infrastructure” (LIFE-CWR) aims to further recover and restore this network of wetlands. Concerning bryophytes, previous inventories accounted for 19 species of mosses and one species of liverwort (*Frullania azorica*). Inventories made in February 2016, along two 300 m’ transects, resulted in a collection of 10 samples (microplots; 10 cm x 5 cm). Although not all samples are fully identified yet, it is possible to register the presence of a new species for the Azores (Macaronesia), *Bryum bornholmense*. Other species, such as *Fissidens crispus*, which has few records in the Azores, was also present in the area. Further monitoring of this process will allow a better assessment of the effects of the restoration of the wetlands of Praia da Vitória.

## Bryophyte functional groups along an elevational gradient: Response to climatic conditions

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Hernández-Hernández, R. A. Rodríguez-Romero, K. Jürgen, C. Ah-Peng & J.M. González-Mancebo 2016. Bryophyte functional groups along an elevational gradient: Response to climatic conditions. Pp. 429 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: La Palma, Canary Islands; *Taxa*: bryophytes; *Other*: elevational gradient, temperature, humidity, functional groups, morphological traits.

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Changes in species assemblages along mountains have long captivated naturalists and ecologists' attention and therefore, have been focus of numerous studies. However, no clear homogeneous pattern of how communities respond to changes along elevational gradients has been found so far. Species functional groups based on ecological and taxonomical criteria are being increasingly used as models to evaluate community response to climatic gradients, since different functional types differ in their response to environmental changes. This could help disentangling the role of each environmental feature in shaping the general pattern of distribution of richness for a given group. We seek to analyse how climatic conditions (temperature and relative humidity) affect bryophyte communities along an elevational gradient (0-2200 m a.s.l.) in the island of La Palma (Canary Islands). For that purpose, bryophytes were collected in 2 plots every 200 m elevation, and a temperature and relative humidity data logger was set at each studied elevation and recorded data during 1 year. We then used a functional group approach based on preference of microhabitat conditions and dispersal ability for defining four functional categories: i) phylogenetic groups (liverworts and mosses); ii) preference for a given substrate; iii) preference for a different microhabitat and based on bryophytes canopy preference and iv) life strategy, which mostly reflect dispersal ability and sporophyte production. In addition, we explored how the environmental gradient along the transect influences some bryophyte morphological traits of the species pool at each elevation. Preliminary results show that regarding substrate preference, terrestrials and saxicolous do not respond to variation in temperature nor humidity along the gradient. Epiphytes are favoured by low variation range of both, temperature and humidity, indicating they need more stable conditions. Regarding life strategies we found contrasting patterns between colonist and the rest of categories. These results will contribute to the understanding of environmental processes driving bryophyte species assemblages and changes along elevational gradients.

## Exploring effects of climate and habitat disturbance on endemic, native and invasive species along an elevation gradient on an oceanic island

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J. PATIÑO, M. STEINBAUER & M. DEL ARCO



González-Mancebo, J.M., R. Hernández-Hernández, J. Klüge, J. Patiño, M. Steinbauer & M. Del Arco 2016. Exploring effects of climate and habitat disturbance on endemic, native and invasive species along an elevation gradient on an oceanic island. Pp. 430-431 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: La Palma, Canary Islands; *Taxa*: spermatophytes; *Other*: habitat quality, ruderal plants, climatic conditions, endemism rate.

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Climate and habitat destruction are among the main drivers explaining richness and distribution of endemic, indigenous and invasive plants. However the combined effects anthropogenic and natural drivers along elevational gradients remain poorly understood. We investigated the effects of temperature, humidity and human disturbance across 66 plots placed along three elevational transects that systematically vary in land use intensity. The study area covers a considerable environmental gradient spanning 50-2000 m elevation in the NE of La Palma (Canary Islands). We recorded flowering plant species richness as well as number and percentage of endemic species (single-island, Canary archipelago-endemics and Canary-Madeira archipelago-endemics), indigenous and probably indigenous species (distinguishing ruderal species from those that are not restricted to disturbed areas) and non-native species (including invasives) systematically in two plots every 200 m along each transect. Each transect covered areas characterized by contrasting levels of conservation, including: preserved areas; disturbed areas following the traditional land uses at each elevation level; and margins of tracks present in the area. At each elevation step, a data-logger recorded temperature and relative humidity for a year. The different endemic floristic elements differed in their response to climatic factors and showed different patterns of variation along the elevational gradient. Neither the numbers, nor the percentage of single island endemics was correlated with temperature and humidity.



In contrast, the number and percentage of Canarian endemics were positively correlated with maximum temperature and temperature range and negatively correlated with minimum humidity and average humidity. The opposite trend was found for the Canary-Madeiran endemics, as well as invasive and ruderal species. Whereas invasive and ruderal species strongly benefit from human disturbances at low elevations, cold temperature and low humidity values above 1200 m limit their occurrence. The pattern for percentage of endemics along the gradient varies depending on the disturbance at lower elevations.



## Pollen-transport: Which plants do wild insects prefer to interact in Azores?

ANA PICANÇO & P.A.V.BORGES



Picanço, A. & P.A.V.Borges 2016. Pollen-transport: Which plants do wild insects prefer to interact in Azores? Pp. 432 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Terceira Island, Azores; *Taxa*: Coleoptera, Diptera, Hymenoptera; *Other*: pollinator insects, island, species interactions, pollen abundance.

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Many studies are known about honeybee and bumblebee pollination but few are related to pollen transportation in other flower-visiting insects, i.e. wild bees, beetles and flies. These flower-visiting insects are not so well known for their capacity and ability to carry pollen grains. For this study, we collected flower-visiting insects ad-hoc from five habitat types (native forest, semi-natural pasture, naturalized vegetation areas, exotic forest and intensively managed pastures) in Terceira Island (Azores) with the purpose to: a) compare the previously observed flower-visiting insects interactions networks with the non-observed interactions based on the information given by pollen grains found on the insects body; b) compare the nestedness and modularity between the observed and non-observed networks with identification of keystone pollinator species; and c) describe patterns of preference in the insect-plant interaction networks. The pollen samples were treated by acetolysis following Erdtman's methodology, with replication in three slides per insect individual. Pollen counting and identification were performed using light microscope, using a previously made pollen reference. Pollen grain counts were based on the total counts of the three slides and were grouped into four classes of relative frequency). In this work we will present the relative abundance of pollen belonging to native and alien plants and will identify the relevance of indigenous wild insect pollinators for pollination ecosystem services in Azores.

## Tree age determination at laurel forest remains in São Miguel Island, Azores

MARIANA CÂMARA, L.B. SILVA, R.B. ELIAS & L. SILVA



Câmara, M., L.B. Silva, R.B. Elias & L. Silva 2016. Tree age determination at laurel forest remains in São Miguel Island, Azores. Pp. x-xx in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: São Miguel Island, Azores; *Taxa*: *Erica azorica*; *Ilex perado* subsp. *azorica*; *Laurus azorica*; *Morella faya*; *Pittosporum undulatum*; *Other*: laurel forest, forest structure, tree age, tree density, t-square sampling.

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Natural forests have been estimated to occupy about 10% of the land surface in the Azores. One aspect that merits further attention is tree age determination in natural forests. This would allow a more complete understanding of temporal forest dynamics. We analyzed forest structure and estimated tree age at breast height at two stands of laurel forest located at the “Área Protegida para a Gestão de Habitats ou Espécies da Serra de Água de Pau” (SMG07, Parque Natural da Ilha de São Miguel), located at 569 (ST1) and 612 m (ST2). We used T-square sampling to estimate tree density and measured tree height, basal diameter and canopy volume. A Pressler borer was used to collect wood samples at breast height that were treated to allow annual tree ring counting. At ST1 *Morella faya* was the most frequent tree species and had the largest basal area but was surpassed in biovolume by *Pittosporum undulatum*; At ST2 *Erica azorica*, *Ilex perado* ssp. *azorica* and *Laurus azorica* were most frequent, *L. azorica* showed the largest basal area but *P. undulatum* equaled its biovolume. Tree ages at breast height, at ST1 ranged 10-52 years in *L. azorica*, 15-82 years in *M. faya*, and 34-79 years in *P. undulatum*; at ST2 tree ages ranged 10-39 years in *L. azorica*, 17-38 years for *I. perado* ssp. *azorica*, 9- 31 years for *E. azorica*, 13-34 years for *M. faya*, and was estimated at 29 years for a tree of *P. undulatum*. Forest soil was almost completely covered by *Hedychium gardnerianum* therefore seedlings and saplings were seldom found. This research also revealed different types of annual ring patterns for the different taxa. This is one of the first studies revealing tree ages at a laurel forest stand in the Azores.

## Leaf litter decomposition on insular lentic systems: Effects of macroinvertebrate presence, leaf species and environmental conditions

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Raposeiro, P.M., V. Ferreira, R.G. Florensa, V. Gonçalves & G.M. Martins 2016. Leaf litter decomposition on insular lentic systems – effects of macroinvertebrate presence, leaf species and environmental conditions. Pp. 434 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Azores; *Taxa*: freshwater macroinvertebrates; *Other*: *Acacia melanoxylon*, macroinvertebrates, Azores, *Pittosporum undulatum*, oceanic islands, *Morella faya*.

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The decomposition of leaf litter of terrestrial origin is a fundamental process in aquatic ecosystems in forest contexts. However, little is known about what drives leaf litter decomposition in oceanic islands, especially in lentic ecosystems. Here, we examine the relative importance of leaf litter identity (*Acacia melanoxylon*, *Pittosporum undulatum* and *Morella faya*) and environmental conditions on litter decomposition in seven lakes in an isolated oceanic island (São Miguel, Azores archipelago) for 28 and 56 days. Leaf litter was incubated in coarse and fine mesh bags to allow assessing the relative contribution of macroinvertebrates (excluded from fine mesh) to leaf litter decomposition. Leaf litter mass loss generally did not differ between mesh sizes suggesting that in these lakes macroinvertebrates generally have a negligible role on leaf decomposition, which can be attributed to a general lack of shredders. Leaf litter decomposition was in the order *M. faya* < *A. melanoxylon* < *P. undulatum*, and a negative correlation was found between leaf litter mass loss and initial lignin concentration. Mass loss of *P. undulatum* was related to lake elevation (taken as a surrogate for water temperature) and chlorophyll *a* concentration (taken as a surrogate for dissolved nutrient availability) on both day 28 and 56, whereas mass loss of *M. faya* was related to chlorophyll *a* concentration on day 56. These results suggest that changes in the composition of the leaf litter input and environmental conditions driven by human activities can affect leaf litter decomposition in Azorean lakes, with potential consequences for nutrient cycling.

## Testing neutral vs. niche species assembly in Azorean canopy arthropod communities after defaunation: Preliminary results

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Nunes, R.N., P. Cardoso, A.O. Soares & P.A.V. Borges 2016. Testing neutral vs. niche species assembly in Azorean canopy arthropod communities after defaunation: Preliminary results. Pp. 435 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Terceira Island, Azores; *Taxa*: arthropods; *Other*: neutral vs. niche, taxonomic diversity, functional diversity, canopy arthropods, Azores, Macaronesia.

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There is an on-going debate on the processes that structure ecological communities in which the neutral theory emphasizes the importance of stochastic processes and the traditional ecological niche-theory emphasizes mechanisms such as competitive interactions and local adaptations in which species are functionally different. In this contribution we implemented for the first time in the Azores archipelago an arthropod defaunation sampling protocol at a plot scale in which insecticide fogging was applied to the canopies of 24 native trees, for two consecutive years, in a native Laurisilva forest patch in Terceira Island, with the intent of answering the following questions: 1) what is the taxonomic and functional diversity of the arthropod communities present in the canopies of these trees, as well as the composition and structure of their trophic guilds? 2) what are the colonization/re-colonization processes that guide these same communities, trying to understanding if communities are assembled based on neutral or niche theory. Preliminary results seem to indicate low beta diversity amongst the arthropod community at small scales. Neutral and niche processes operate at some time, since some species keep host specialization, but others seem to recolonize randomly the tree species.

## Water retention pathways in bryophytes: A characterization and quantification study in native vegetation of the Azores

MÁRCIA C.M. COELHO, F. PEREIRA, C. AH-PENG & R. GABRIEL



Coelho, M.C.M., F. Pereira, C. Ah-Peng & R. Gabriel 2016. Water retention pathways in bryophytes: A characterization and quantification study in native vegetation of the Azores. Pp. 436 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Terceira Island, Azores; *Taxa*: Division Bryophyta, Division Marchantiophyta; *Other*: AWC - Absolute Water Content, external water, apoplast water, symplast water, liverworts, mosses.

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Bryophytes are poikilohydric plants, meaning that the cellular water content fluctuates with external water availability. They can absorb and conduct water internally (endohydric) and/or externally (ectohydric). The aims of this work are: i) to characterize and quantify the ability of 14 bryophytes, typical of the Azorean native vegetation (six liverworts, eight mosses), to retain water through those pathways; ii) analyse which pathway is dominant among the studied species and iii) assess if there are differences among different life forms – leafy liverworts, acrocarpic, cladocarpic and pleurocarpic mosses. Twelve replicates of each species were collected in Terceira Island in order to obtain the absolute water content (AWC). In the lab, the samples were fully hydrated for at least 12 hours, squeezed and dried, allowing the quantification of saturated, free of external water and dry weights. External and internal water were correlated ( $r=0,82$ ). All species showed a higher (>50%) ability to retain water externally over internally, showing predominantly a ectohydric behaviour. The species with the lowest external water retention ability were *Isoetecium prolixum* and *Polytrichum commune*, which was expected in the latter, since it has a well-developed internal conducting system, with specialized hydroids. As expected, the highest AWC value was achieved by the cladocarpic moss, *Sphagnum subnitens*, which is able to retain 53 grams of water per gram of dry weight, probably due to its morphological structure. Different life forms present significant differences ( $p<0,05$ ) in their ability to retain water externally and internally. Nevertheless, and in accordance with literature, all species may be considered as preferentially ectohydric, so these bryophytes typically maintain their internal water content constant by absorbing water from the external capillary spaces, as needed. Bryophytes clearly behave as terrestrial sponges and besides their own water needs, the retention of additional external water will undoubtedly confer an overall positive effect on the ecosystem functioning.

## Spatiotemporal variation in macroinvertebrate assemblages on an oceanic island: The singular ponds of the Azorean island of Terceira

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& P.A.V. BORGES



Florencio, M., L. Lamelas-López, V. Gonçalves, L. Serrano & P.A.V. Borges 2016. Spatiotemporal variation in macroinvertebrate assemblages on an oceanic island: The singular ponds of the Azorean island of Terceira. Pp. 437-438 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Terceira Island, Azores; *Taxa*: macroinvertebrates; *Other*: temporary ponds, spatiotemporal variation, endemic species, beta-diversity, Macaronesia.

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The EU Water Framework Directive prioritised freshwater conservation areas in the Macaronesian Islands. However, few studies have investigated these sites despite their singularity as unique ecosystems in Europe. We aimed to study the seasonal variation (10 months) of the macroinvertebrate assemblages and the environmental characteristics of three temporary and two permanent ponds on an oceanic island (Terceira, Azores archipelago). We also carried out a spatial survey including almost all the natural ponds (N=12) of the island. The study ponds were characterised as well-oxygenated and slightly acidic waters, with low values of conductivity, which indicates that the ponds were primarily flooded with rainwater. These ponds presented a low diversity that contrasts with a high degree of endemism. In particular, temporary ponds exhibited the highest species richness and number of endemic species. Although the composition of macroinvertebrates varied according with the sampling month and pond, pond differences explained the highest variation (14.5 %) in comparison with the sampling months (7%). Moreover, the significant interaction between month and pond (13.4% of explained variance) indicated that these differences among ponds were dependent on the sampling month. We detected a predominant pattern of species replacement among ponds, with the exception of the month of August, when only a temporary pond and the two permanent ponds held water. Pond desiccation reduced the water level of these ponds leading to similar species compositions but also to a gradual reduction in species richness. We suggest that monitoring artificial waterbodies may be a useful tool to establish proper guidelines for pond conservation in the study island, i.e. to assess if

artificial waterbodies could support the macroinvertebrate diversity during the annual period of desiccation.



## The effect of geological origin of islands on soil microbial communities during long-term succession

FERNANDO D. ALFARO, M. MANZANO, P. MARQUET & A. GAXIOLA



Alfaro, F.D., M. Manzano, P. Marquet & A. Gaxiola 2016. The effect of geological origin of islands on soil microbial communities during long-term succession. Pp. 439 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Uyuni salt flat, Central Andean Puna, Bolivia; *Taxa*: soil bacterial and fungal communities; *Other*: bacterial, fungal, soil development, island, Andean Puna.

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1. Bacteria and fungi have contrasting metabolic requirements; therefore during soil development these groups are differentially affected by changes in soil biogeochemistry. Parent material, affects soil pH, nutrient availability and indirectly litter nutrient content, thus it can be an important driver of microbial community patterns during soil development, yet its effects remain relatively untested. 2. In this study, we tested for the effect of soil and litter properties from distinct parent material upon microbial community patterns in ca. 20,000-years old chronosequences developed on Sedimentary and Volcanic (Andesitic and Dacitic) soils in the Dry Puna of Bolivia. We evaluated microbial patterns by analyzing the Terminal Restriction Length Polymorphism (T-RFLPs) from amplified bacterial (16S rRNA) and fungal (Internal Transcribed Spacer) genes. 3. The composition of bacterial communities among stages of soil development changed in the volcanic chronosequences but not in the sedimentary one. Further, the degree of bacterial community dissimilarity within volcanic chronosequences increased as a function of reductions in soil pH and increases in litter quality. Fungal community composition, in contrast, did not change along all studied chronosequences. 4. On the other hand, the relative microbial abundance, expressed as fungal:bacterial ratio, declined across stages of the Sedimentary and Andesitic chronosequences. These patterns were associated to increases in litter quality and declines in soil pH. 5. Synthesis. Our results demonstrate that differences in microbial community patterns during soil development are dependent upon parent material, via its effect upon soil pH. Further, we highlight the role of intraspecific variability in litter quality in promoting changes in bacterial composition and shifts in microbial relative abundance during soil development.

## Cloud layer, trade wind inversion and cloud water interception by bryophytes on an oceanic island

CLAUDINE AH-PENG, O. FLORES, J.L. DE BELLEVUE, F. JEAMBLU, E. DELCHER, E. MOUREAU, A. PITEAU ET AL.



Ah-Peng, C., O. Flores, J.L. Bellevue, F. Jeamblu, E. Delcher, E. Moureau, A. Piteau, P. Staménoff, D. Strasberg & V. Dufлот 2016. Cloud layer, trade wind inversion and cloud water interception by bryophytes on an oceanic island. Pp. 440 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: La Réunion, Mascarenes; *Taxa*: bryophytes; *Other*: atmosphere, ceilometer, ecohydrology, ceilometer, liverworts, horizontal precipitation, plants, tropical cloud forest.

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On oceanic islands, considerable precipitation (direct or indirect) is provided by trade wind-induced orographic uplift of humid air masses, which in return affects the zonation of ecosystems and species assemblages. However, on islands, cloud layer elevation, orographic cloud formation and the associated patterns of rainfall, solar radiation, temperature and humidity depend on the position of the highly variable trade wind inversion layer (e.g. Hawaii). At the highest elevations, those above the trade wind inversion layer, an increase of aridity and temperature may threaten the high number of endemic species present. Currently, there are contrasting projections about how the thermal inversion layer and associated cloud formation is shifting. Upward or downward shifts of the trade wind inversion layer could endanger these vulnerable ecosystems. For the first time, the structure of the cloud layer on La Réunion (Mascarenes) is investigated/studied using a ceilometer. Of particular interest is the cloud-base height and trade wind inversion layer. The seasonality of this cloud layer will be investigated at a monthly level on both leeward and windward slopes. In this poster, we further present the importance of cloud water interception for tropical montane bryophytes using *in situ* lysimetric experiments and environmental sensors. The hydrological role of the two most abundant liverworts *Bazzania decrescens* and *Mastigophora diclados* is quantified. Their measured water holding capacities approach nearly 1000 % of their dry weight, with *B. decrescens* having a higher storage capacity while *M. diclados* has a better water interception capacity. Very sensitive to their environment, these two liverworts are constantly traversed by incoming and outgoing flows of water, supporting their important role in the hydrology of this tropical montane cloud forest.

## The dynamics of *Ocotea foetens* (Lauraceae) on current laurel forests of Macaronesia

ALBANO FIGUEIREDO, M.E.A. CONCEPCIÓN & J.M. PANAREDA



Figueiredo, A., M.E.A. Concepción & J.M. Panareda 2016. The dynamics of *Ocotea foetens* (Lauraceae) on current laurel forests of Macaronesia. Pp. 441 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Macaronesian islands; *Taxa*: *Ocotea foetens*; *Other*: distribution, suitable area, land use, climate, forest dynamics.

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*Ocotea* is one of the largest genus in the Lauraceae family, present in Central and Southern America (Mexico to Argentina), Africa and Madagascar, between sea level and about 3000m a.s.l. The genus is also present in the Macaronesian islands, but, contrarily to the diversity of species found on the tropical forests, on such islands it is represented by one species - *Ocotea foetens* (Aiton) Benth. & Hook.f.. This work aims to clarify differences on the role and dynamics of *O. foetens* on the laurel forests of Macaronesia, namely on Madeira and Canaries. Such assessment is based on: **i)** evaluation of suitable area, based on species distribution models, in order to identify differences between islands in terms of current and potential distribution; **ii)** analysis of importance in the structure of current laurel forests and related communities based on inventories and forest sections. In the Madeiran archipelago, the species is only present on Madeira Island, where current suitable area is quite large. Like on Canarian islands (La Gomera, Tenerife, La Palma), suitable area is very likely underestimated because of land use, namely grazing, forest fires, charcoal production and afforestation with exotics. Nevertheless, Madeira Island is the one where such species has higher suitable area and undeniable importance on the structure of current temperate laurel forests. In the Canaries, the species is currently restricted to small areas, where few times is the dominant taxa at the tree layer. The absence of the species on forest communities present on suitable areas might indicate the extirpation on seed bank or the sensitivity of the species to disturbance, recovering only after the establishment of a secondary forest. In fact, the recovery rate is very low in the Canaries, where such species is currently associated to very old specimens located on the margins of pathways or routes, and few times young specimens under the canopy of a secondary forest. Such pattern might indicate that current structure exhibits the deep interference of human activities on the structure and floristic composition of current laurel forests.

## Interaction networks over time: Using next generation sequencing to determine changes in predation and competition across substrates of different age in Hawaii

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Figueiredo, A., M.E. Arozena Concepción & J.M. Panareda 2016. Interaction networks over time: Using next generation sequencing to determine changes in predation and competition across substrates of different age in Hawaii. Pp. 442 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hawaii; *Taxa*: arthropods; *Other*: species interactions, niche differentiation, NGS.

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Ecological communities are clearly much more than the species and individuals that persist within particular habitats; they also critically include the interactions and relationships among species, including predation and competition. Interaction networks can be very complex, and include interactions within and between species and trophic levels, and that vary across space and time. Understanding these complex interactions or food webs is critical in order to determine the ecological characteristics of a community, and its stability and resilience to disturbance. However, identification and quantification of both predation and competition is difficult, as such interactions tend to be cryptic. Molecular approaches offer a means to reveal cryptic interactions, and thereby greatly contribute to refining our understanding of predator prey interactions, as well as feeding niche and hence competition. Next generation sequencing (NGS), in particular, is providing an avenue for large scale analysis of the identity and frequency of predation in whole ecosystems. Here we use a novel next generation sequencing protocol to study gut content of predatory arthropods in the Hawaiian Archipelago, a biodiversity hotspot of global importance and a volcanic hotspot. Given its origin as a geological hotspot, the islands present a chronosequence in which communities become progressively older towards the northwest. We use the chronosequence to test the hypothesis that interaction networks become stronger, and niches become narrower, over extended time. We compare two substrates on the youngest big island, one with age ranging from 5000 to 11000 years old, and the other one ranging from 200 to 750; we study niche differentiation and food web structure of the predatory arthropod community. This study is nested in a large scale project to explore biodiversity assembly on the Hawaiian archipelago.

## Taxonomic and functional diversity of phytophagous insects associated with trees from the Azorean native laurel forests

CARLA REGO, M. BOIEIRO, F. RIGAL, S.P. RIBEIRO, P. CARDOSO & P.A.V. BORGES



Rego, C., M. Boieiro, F. Rigal, S.P. Ribeiro, P. Cardoso & P.A.V. Borges 2016. Taxonomic and functional diversity of phytophagous insects associated with trees from the Azorean native laurel forests. Pp. 443 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Terceira Island, Azores; *Taxa*: insects and plants; *Other*: phytophagous insects, Laurisilva, functional diversity, taxonomic diversity, beta partition.

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Functional diversity has emerged in recent years as a key concept in ecology to understand community assemblages, replacing the traditional approach of using taxonomic diversity alone. In this study we compare the taxonomic and functional diversity of insect herbivore assemblages associated with the dominant tree species of the Azorean native forests and evaluate the relative contribution of  $\beta$ -diversity components (turnover and richness) to unveil the underlying ecological patterns. The insect phytophagous communities of the five dominant trees /shrubs - *Erica azorica*, *Ilex perado* subsp. *azorica*, *Juniperus brevifolia*, *Laurus azorica* and *Vaccinium cylindraceum* - in the remnants of native laurel forest of Terceira Island (Azores) were sampled using a standardised methodology, allowing the finding of 67 insect species, mostly hemipterans and caterpillars. The taxonomic and functional diversity of insect herbivore assemblages was assessed using complementary metrics and beta diversity partitioning analysis allowed us to evaluate the variation in insect herbivore assemblages within and between the study plant species. The results show that species turnover is the most important component for both taxonomic and functional beta diversity of phytophagous insects associated with the native laurel forest trees of Terceira Island. We found low taxonomic and functional diversity of insect herbivore assemblages associated with the laurel forest canopy and high levels of generalism since most native insects were found on phylogenetically unrelated host plants. However, the endemic tree *Erica azorica* stands out by having associated a distinct species rich insect herbivore community, mainly composed by endemic and non-endemic native species. Finally, the comparisons between taxonomic and functional diversity of insect herbivore assemblages from the different native trees indicate that both metrics are closely related.

POSTER SESSION 2  
19 July 2016

CONSERVATION



## Epilithic biofilms diversity and assembly across the three domains of life in island tropical rivers (Guadeloupe) submitted to chlordecone contamination pressure

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Hubas, C., F. Rigal, D. Monti, S. Pennarun, A. Carbon, H. Budzinski, R. Duran & B. Lauga 2016. Epilithic biofilms diversity and assembly across the three domains of life in island tropical rivers (Guadeloupe) submitted to chlordecone contamination pressure. Pp. 445-446 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

**Key words:** *Location:* Guadeloupe Island, French West Indies; *Taxa:* Microbial communities, Archaea, Bacteria, Eukarya; *Other:* epilithic biofilms, community assembly, tropical biodiversity, pesticide contamination, regional pool, environmental filters.

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Rivers and streams are open ecosystems dominated by a continuous unidirectional flow from headwaters to the mouth and in constant interaction with surrounding areas. Numerous species thrive in these ecosystems but biofilm microbial communities play there a pivotal role driving key ecosystems processes and sustaining biogeochemical fluxes. The literature reports several studies that investigate epilithic biofilm biology in temperate or boreal continental areas including community composition and assembly, origin of microorganisms, impact of contaminants, etc... Surprisingly however it seems that no attention has been paid to island epilithic biofilms whereas they provide ideal model to study community assembly in microbial community. The situation is even more astonishing since very few reports investigated the biological diversity of tropical biofilms that may substantially differ from temperate or boreal lotic hydrosystems. The study presented here is a first step to apprehend some of these topics in the context of tropical islands and contamination pressure. In that aim the study focus in Basse-Terre region in Guadeloupe. Indeed during decades, chlordecone was used intensively in this region in banana plantations to prevent attacks by *Cosmopolites sordidus*, a weevil that destroys the banana plant leading to river contamination due to pesticide run-off. Since



epilithic biofilms in lotic systems are complex assemblages of microorganisms we considered the three domains of life (Archaea, Bacteria and Eukarya) to decipher the spatial organisation of biofilm communities. We explicitly assessed the impact of chlordecone on microbial assemblages along a contamination gradient. In addition the experiment last during 21 days to integrate successional changes that occur during biofilm development.

## BEST, fostering Biodiversity conservation and sustainable development in 7 regions of the world

CAROLE MARTINEZ, F.M. WALLENSTEIN & J.M.N. AZEVEDO



Martinez, C., F.M. Wallenstein & J.M.N. Azevedo 2016. BEST, fostering Biodiversity conservation and sustainable development in 7 regions of the world. Pp. 447 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: 7 globally important regions: Macaronesia, Caribbean, Amazonia, Pacific, Indian Ocean, North-South Atlantic, Polar; *Taxa*: all; *Other*: European Overseas, ecosystem profiles, Key Biodiversity Areas, priority areas for action, funding partnership.

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BEST – voluntary scheme for Biodiversity and Ecosystem Services in Territories of European overseas – aims to support the conservation of biodiversity and the sustainable use of ecosystem services (including ecosystem-based approaches to climate change adaptation and mitigation) in the EU Outermost Regions (ORs) and Overseas Countries and Territories (OCTs). EU Overseas biodiversity is exceptionally rich and is recognized as being of international importance. European ORs and OCTs are indeed part of biodiversity hotspots and are key actors for the implementation of international and regional conservation targets and to foster regional cooperation in 7 globally important regions of the world. As a dedicated pilot funding mechanism, BEST is operating to target friendly calls for proposals in order to improve access of local actors to European funds. In order to guide the process, the European Commission decided to mandate a consortium led by IUCN to elaborate regional ecosystem profiles and regional investment strategies. This consortium includes a coordination team and regional hubs in order to be closer to local actors. In the Macaronesian region Fundo Regional para a Ciência e Tecnologia, based in the Azores, is acting as regional hub. Thanks to a participative process, Key Biodiversity Areas and priority actions have been thus identified in the Pacific, Caribbean, Amazonia, Indian Ocean, South and North Atlantic, Polar and Macaronesia regions.

## Volunteer tourism for island conservation: Case of Lord Howe Island

IAN HUTTON



Hutton, I. 2016. Volunteer tourism for island conservation: Case of Lord Howe Island. Pp. 448 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Lord Howe Island; *Taxa*: -; *Other*: conservation, islands, volunteers, tourism.

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Volunteers have provided a major force for dealing with weeds, particularly around cities with large human populations. However, what do you do on isolated islands with small human populations, or none at all? Volunteer tourism has the potential to provide a labour supply for island conservation projects. On Lord Howe Island such a volunteer tourism program commenced in 1995. This program consists of weeklong ecotours where people pay to travel and assist with weed eradication in the mornings, and enjoy walks and lectures about the island in the afternoons. There have been 78 weeklong ecotours between 1995 and 2015. The hours contributed by volunteers' total 25,144; with a dollar value of A\$35 per hour is A\$880,040 to conservation on Lord Howe Island. The total estimated contribution to the tourist economy, in 2015 dollars, is about A\$3.5 million. Many people participate more than once. Out of a total of 793 persons who have been on an ecotour, 189 people have been more than once, 23 people have been more than 10 times. What makes the program a success? The beautiful environment of Lord Howe Island appeals to many people; but to pay around A\$2200 for a trip it needs more. It is the combination of strong leadership, quality natural history interpretation, contributing to conservation of the environment, good company with people of similar outlook, cooperation with the land managers and a high standard of hospitality. This type of program then has a win-win situation – good long-term success in conservation, governments save dollars, tourism operators have an ongoing income and many people enjoy the experience. So for island destinations with a serious weed problem or other conservation issue, organised ecotours can make a major contribution. It is working on Lord Howe Island.

## From null to full protection: Challenges and novel approach in implementing a new sea turtle protection legislation in Gulf of Guinea

SARA VIEIRA, V. JIMÉNEZ, A. BESUGO, J. HANCOCK, H. LIMA, L. OLIVEIRA & B. LOLOUM



Vieira, S., V. Jiménez, A. Besugo, J. Hancock, H. Lima, L. Oliveira & B. Loloum 2016. From null to full protection: Challenges and novel approach in implementing a new sea turtle protection legislation in Gulf of Guinea. Pp. 449 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: São Tomé and Príncipe, Gulf of Guinea; *Taxa*: Testudines; *Other*: sea turtle conservation, participatory approach, education program.

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São Tomé and Príncipe is a breeding place for four of the seven known species of marine turtles in the world, including the only viable nesting population of the critically endangered Eastern Atlantic hawksbill (*Eretmochelys imbricata*). Despite efforts over the last decade, sea turtles are still heavily exploited for human consumption in São Tomé and Príncipe and represent an important source of income to the local population. The NGO Marapa has been running *Program Tatô* since 2003, that is dedicated to the protection, conservation and research of the sea turtle populations occurring in São Tomé and Príncipe. The program has been leading awareness and conservation activities since then, being partially successful in halting sea turtle harvesting and nest loss due to anthropogenic threats on 15 km of nesting beaches. However, without adequate legal framework, mortality rates ranged from 67 - 89% of nesting females each year. Intense campaigning and negotiation with the national government for more than a decade finally gave rise to the first national legislation for the full protection of sea turtles in April 2014. This has posed new challenges to the NGO that partnered with the Portuguese NGO ATM in order to strengthen its conservation and research program, and develop an intense national outreach campaign and environmental education program in five target fishing communities with a great tradition on sea turtle harvesting and consumption. With novel approaches and a solid participatory approach to law implementation, the NGOs present the results and share its experiences of the first two years of new protective framework.

## Islands in interdisciplinary education: Balancing connectivity and isolation

SIETZE J. NORDER & K.F. RIJSDIJK



Norder, S.J. & K.F. Rijdsdijk 2016. Islands in interdisciplinary education: Balancing connectivity and isolation. Pp. 450 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: -; *Taxa*: -; *Other*: elective undergraduate course, sharing teaching materials, course development, critical alignment, social-ecological systems.

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Since Island Studies is an inherently interdisciplinary academic field, studying islands can help academic students acknowledge the values and shortcomings of their own and other disciplines. In this paper we will present the outline of an interdisciplinary lecture module entitled: 'Islands: Models for our Planet – Metaphors for our World', and will reflect on insights gained during its development and teaching during two consecutive academic years (2014-2015, 2015-2016). For this course, which was open to second and third year bachelor students from all disciplines, 80-100 students enrolled, of which approximately 50% took part in the final examination. Central to this module is the realization that, when studying islands, island boundaries are drawn in many different ways. Where boundaries are drawn mainly depends on three aspects: 1) the disciplinary viewpoint of the researcher, 2) the focus of the research (an island for whom?), and 3) the time period under consideration (since island boundaries change over time). Studying islands in an interdisciplinary team is therefore about finding a balance between (actively) isolating an island (or island phenomenon) to be able to study it, and meanwhile doing justice to its complexity, diversity, and interconnectedness. During the three months of the course, students received weekly lectures by island scholars working in the social sciences, natural sciences, or humanities. An important element of the module is participative learning whereby students collaborate in interdisciplinary teams, with each team writing an integrative chapter of a jointly produced book on islands. The course concluded with a symposium during which the teams present the findings of their island research project. The course received a high overall assessment from students (7,7/10 in the first year; 8,1/10 in the second year). We aim to make the developed course materials freely available to colleagues around the world who are teaching in island studies.

## Constraints to species' elevational range shifts as climate changes: Insights from an oceanic high mountain violet (*Viola cheiranthifolia*) using niche modeling and genetic diversity data

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Fernández de Castro, A.G., P. Rodríguez-Rodríguez, J. Seguí Colomar, P.A. Sosa & A. Traveset 2016. Constraints to species' elevational range shifts as climate changes: Insights from an oceanic high mountain violet (*Viola cheiranthifolia*) using niche modeling and genetic diversity data. Pp. 451-452 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Tenerife, Canary Islands; *Taxa*: *Viola cheiranthifolia* Humb. & Bonpl.; *Other*: alpine, endemic, global warming, niche modelling.

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Summit ecosystems of oceanic islands are some of the most isolated of the world, acting as islands within islands, which confers to their biota a particular vulnerability to climate changes and disturbances. Predicting whether the ranges of mountain species in oceanic islands will shift to higher elevations in response to climate change requires models that incorporate accurate environmental predictors along with other natural history traits. We incorporated temperature gradients, topography and snow covering maps at very high spatial resolution (5 meters) to conduct a niche modeling approach from the current ranges of an endemic oceanic alpine violet species (*Viola cheiranthifolia*). Models were projected into climate change scenarios to assess the extent of the altitudinal shifts of environmental suitability. We developed 14 microsatellites markers for analyzing genetic diversity and gene flow. We combined niche modeling with the genetic variability and reproductive success, to evaluate if these traits will diminish at the same pace as the distribution range and if the gene flow may promote the resilience of this alpine species when confronted with global warming. As expected, snow cover along topography explains the higher share of variance of the distribution model. All projected climate change scenarios predict a severe decrease or disappearance of the climate suitability envelope of the species. The most peripheral genetic group is likely to disappear while the central one shows a shift to the most extreme altitudes. The loss of genetic variability combined with

the severe impacts of grazing in the National Park will lead, in a short period of time to the extinction of this fragile, unique endemic plant. Conservation practices on *V. cheiranthifolia* should then urgently incorporate the promotion of in situ genetic exchange between both genetic groups so that all variability persists in the nature. It is clear as well that ex situ conservation measures are needed and a seedbank must be collected accounting for both populations.



## Using species distribution modelling for IUCN Red Listing

EMAD KAKY & F. GILBERT



Kaky, E. & F. Gilbert 2016. Using species distribution modelling for IUCN Red Listing. Pp. 453 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Egypt; *Taxa*: plants; *Other*: species distribution modelling (SDM), MaxEnt, IUCN Red List, climate change, emission scenarios, dispersal limitation.

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The IUCN Red List of threatened species is one of the most important of all conservation indicators, but most developing countries do not have enough information (species data and human resources) with which to make assessments. Species distribution modelling (SDM) approaches are one of the best methods for predicting the potential occurrence of species, both currently and in the future under the effects of climate change, and offer a potential solution. In this study, we use SDM in evaluating 114 Egyptian plants based on IUCN Red List criteria and categories. Using MaxEnt, and eleven environmental variables, distributions were projected for 2020, 2050, and 2080 under two emission scenarios (A2a and B2a) assuming unlimited and no dispersal. Assessments used actual and predicted extent of occurrence (EOO) and area of occupancy (AOO). For the present-day, there was a positive correlation between EOO estimates based on actual records and based on SDM. Based on records, between 75% and 90% of species could be classified as Least Concern (LC), according to the assumption made. Similarly, based on SDM all species could be classified as LC at the current time, whilst in the future under climate change, up to 18% of species face extinction, depending on the assumptions. In conclusion, SDM is a reliable tool with which to make IUCN Red List assessments for countries where data are sparse

## Mauritius on fire: A charcoal record of the last thousand years shows the human destruction of an oceanic island

ERIK J. DE BOER, J. KRUIF & W.D. GOSLING



de Boer, E.J., J. Kruijff & W.D. Gosling 2016. Mauritius on fire: A charcoal record of the last thousand years shows the human destruction of an oceanic island. Pp. 454 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: SW Indian Ocean, eastern coastal lowlands of Mauritius; *Taxa*: semi-dry deciduous forest, palm woodland, sugar cane; *Other*: macro-charcoal, fire regime, extinction megaherbivores, land-use change.

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Human arrival on oceanic islands has led to large-scale habitat destruction and extinctions of local flora and fauna. Understanding of the process of how humans have so thoroughly transformed island environments soon after first colonization has obvious relevance to current conservation and restoration strategies. However, only a few island groups worldwide were apparently colonized for the first time within the period of locally recorded history. Places that were first colonized historically offer a special opportunity to calibrate paleoecological methods and evaluate conclusions from other places. The Indian Ocean island of Mauritius was first colonized in the 17th century and has a well-documented history of human impact. High-resolution paleoecological reconstructions from these islands provide a unique opportunity to compare ecosystem processes and dynamics before and after colonization. A charcoal record from Mare Tatos, a wetland in the coastal lowlands of Mauritius, gives a first high-detailed history of fire and land use change during the last thousand years. Before human contact, fire was infrequent and had only small-scale impact. Increased fire activity and large fire events co-occur with the arrival of the Dutch in AD 1638. The extinction of megaherbivores caused an increase in biomass from grasses and shrubs, resulting in stronger and more frequent fire events. The destruction of large areas of forest for sugarcane plantation by the French around AD 1800 is marked by an anomalous fire event. The fire frequency increases continuously up to present-day.

## Improving the monitoring of fish communities in Azorean freshwater lakes

VÍTOR GONÇALVES, A.C.L. PRESTES, A. DALLAIRE, G. GEA, J.-C. RIVA, D.M. PACHECO, M. MATIAS ET AL.



Gonçalves, V., A.C.L. Prestes, A. Dallaire, G. Gea, J.-C. Riva, D.M. Pacheco, M. Matias, A. Fonseca, P.M. Raposeiro & J.M.N. Azevedo 2016. Improving the monitoring of fish communities in Azorean freshwater lakes. Pp. 455-456 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: São Miguel Island, Azores; *Taxa*: Cyprinidae, Esocidae, Percidae, Salmonidae; *Other*: EU Water Framework Directive, monitoring, freshwater fish, eDNA.

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The EU water framework directive (WFD), adopted in 2000, considers the fish fauna as a biological quality element in the evaluation of inland surface waters ecological status. The monitoring of fish communities on inland surface water bodies of Azores has never been implemented because traditional methods, such as electrical fishing or multi-mesh gillnets, are financially demanding. New quantification techniques, based on environmental DNA (eDNA), promise to lower the sampling cost but still need to be tested in the field. We present here the first results of a pilot study (project GestAqua, financed by the Environment Agency of the Azores Government) aimed at i) proposing a methodology for fish monitoring applicable to Azorean lakes, and at ii) exploring the potential of eDNA methodologies to address the requirements of the WFD regarding lake ecological status assessment. The project is focused on a limited group of Azorean lakes: Rasa, Canário, Empadadas Norte, Verde and Fogo, all on São Miguel Island. These have been sampled during the winter of 2015/16 with benthic and pelagic multi-mesh gillnets, following the European standard (EN 14757). Complementarily, water samples were collected for eDNA analysis. From the 13 fish species known to have been introduced to the Azores archipelago, 9 were found in the sampled lakes: *Achondrostoma oligolepis*, *Carassius auratus*, *Cyprinus carpio*, *Esox lucius*, *Micropterus salmoides*,

*Perca fluviatilis*, *Rutilus rutilus*, *Oncorhynchus mykiss*, and *Salmo trutta*. *M. salmoides* was present in all sampled lakes, with the exception of Verde lake, where *P. fluviatilis* was present. *O. mykiss* and *S. trutta* were only found in Fogo Lake. Fogo lake presented the more diverse fish assemblage (n=6), while in Rasa lake only *M. salmoides* was observed.

## Insular frugivore communities: Extinction and its consequences for functional diversity

JULIA H. HEINEN, D.M. HANSEN & W.D. KISSLING



Heinen, J.A., D.M. Hansen & W.D. Kissling 2016. Insular frugivore communities: Extinction and its consequences for functional diversity. Pp. 457 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Islands globally; *Taxa*: birds, mammals and reptiles; *Other*: island communities, frugivores, seed dispersal, extinction, body mass.

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Compared to continental ecosystems, islands have suffered disproportionately high levels of extinctions. Extinctions can lead to the loss of mutualistic interactions, such as seed dispersal, within communities. Especially the loss of many of the largest insular frugivores, such as the dodo, giant tortoises and elephant birds, is a global trend. However, we still know little about the geographic variation of extinction-driven changes in the functional ecology of seed dispersal in insular communities. Here, we quantify insular frugivore extinctions globally for birds, mammals, and reptiles and investigate the resulting consequences for body mass distributions and functional diversity of traits that are relevant for seed dispersal (diet, body mass and movement potential). Specifically, we compiled a new database of island frugivore communities, and extinction within these communities, across a large number of oceanic islands worldwide. We then compare the community mean body mass and the occupancy of unique functional trait combinations between pre- and post-extinction communities to evaluate the decrease in mass and changes in functional diversity. Results show that most islands have seen a decrease in community mean body mass which strongly affects functional diversity after frugivore extinctions. Some islands such as Mangaia (Cook Islands) have lost up to 75% of their original frugivore community. This has likely severe consequences for seed dispersal of insular plants and their mutualistic interactions with vertebrate frugivores. Our results could guide conservation and rewilding efforts by suggesting effective focal species for the restoration of seed dispersal interactions in island ecosystems.

## Updates on whole-dataset analyses using Spark and the GUODA Data Service

MATTHEW J. COLLINS, J. POELEN & A. THOMPSON



Collins, M., J. Poelen & A. Thompson 2016. Updates on whole-dataset analyses using Spark and the GUODA Data Service. Pp. 458 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: all; *Other*: Spark, iDigBio, biodiversity informatics.

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Since the Taxonomic Databases Working Group (TDWG) meeting in September 2015, the authors have continued to develop applications and techniques for analyzing entire biodiversity data sets using Apache Spark. This collaboration has led to the development of the GUODA (Global Unified Open Data Access) service, now in alpha status, which aims to ease the systems administration and cognitive load burdens of large-scale data processing by providing a place to collect and run analysis code written for the Apache Spark data processing engine. Applications of this service are summarized with the hope that other members of the community will become involved in testing this service. Using GUODA, we have built a two web services. The first compiles taxonomic checklists from user provided geospatial, taxonomic, temporal and trait constraints (see <http://effechecka.org>). The second, called Fresh Data, sends notifications whenever new occurrence records are available that match user-specified queries. An essential part of the GUODA service is codifying ways in which researchers and other data users can disseminate their results. This includes establishing best practices for products and their metadata and enabling workflows that provide a communication channel back to the original sources of the data. We have been prototyping this latter use case by using the iDigBio data quality assessment process to drive an annotation system at iDigBio. Although an important advantage of Spark is that it removes an enormous amount of expertise traditionally required to make MapReduce jobs or parallel analyses, it is not simple. We have also been working on ways to make the power of GUODA available to bioinformatics researchers using libraries and interfaces in scripting language like R and Python.

## Habitat characteristics and population dynamics of the endangered species *Lotus kunkelii* in the Protected Scientific Site of Jinámar (Gran Canaria-España)

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Naranjo Cigala, A., J.R. Arévalo, M. Salas, F. Díaz, A.M. González, S. Santana & A. Ramos 2016. Habitat characteristics and population dynamics of the endangered species *Lotus kunkelii* in the Protected Scientific Site of Jinámar (Gran Canaria-España). Pp. 459-460 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Gran Canaria, Canary Islands; *Taxa*: *Lotus kunkelii* (Esteve) Bramwell & D. H. Davis; *Other*: protected areas, biodiversity conservation, matrix analysis, population dynamics.

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The species *Lotus kunkelii* (Esteve) Bramwell & D. H. Davis, is present in only one population in the ravine of Jinámar, at East of Gran Canaria. The habitat is included in a Site of Scientific Interest of Canarian ENP Network, in a very small coastal area in an halophyte-psammophyte ecosystem, highly disturbed by human action in many sectors of the Site. The species is considered in danger of extinction base in the Protected Species Canarian Catalogue (2010) and the Protected species Spanish Catalogue (2011). In its Recovery Plan (BOC nº 29, February 12th, 2009) it is established the objectives to improve the population number of individuals and analysis of the dynamic of the population. We monitored the population from March 2013 to March 2016 (80 senior individuals, including a 20-30% new germinated individuals). We measured the biovolumen and analyzed changes for these values in the individuals. We indicated the presence of flowers and fruits and survivorship of the new individuals, as well as change of biovolumen class of the individuals. We correlated phenological characteristics of the plant with climatic variables (temperature, rainfall and humidity). Our matrix population analysis revealed stability in the population and the number of individuals in the different classes. There is some increases in the population in the first class, but this increase is temporal due to the high natural mortality, although there is some transference of individuals from



inferior classes to superior ones. The growth rate is very low at a running period of the model of 100 years. Base in the information obtained in this study together with the information from a reintroduced population last year, provided us with the possibilities to suggest some recommendations for the conservation of the species to the responsible of the management of the species.

## Feeding preferences, growth and survival of the endemic stream shredder *Limnephilus atlanticus* (Trichoptera, Limnephilidae) when offered leaf litter conditioned in stream water naturally contaminated with heavy metals

ANA BALIBREA, V. GONÇALVES, V. FERREIRA & P.M. RAPOSEIRO



Balibrea, A., V. Gonçalves, V. Ferreira & P.M. Raposeiro 2016. Feeding preferences, growth and survival of the endemic stream shredder *Limnephilus atlanticus* (Trichoptera, Limnephilidae) when offered leaf litter conditioned in stream water naturally contaminated with heavy metals. Pp. 461 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: *Limnephilus atlanticus* (Trichoptera, Limnephilidae); *Other*: shredder, stream, naturally heavy metal contamination, feeding preferences.

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Many island streams are naturally affected by heavy metal contamination, mostly due to volcanic activity. We investigated the feeding preferences, growth and survival of larva of the endemic caddisfly shredder *Limnephilus atlanticus* when offered leaves (*Alnus glutinosa*, *Ilex perado* and *Laurus azorica*) conditioned in stream water naturally contaminated by heavy metals (contaminated leaves) *versus* non-contaminated stream water (non-contaminated leaves). Shredders consumed all leaf species offered, but when given a choice of non-contaminated leaves, they significantly preferred *A. glutinosa*, while when given a choice of contaminated leaves, they preferred *I. perado*. Also, when given a choice, *L. atlanticus* always preferred non-contaminated over contaminated leaves. Relative larval growth rate was significantly higher when *L. atlanticus* fed on *A. glutinosa* and *I. perado* leaves in comparison with *L. azorica*, for both contaminated and non-contaminated leaves. No significant differences were found on the survival when shredders were fed with contaminated and non-contaminated leaves.

## Factors limiting the establishment of canopy-forming algae on artificial structures

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& A.I. NETO



Cacabelos, E., G.M. Martins, R. Thompson, A.C.L. Prestes, J.M.N. Azevedo & A.I. Neto 2016. Factors limiting the establishment of canopy-forming algae on artificial structures. Pp. 462 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: São Miguel Island, Azores; *Taxa*: *Fucus spiralis*; *Other*: coastal urbanization, substratum orientation, substratum slope.

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Macroalgal canopies are important ecosystem engineers, contributing to coastal productivity and supporting a rich assemblage of associated flora and fauna. Yet, they are often absent from infrastructures such as coastal defences and there has been a worldwide decline in their distribution in urbanized coastal areas. The macroalga *Fucus spiralis* is the only high-shore canopy present in the Azores. It is widely distributed in the archipelago but is never found on coastal infrastructures. Here we evaluate factors that may potentially limit its establishment on artificial structures. A number of observational and manipulative experiments were used to test the hypotheses that: (i) limited-dispersal ability restricts the colonization of new plants onto artificial structures, (ii) vertical substratum orientation negatively influences the survivorship of recruits, and (iii) vertical substratum orientation also negatively influences the survivorship and fitness of adults. Results showed that the restricted dispersal from adult plants may limit the species ability to colonize coastal infrastructures, and reinforce the notion that a greater proportion of vertical surfaces compared to natural habitats, consequence of urbanisation, could strongly affect Azorean canopy-forming algae. This could have important effects on Azorean coasts, where *F. spiralis* is the only leathery canopy-forming algae at upper intertidal level ameliorating the otherwise harsh conditions during low tides.

## The conservation status of the endemic flora of French Polynesia: *La maison brûle* (the house is burning)!

JEAN-YVES MEYER



Meyer, J.-Y., 2016. The conservation status of the endemic flora of French Polynesia: *La maison brûle* (the house is burning)!. Pp. 463 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: French Polynesia (South Pacific); *Taxa*: vascular plants; *Other*: conservation, endangered plants, invasive species, prioritization.

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The native vascular flora of French Polynesia, a French Overseas territory located in the South Pacific and formed by about 120 oceanic islands grouped in 5 archipelagoes (namely the Australs, the Gambier, the Marquesas, the Society and the Tuamotu), comprises about 870 native species, including 460 endemic species and 61 endemic subspecies and varieties, i.e. an endemism rate of 62%. Until now, the IUCN Red List ([www.iucnredlist.org](http://www.iucnredlist.org)) recognized 47 threatened species for French Polynesia. A revision was recently conducted with French, foreign and local plant experts and coordinated by the French Polynesian government and the French UICN committee. This report, published in December 2015, reveals that 65% of the endemic flora (302 species) is considered threatened, including 119 critically endangered species (CR), 133 endangered species (EN) and 50 vulnerable species (VU), with 6 other endemic species now considered extinct (EX). The highest number of threatened species is found in the Marquesas (131 species) and the Society (110) archipelagoes. The major threats are forest destruction and fragmentation caused by increasing urbanization and fires, and invasive alien species (both plants and feral ungulates) which constitute a direct threat to half (65 species) of the most endangered species. Because of geographic isolation, limited funding and human resources, poor infrastructures, and the paucity of protected terrestrial areas (with ten sites covering about 8500 ha, i.e. 2% of the total land surface), a plant conservation strategy is urgently needed in French Polynesia, and priorities should be defined. We recommend to protect the most critical and irreplaceable taxa (i.e. belonging to the 8 endemic genera) as well as threatened and unique habitats (e.g. remnant semi-dry and mesic forests, cloud forests, high elevation plateaus and wetlands, subalpine vegetation). Conservation of native and endemic species should not obliterate the importance of Polynesian introduced plants (“endemic” cultivars) of high cultural value.

## The Cabo Verde islands as important biogeographical refuge areas for some remarkable bryophytes

CECÍLIA SÉRGIO, C.A. GARCIA & M. SIM-SIM



Sérgio, C., C.A. Garcia & M. Sim-Sim 2016. The Cabo Verde islands as important biogeographical refuge areas for some remarkable bryophytes. Pp. 464 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Cabo Verde; *Taxa*: bryophytes; *Other*: Macaronesia, hornworts, mosses, Krober similarity index, conservation.

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The lack of floristic data, and / or the difficulty of obtaining them, makes the study of bryophytes in some regions of Africa very difficult; Cape Verde is no exception. In fact, knowledge of the bryophyte flora of Cabo Verde is still very incomplete and the country appears to be bryologically under sampled. The small *Laurisilva* areas of the Cape Verde are hotspots for endemic vascular plants, but the xerophytic habitats are equally important, and it is likely that a large number of Mediterranean or tropical bryophytes occur. Presently, there are very few reports for those plants in this archipelago. It should be noted that a significant number of new species have been reported based on sporadic studies some carried out recently. Examples are: *Phaeoceros carolinianus* (Michx.) Prosk., *Riccia atromarginata* Levier, *R. crinita* Taylor, *R. macrocarpa* Levier, *Barbula bolleana* (Müll. Hal.) Broth., *Cryphaea heteromalla* (Hedw.) D. Mohr, *Entosthodon kroonkurk* Dirkse & Brugués, *Fissidens allorgei* P. de la Varde, *F. flaccidus* Mitt., *Gymnostomiella vernicosa* (Harv.) Fleisch. and *Tortula revolvens* (Schimp.) G.Roth. These new records are an important new step towards a more updated bryoflora of the archipelago. In the present work the occurrence of these representative taxa in the Cabo Verde islands is analyzed, as well as a presentation of its the overall distribution. Preliminary results show that these islands were important refuge areas during the Quaternary glaciations. Thus, we emphasize the biogeographic and ecological importance of the new species presented in this paper; the relevance of bryological flora of Cape Verde, and the need for monitoring plans for specific habitats, crucial at this period in which climate-change effects and biodiversity loss are to be expected.

## Effects of land use on macroinvertebrate communities on oceanic island streams (Azores archipelago)

CYNTHIA SOUED, V. GONÇALVES, A.C. COSTA & P.M. RAPOSEIRO



Soued, C., V. Gonçalves, A.C. Costa & P.M. Raposeiro 2016. Effects of land use on macroinvertebrate communities on oceanic island streams (Azores archipelago). Pp. 465 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: freshwater macroinvertebrates; *Other*: land use change, stream, macroinvertebrates, endemic taxa.

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Macroinvertebrate assemblages are major players in stream ecosystem functions, but their role can be substantially altered by environmental changes in their watersheds. Catchment land cover is tightly linked to macroinvertebrate community composition in streams. The effect of vegetation clearing on stream macroinvertebrates has been clearly demonstrated, however, the consequences of vegetation replacement in stream catchments have seldom been explored. Changes in catchment vegetation are a widespread phenomenon, especially on oceanic islands where exotic species introduction is common. In this study we compare macroinvertebrate community composition and diversity indexes among nine streams of São Miguel Island (Azores), in catchments dominated by three different tree species; one native (*Ilex perado*), and two exotic (*Cryptomeria japonica* and *Pittosporum undulatum*). Macroinvertebrate richness and diversity did not differ among catchment, however, evenness was significantly higher in catchments dominated by the native species. Lower evenness in exotic tree catchments could render communities more vulnerable to species loss. The variability in macroinvertebrate community composition was mainly correlated to physical and chemical stream properties, while tree cover type alone explained 13 % of the variability. We conclude that tree species has a measurable effect on stream macroinvertebrate assemblages, but is not a strong driver of these communities. Overall our results suggest that tree species replacement in a catchment can have a subtle effect on macroinvertebrate assemblages, possible lowering their resilience. However, further research is needed to draw stronger conclusions on the subject.

## Makauwahi Cave Reserve, Kauai: Research, conservation, and tourism

DAVID A. BURNEY & L.P. BURNEY



Burney, D.A. & L.P. Burney 2016. Makauwahi Cave Reserve, Kauai: Research, conservation, and tourism. Pp. 466 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Kauai, Hawaii; *Taxa*: all; *Other*: paleoecology, archaeology, restoration, cave research, conservation paleobiology.

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Makauwahi Cave, Kauai, is the centerpiece of a reserve dedicated to the protection, study, and interpretation of its unique resources. Each year over 30,000 people -- local school children, residents, and visitors to the islands from throughout the world -- learn about the past from the evidence gleaned from a quarter century of coring, excavation, and analysis of the site's rich record. Spectacular preservation of fossil vertebrates, invertebrates, plants, and a full range of microfossils spans the Holocene millennia before human arrival, provides some of the earliest well-dated evidence for human arrival, and documents subsequent human ecological history, up to the present. Visitors make personal connections to the goals of cultural and ecological restoration by having the opportunity to see and participate in community collaborations on the site such as native plant propagation and restoration, Polynesian-style traditional agriculture, and experiments in large-scale restoration of lost ecological functions. The site was initially noted for the wide array of fossils and artifacts preserved. More recently, newspapers worldwide carried the story derived from a study coupling sedimentological evidence for a mega-tsunami about four centuries ago at the site with fluid dynamics modeling of seismological and hydrological parameters. This showed where and how such a tsunami could occur. Also the discovery that bird bones in the site preserve ancient DNA has led to a recent reconstruction of the origins and travel route of the "canoe chickens" brought to Kauai by the Polynesians. In addition, fossil insects in the prehuman and Polynesian-aged sediments have documented insect extinctions and led to the naming and technical description of new species of extinct endemic beetles. The concepts pioneered at this site for using archaeological and paleoecological information to guide adjacent restoration activity have played a key role in the emergence of a new subdiscipline, Conservation Paleobiology.



## Rewilding Rodrigues Island with Aldabra giant tortoises: An experimental assessment of soft- and hard-release methods

NINA-XENIA PFISTER, W. FALCÓN & D.M. HANSEN



Pfister, N-X., W. Falcón & D.M. Hansen 2016. Rewilding Rodrigues Island with Aldabra giant tortoises: An experimental assessment of soft- and hard-release methods. Pp. 467 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Rodrigues Island, Mauritius; *Taxa*: Aldabra giant tortoise, *Aldabrachelys gigantea*; *Other*: paleoecology, archaeology, restoration, cave research, conservation paleobiology.

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Defaunation on islands in the last centuries has disrupted many interactions and has resulted in the loss of important ecosystem functions. Rewilding with functional substitutes has been proposed to counteract this loss, and several projects are ongoing. Few projects include experimental elements in the very early stages, such as the release of the functional substitutes, however. Using a movement ecological framework, our study experimentally examines soft- and hard-release in a rewilding project. We use Rodrigues Island, Mauritius, one the most degraded ecosystems in the world, as our study system. Here, a rewilding project has been initiated at the François Leguat Reserve. Native flora is being replanted, and two extinct, endemic giant tortoises (*Cylindraspis* spp.) are being replaced by the Aldabra giant tortoise (*Aldabrachelys gigantea*) to restore tortoise-mediated ecosystem functions. Specifically, we studied how soft- vs. hard release influences the short-term spatial behaviour of tortoises after release, by using GPS loggers. Additionally, we examined thermoregulatory behaviour with temperature loggers. Contrary to most of the published literature on tortoise translocations, soft-release did not facilitate acclimatisation. Soft-released tortoises had a higher movement activity, dispersed further away from the release site, and had larger home ranges than residents, whereas hard-released tortoises had movement patterns similar to those of residents. There was no difference in thermoregulatory ability between the release groups. All tortoises were able to find effective shade refuges, although their shading plant preferences differed. Our results suggest that hard release is a suitable method for the use of Aldabra giant tortoises in rewilding projects. It also highlights the usefulness of experimental assessments of early stages of rewilding projects, which can feed directly into developing effective release strategies for planned rewilding projects.

## Conservation status of Príncipe Island biodiversity: A preliminary assessment of its herpetofauna

ESTRELA MATILDE & A.D. ABREU



Matilde, E. & A.D. Abreu 2016. Conservation status of Príncipe Island biodiversity: A preliminary assessment of its herpetofauna. Pp. 468 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Príncipe Island, São Tomé and Príncipe, central Africa; *Taxa*: reptiles; amphibians; *Other*: conservation status, biodiversity.

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The Gulf of Guinea islands are of global interest for conservation and science, especially due to the high number of endemics. Despite its small size (142 km<sup>2</sup>; 948m), Príncipe supports 15 single-island endemic species of vertebrates, from 38 endemics shared with nearby islands and over 37 endemic plants. Although recent research has improved the knowledge of its biodiversity, there is still little information to assess species conservation status. The three amphibians are all endemic and already evaluated in the IUCN Red List. Out of 18 reptiles found on the island, nine are endemic, and of these only two have been evaluated. Amongst the non-endemic reptiles, only the five sea turtle species have been listed by IUCN, and they are considered threatened. We compiled existing information to assess the conservation status of Príncipe's native herpetofauna, using IUCN Red List criteria. We reviewed their existing conservation status, providing a local conservation status for all species and identifying knowledge gaps. The three amphibians were considered as 'Least Concern' and amongst reptiles 8 are 'Least Concern', 2 'Nearly Threatened', 4 'Vulnerable', 3 'Endangered', and 1 'Critically Endangered'. This assessment provides a much-needed updated species checklist, with useful insights for a review of IUCN classification of Príncipe's endemic herpetofauna. It will soon be extended to other taxa, namely birds and mammals. The overarching goal of this initiative is to establish the official lists of endangered species for the Regional Autonomous Government of Príncipe, to support the island's strategy for biodiversity conservation. Specifically, by providing baseline information for monitoring, and by encouraging conservation action on the most threatened taxa and further research on the least known.

## Genetic structure of the red-headed wood pigeon *Columba janthina nitens*, an endangered subspecies endemic to the Ogasawara Islands, Japan

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Ando, H., H. Ogawa, H. Suzuki, K. Horikoshi, S.-I. Seki, F. Nakahara, M. Takayanagi, K. Kawakami & Y. Isagi 2016. Genetic structure of the red-headed wood pigeon *Columba janthina nitens*, an endangered subspecies endemic to the Ogasawara Islands, Japan. Pp. 469 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Ogasawara Islands; *Taxa*: *Columba janthina nitens*; *Other*: *Columba janthina*, genetic diversity, gene flow, inter-island movement.

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Island endemic bird species are often described as lacking the ability to fly. However, Columbiformes are thought to be strong fliers and move among island habitats. This behavioral trait may cause weak genetic differentiation among island populations, which should be considered when determining evolutionarily significant units. We conducted genetic analyses of the endangered endemic red-headed wood pigeon *Columba janthina nitens* found on the Ogasawara Islands, Japan, using mitochondrial control region sequences and microsatellite markers. We collected feather samples of *C. j. nitens* from two wild populations from the Bonin ( $n=36$ ) and Volcano Islands ( $n=31$ ) in the Ogasawara Islands, which are about 150 km apart each other. We estimated the genetic characteristics of the subspecies, and the degree of genetic differentiation between two wild populations. The genetic diversity of *C. j. nitens* was much lower than that of a nominal subspecies of the Japanese wood pigeon *C. j. janthina*, indicating a strong genetic bottleneck. The genetic differentiation between the two populations was low, and the populations of the two island groups should be regarded as a single evolutionarily significant unit. Despite the apparent genetic differentiation of *C. j. nitens* from *C. j. janthina*, hybrids of these two subspecies were found in the Ogasawara Islands, indicating long-distance migration and gene flow. Even in low frequency, such hybridization may contribute to maintaining the genetic diversity of isolated island populations of *C. j. nitens*.

## Island Studies Journal' special section on sustainable development and environmental conservation in the Outermost European Regions

ARTUR GIL



Gil, A. 2016. Island Studies Journal' special section on sustainable development and environmental conservation in the Outermost European Regions. Pp. 470in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Outermost European Regions; *Taxa*: -; *Other*: sustainable development, environmental challenges, planning, conservation, science-based policies.

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The Outermost European Regions (OERs) are geographic areas which are part of a European Union Member State, but situated outside continental Europe. A total of nine territories are registered to have OER status: Guadeloupe, French Guiana, Martinique, Réunion, Saint-Martin, Mayotte (France), Azores, Madeira (Portugal), and the Canaries (Spain). In 2011, about 4.5 million people lived in the OERs, representing 0.9% of the EU population. OERs face several challenges to full development – remoteness, insularity, terrain and climate constraints, economic dependence and a narrow range of exportable commodities or services. All OERs except French Guiana are islands or archipelagos. Climate variability and changes, the proliferation of invasive exotic species, the increasing growth of tourist activity, natural catastrophes, the overexploitation of natural resources as well as the pollution and residue management are threats to sustainable development, to environmental conservation and to the maintenance of island biodiversity. These characteristics, associated with remoteness, isolation and smallness, make the sustainable development, and environmental conservation strategies and policies of OERs especially challenging in scientific, technical and political terms. *Island Studies Journal* (ISJ) is a scholarly journal dedicated to the inter-disciplinary study of our 'world of islands'. It is included since 2010 in the Social Sciences Citation Index and Journal Citation Reports. An ISJ special section on "Sustainable Development and Environmental Conservation in Outermost European Regions" was included in its May 2016 issue (Vol. 11, Nº. 1) and is freely available at <http://www.islandstudies.ca/node/478> in full open access regime. This special section includes five articles that describe, analyse and address directly several social-ecological systems' issues in Portuguese (Azores) and Spanish (Canaries) OERs. These studies propose novel concepts, strategies and models aiming to design and implement better and more cost-effective sustainability and environmental conservation policies in these remote European regions. This ISJ special section may be especially useful to remote territories/ island researchers, technical officers, stakeholders and decision makers generally, as they might be able to develop and support more sustainable and cost-effective science-based policies.

POSTER SESSION 3  
21 July 2016

INVASIVE SPECIES AND BIOGEOGRAPHY

# Antagonist effects of rabbits on endemic plants as drivers of the vegetation changes in subtropical high mountain insular environments

JONAY CUBAS, M. NOGALES, J.L. MARTÍN ESQUIVEL, M. LÓPEZ-DARIAS, R. HERNÁNDEZ-HERNÁNDEZ, M. MARRERO GÓMEZ, M. DEL ARCO & J.M. GONZÁLEZ-MANCEBO



Cubas, J., M. Nogales, J.L. Martín Esquivel, M. López-Darias, R. Hernández-Hernández, M. Marrero Gómez, M. del Arco & J.M. González-Mancebo 2016. Antagonist effects of rabbits on endemic plants as drivers of the vegetation changes in subtropical high mountain insular environments. Pp. 472-473 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Tenerife, Canary Islands; *Taxa*: spermatophytes; *Other*: Teide National Park, oceanic island, vegetation dynamic, invasive herbivores.

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The European rabbit, *Oryctolagus cuniculus*, is an invasive mammal in the Canary Islands and a keystone species in alteration of island ecosystems worldwide. It may dramatically affect the vegetation through different mechanisms, and therefore contribute to modifying habitat and communities, producing benefits in some species and damaging others. Thus, the rabbit might be considered as an ‘ecosystem engineer’. Through a study on the population structure of the endemics shrubs *Spartocytisus supranubius* and *Pterocephalus lasiospermus*, we explored the role of rabbits as a keystone in driving changes on dominant species of the summit vegetation of El Teide National Park (Tenerife, Canary Islands). We also analysed the spatial heterogeneity of these two dominant species, their relation with the herbivores, the plant age-classes and the growth response to variation in soil nutrient availability. For these purposes 90 plots were established at 30 localities within the high mountain area. Furthermore, we used 13 permanent plots in two types of herbivore exclusions (‘only big-herbivores’ and ‘all herbivores’). In one of the localities, 100 soil samples were collected to analyse the relationship between changes in nutrients (N, NO<sub>3</sub>, K) produced by rabbits and plant growth. The population of *S. supranubius* is clearly declining due to the negative effect of rabbits in its regeneration, matching with a rapid increase in the population of *P. lasiospermus*. This study also showed that the density of rabbits is the most influential variable affecting the population structure of *S. supranubius*. Furthermore, the increase in nitrates and potassium favour the growth of *P.*

*lasiospermus*. The high contrast in palatability between both species and the different response to the increase in nitrates and potassium, represent the main forces in explaining the current dynamic of the vegetation in the high mountain of Tenerife. Our results highlight the urgency to control the great density of rabbits in this area.



# Population dynamics of aphid species (Hemiptera: Aphididae) infesting endemic plants reared in forestry nurseries in the Azores

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Meseguer, R., V. Vieira, I. Borges, P. Arruda, T. Eleutério, J. Cabral, C. Nóbrega, C. Quintela & A.O. Soares 2016. Population dynamics of aphid species (Hemiptera: Aphididae) infesting endemic plants reared in forestry nurseries in the Azores. Pp. 474-475 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Azores; *Taxa*: plants, arthropods, aphids; *Other*: conservation programs, endemic plants, aphids, biological control agents.

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Aphids are one of the major pests inflicting important damages on crops around the world. They cause economic losses because they feed on phloem, which leads to a considerable growth decrease and morphology degradation, causing their death and eventually the installation of pathogens. The knowledge of aphid's species infesting endemic plants mass reared to be used in programs of restoration is of paramount importance to designing programs of biological control. A two years field study (2014 and 2015) was conducted to follow the population dynamics of aphid species infesting endemic plants reared in Furnas and Nordeste forestry nurseries. We determine the following population parameters: total and seasonal abundance, contamination level and life-span of aphid colonies. *Ilex perado* subsp. *azorica* (Loes) Tutin, *Frangula azorica* (Tutin), *Viburnum treleasei* (Grand.) and *Juniperus brevifolia* (Seub.) Antoine were the most infested host plants. The main aphid species were *Toxoptera aurantii* (De Fonscolombe), *Aphis frangulae* (Kaltenbach), *Aphis spiraeicola* (Patch) and *Cinara juniperi* (De Geer), and were found on *I. perado* subsp. *azorica*, *F. azorica*, *V. treleasei* and *J. brevifolia*, respectively. *Aphis spiraeicola* showed the highest abundance values in both nurseries, during 2014 and 2015, with a peak of abundance in the summer. *Cinara juniperi* presented the highest abundances values during spring, contamination mean level of 30% and colony average life-span of 9.3 weeks. *Toxoptera aurantii* presented the lowest contamination level mean (11%) and colony average life-span (5.2 weeks). *Aphis spiraeicola* showed a higher total abundance value in 2015, while *A. frangulae* and *C. juniperi* had a lower impact than in 2014. Nordeste showed a

delay in terms of abundance distributions, probably due to existing differences between the abiotic factors of both regions. In this field study the predator *Scymnus interruptus* (Goeze) and the parasitoid *Aphidius colemani* Viereck were recorded as potential biological control agents.

## Expansion dynamics of introduced *Pinus halepensis* plantations at short and long distances in an oceanic island

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Bello-Rodríguez, V., A. Fernández-López, M.J. Del Arco & J.M. González-Mancebo 2016. Expansion dynamics of introduced *Pinus halepensis* plantations at short and long distances in an oceanic island. Pp. 476 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: La Gomera, Canary Islands; *Taxa*: *Pinus halepensis*; *Other*: forest plantations, biological invasions, disturbance, spread at short and long distance.

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Aleppo pine is widely known for its success as invasive species in many areas out of its native range, where it has been remarked the negative consequences of its dispersal into natural ecosystems. Its relatively low environmental requirements and its massive use as the main floristic component of many plantations have facilitated its rapid expansion in different areas, favored in some cases by fire, grazing or degradation (Rouget et al. 2004; Osem et al. 2010). As far as we know, previous studies have not addressed the expansion of this species on oceanic islands. In this study, we assessed the expansion of a series of plantations of *P. halepensis* carried out on the island of La Gomera (Canary Islands) in the late 60's and early 70's. We evaluated the dynamics expansion of several populations located in high-contrast areas of the island. We performed transects of 140 m, the first 40 m inside the plantations and 100 m in the surrounding areas, for checking the success of the species to regenerate and to spread in the ecosystems at short distance. At the same time, we also monitored through aerial photographs the spontaneous expansion of the species at longer distance. Our results revealed that the species is regenerating around all of the plantations studied, spreading in both, natural and anthropised areas. We found contrasted differences in the spreading effectiveness of the species being more successful in the current and potential areas of thermophilous forest and in general, in open canopy areas. We also identified that the patterns of spread at long distance for *P. halepensis* are mostly occurring in the southern slope of the island.

## Competitive interactions between invasive and endemic species is mediated by water availability in the Trindade Island, Brazil

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Gomes, A.S., T.B. Trindade & F. Borghetti 2016. Competitive interactions between invasive and endemic species is mediated by water availability in the Trindade Island, Brazil. Pp. 477 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Trindade Island, Southern Atlantic Ocean, Brazil; *Taxa*: *Cyperus atlanticus*, *Guilandina bonduc*; *Other*: competition, resources, water potential.

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Competition for natural resources such as water, nutrients and light are among the determinants of plant communities, and changes in resources availability may intensify intra- and inter-specific competition. Unraveling how competition for resources modify interactions between species is a key factor for understanding ecosystem dynamics and predict changes in vegetation patterns in response to variations in abiotic conditions. Insular species are often susceptible to, and tend to have limited defense mechanisms against invasive species of (usually) strong competitive potential. Trindade is an oceanic island located 1,200 km east of the Brazilian coast. Altitude and rainfall interact determining the existence of different environments, highlighting its top (altitude > 600m), more humid and covered by a dense and tall vegetation, and its lower slopes (altitude > 200m), drier, sandy and mostly covered by shrubby-herbaceous vegetation. At the top the species *Guilandina bonduc* (pantropical) and *Cyperus atlanticus* (endemic) coexist side by side, while on the lower (and drier) slopes *G. bonduc* promotes the mortality of the endemic when they are in contact. Measurements of the soil water potential performed during 3 months show that in the top the values range from 0 MPa (in soil covered by *C. atlanticus*) to -20.9 MPa (in bare soil). In the lower slopes the values ranged from -89.9 MPa (in soils covered by *C. atlanticus*) to -281.2 MPa (in bare soils). The results show a clear difference in the soil water availability in these areas, and indicate that competition for water between *G. bonduc* and *C. atlanticus* may be promoting mortality of the endemic by the leguminous in the drier slopes. In conclusion, with increased competitiveness *G. bonduc* may lead to the displacement and exclusion of *C. atlanticus*, thus modifying the vegetation cover of Trindade Island.

## Selective predation on island endemic vertebrates by feral cats revealed by cat diet and prey availability

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Watari, Y., N. Kotaka, H. Torikai, K. Yamamuro, N. Kudaka, Y. Abe & T. Watanabe 2016. Selective predation on island endemic vertebrates by feral cats revealed by cat diet and prey availability. Pp. 478 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Amami-Oshima Island, Japan; *Taxa*: mammals, birds; *Other*: food availability, invasive species, domestic cats, Amami, diet analysis, impacts.

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Feral cats are known as some of the most notorious invasive predators, preying on a variety of native species and potentially causing severe population decline and even extinction. Devastating impacts can occur, especially in insular ecosystems, where native species lack evolved defense mechanisms against mammalian predators. In many cases, dietary analysis is conducted to infer cat impacts. However, few studies have clearly shown the vulnerability of island native species against cat predation as, in many cases, relative abundances of prey species are unavailable; thus, dietary analysis alone cannot necessarily be used as an index of impact. The object of this study was to obtain evidence that native species are relatively more vulnerable to cat predation. To this end, we used both cat diet data and prey availability, and showed selective predation on island endemics by feral cats. Surveys were conducted on Amami-Oshima Island, Japan, which harbors many endemic vertebrates without native mammalian predators. In winter 2015/2016, we collected 54 cat scats and also conducted a sensor-camera survey to obtain prey availability of mammals and birds, which are the main prey of feral cats. Four species of mammals, the Ryukyu long-furred rat *Diplothrix legata* (endemic, 41% of scats), Amami spiny rat *Tokudaia osimensis* (endemic, 37%), black rat *Rattus rattus* (introduced, 15%) and Amami rabbit *Pentalagus furnessi* (endemic, 13%), and two species of bird, the pale thrush *Turdus pallidus* (migratory, 7%) and Ryukyu robin *Erithacus komadori* (endemic, 2%), were found from scats. Based on both scat data and the relative number of photos taken by sensor-cameras, we calculated a selectivity index of cat predation, which showed 1) mammals >> birds, 2) endemic rats > introduced rats, and 3) endemic birds > migratory birds. Our results provide evidence that island vertebrates are vulnerable to cat predation via the process of selective predation.

## Biological control: Feasible reality or "pipe dream"? The case of *Ageratina adenophora* (Spreng.) R.King & Rob. (Asteraceae) in Madeira Island

AIDA PUPO-CORREIA & M.M. SEQUEIRA



Pupo-Correia, A. & M.M. Sequeira 2016. Biological control: Feasible reality or "pipe dream"? The case of *Ageratina adenophora* (Spreng.) R.King & Rob. (Asteraceae) in Madeira Island. Pp. 479 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Madeira Island, Portugal; *Taxa*: *Ageratina adenophora* (Spreng.) R.King & Rob.; *Other*: Eupatory, abundance, invasive plant, biocontrol.

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*Ageratina adenophora* (Spreng.) R.King & Rob was introduced in Madeira Island prior to 1840 as an ornamental plant and recorded as garden escapee since 1855. The species became very abundant in early 1960s and started to be considered a serious ecological and economical problem. Aiming to reduce adverse effects on agricultural yield and native vegetation it was attempted to suppress *A. adenophora* by introducing the eupatorium gall fly (*Procecidochares utilis* Stone). Nowadays, all over the island, *A. adenophora* is profusely scattered over stream banks, rocky cliffs, wastelands, stone walls supporting terraces, and in the understory of both exotic and native woods. Some environments where the species is currently established, such as ravines and garden edges, were also referred to in the nineteenth century as being densely covered by this species; however, at that time the spread throughout agricultural fields had not been mentioned. Nowadays, it has overrun forsaken agricultural areas where it frequently forms a community with *Rubus ulmifolius* (*Rubus ulmifoliae-Ageratinetum adenophorae*). In spite of the fact that almost all plants are garnished with galls, the species occupies large areas and has invaded environments with lesser water availability, where control should have been more effective, being a clear indication that the programme has failed.

# Acquired interspecific interactions influence the population growth rates of an invasive orchid in Puerto Rico

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Falcón, W., J.D. Ackerman & R.L. Tremblay 2016. Acquired interspecific interactions influence the population growth rates of an invasive orchid in Puerto Rico. Pp. 480 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Puerto Rico, Caribbean; *Taxa*: Orchidaceae, Curculionidae, Formicidae; *Other*: invasive species, plant–animal interactions, population growth, matrix models, invasion resistance, invasional meltdown.

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Non-native species often acquire novel interspecific interactions, which are central to several hypotheses of invasion success, including biotic resistance and invasional meltdown. However, the outcome of these interactions is not often linked with the demographic evidence based on the full life cycle of the species. The Philippine Ground Orchid (*Spathoglottis plicata*) has invaded Puerto Rico and has acquired both negative and positive interspecific interactions involving the native weevil *Stethobaris polita* the invasive red fire ant *Solenopsis invicta*, respectively. We ask how these interactions affect population demography by using a combination of field, experimental and modelling approaches. Stage-structured matrix population models based on four years of field observations showed that the population of *S. plicata* is growing at a rate ( $\lambda$ ) of 1.03 under natural conditions. When we modified fecundity values based on experimental exclusion of weevils and ants, the control treatment showed similar  $\lambda$  values. Experimentally excluding weevils increased  $\lambda$  to 1.18, and the exclusion of ants decreased  $\lambda$  to 1.01. When we incorporate demographic and environmental stochasticity in our models, exclusion of invasive red fire ants significantly reduces the orchid abundance over time. Although weevils offer some biotic resistance to *S. plicata*, by dramatically reducing its fruit set, these effects do not prevent orchid population growth and expansion. On the other hand, invasive red fire ants have a positive effect on the invasive orchid's  $\lambda$ , partially supporting the invasional meltdown hypothesis. The results of this study highlight the importance of considering acquired plant– animal interactions and stochastic processes when evaluating the population growth rates and dynamics of invasive plants.



## The first aerial poison application project to eradicate black rat populations in the French Mediterranean islands: The case study of Riou Archipelago in the Calanques National Park

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Meheut, M., E. Debize, O. Lorvelec & L.M. Pecheux 2016. The first aerial poison application project to eradicate black rat populations in the French Mediterranean islands: The case study of Riou Archipelago in the Calanques National Park. Pp. 481-482 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Riou Archipelago, Calanques National Park, France, Mediterranean Sea; *Taxa*: *Rattus rattus*, seabird, bird, reptile, invertebrate, plant; *Other*: biological invasion, Mediterranean islands, rodent, eradication -aerial broadcast, ecological monitoring.

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The Calanques national Park, the tenth French national park created in 2012, encompasses a group of islands, including Riou Archipelago, on which a remarkable biodiversity is represented. Indeed, these islands are the western limit of European Leaf-Toed Gecko (*Euleptes europaea*) distribution area and are home to rich seabird diversity, including Mediterranean Storm Petrel (*Hydrobates pelagicus melitensis*), Scopoli's Shearwater (*Calonectris diomedea diomedea*) and Yelkouan Puffin (*Puffinus yelkouan*). Rodents are well known to negatively affect seabird population and cause a severe impact on breeding success. For conservation reasons, eradication programs against Black Rat (*Rattus rattus*), introduced by humans since Antiquity in these islands, have been planned. On the smallest islands of Riou Archipelago, rodent eradication programs have already been initiated with success using rat trapping method and second generation anticoagulant toxin inside baiting stations. Eradicating rats from Riou Island (93ha) and Maïre Island (28ha), the first one is among the most important Scopoli's Shearwater French breeding sites, would require a different approach considering the very steep environment of these islands. An aerial broadcast method using a helicopter seems to be the most suitable technique and such a poison bait campaign would be the first in the French Mediterranean islands. This program aims to design a protocol consistent with the topographical conditions of the islands, which will be able to fully eradicate an invasive mammal species (*i.e.*, Black Rat) and be the least risky for non-target species. A complete monitoring study of the biodiversity will be set up

before the eradication operation, allowing land managers to have an initial inventory to compare with future biodiversity assessment and highlight the evolutionary trend of the invasive rat removal impact. Details of these monitoring protocols will be defined for some species of various components of the island such as vegetation, invertebrates, birds, reptiles and small mammals.

## Impacts of control of an invasive tree, *Casuarina equisetifolia*, on soil water contents in North Pacific Islands, Ogasawara

KENJI HATA, K. KAWAKAMI & N. KACHI



Hata, K., K. Kawakami & N. Kachi 2016. Impacts of control of an invasive tree, *Casuarina equisetifolia*, on soil water contents in North Pacific Islands, Ogasawara. Pp. 483 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Ogasawara Islands; *Taxa*: *Casuarina equisetifolia* Forst.; *Other*: herbicide experiment, non-native woody species, transpiration, volumetric soil water content.

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The control of dominant, non-native trees can alter the water balance of soils in forest ecosystems via hydrological processes, which results in changes in soil water environments. To test this idea, we evaluated the effects of the mortality of an invasive tree, *Casuarina equisetifolia* Forst., on the water content of surface soils on the Ogasawara Islands, subtropical islands in the northwestern Pacific Ocean, using a manipulative herbicide experiment. Temporal changes in volumetric water content of surface soils at 6 cm depth at five sites where all trees of *C. equisetifolia* were killed by herbicide were compared with those of adjacent control sites before and after their mortality with consideration of the amount of precipitation. In addition, the volumetric water content of surface soils at 28 sites where all trees of *C. equisetifolia* were killed by herbicide was compared with adjacent invaded control sites, and effects of time since tree control (up to three years) were assessed. Soil water content at sites treated with herbicide was significantly higher after treatment than soil water content at control sites during the same period. The soil water contents at the herbicide sites decreased during dying periods more slowly than those at the control sites. The effect of *C. equisetifolia* control on soil water content slightly decreased three years after control, which could be related to changes in amount of accumulated litter, canopy openness and cover and height of understory vegetation. Our results indicated that the mortality of non-native trees from forest ecosystems increased water content of surface soils, due primarily to a slower rate of decrease in soil water content during dry periods. These increases may be related to changes in the water balance of the ecosystem, which can in turn affect restoration of forest ecosystems.

## The impact of RHDV2 in the RHD naïve European rabbit populations of Flores, Azores

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Esteves, P.J., T. Almeida, A.M. Lopes, M. Leitão, T.M. Rodrigues, J. Abrantes & D. Gonçalves 2016. The impact of RHDV2 in the RHD naïve European rabbit populations of Flores, Azores. Pp. 484 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Azores; *Taxa*: European rabbit, *Oryctolagus cuniculus*; *Other*: RHDV2, Azores, European rabbit, naïve population.

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The European rabbit populations have been severely affected by rabbit hemorrhagic disease caused by rabbit hemorrhagic disease virus (RHDV), an RNA virus of the genus *Lagovirus*, family *Caliciviridae*. Phylogenetically, three groups exist: the classical RHDV subdivided into G1–G5, the antigenic variant RHDVa/G6 and RHDV2/RHDVb that emerged in 2010. The European rabbit (*Oryctolagus cuniculus algirus*) was introduced in the Azores in the 15th century by Portuguese settlers, where they reached high numbers due to the absence of natural predators. The first RHDV outbreaks in the Azores were recorded in the late 1980s. Characterization of these strains showed that they belonged to a G3-G5 like group. In 2014-2015, RHDV2 was detected on all islands with wild rabbits. Phylogenetic analyses showed that the RHDV2 strains circulating were G1/RHDV2 recombinants suggesting an Iberian origin. We evaluated the impact of RHDV2 in the rabbit population of Flores that only contacted with RHDV in 2015, and of Graciosa and São Miguel, that have been in contact with this virus since late 1980s. The results showed a decrease of 60% in abundance on Graciosa and São Miguel and of >97% on Flores. The populations stabilized at lower levels of abundance, but the Flores' rabbits show no signs of recovery. The situation reported for Flores resembles that of the first RHDV outbreaks. We hypothesize that the difference in the observed mortality rates might be explained by the fact that Flores' population had never been in contact with RHDV and did not have any protection against the disease. Indeed, it has been suggested that the antibodies produced against RHDV give partial cross-protection against RHDV2. Flores is a natural laboratory to study the impact of RHDV2 in a naïve population of European rabbit, reinforcing the importance of a systematic monitoring of the RHDV2 impact.

## Feral cat in the Azores islands: Habitat preferences and biological interactions

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Lamelas-López, L., P.A.V. Borges, J.G. Casanovas, J.F.G. Mangas, X. Pardavila, I.R. Amorim & M. Santos-Reis 2016. Feral cat in the Azores islands: Habitat preferences and biological interactions. Pp. 485-486 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Terceira Island, Azores; *Taxa*: *Felis silvestris catus*; *Other*: feral cat, habitat preferences, biological interactions, invasive species, rodents, camera traps.

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Biological invasions are considered a major global threat to biodiversity, this effect being particularly problematic in oceanic islands. Introduced mammals, especially predators, have been responsible for the extinction of many insular native species. The established feral populations of domestic cats, in particular, are one of the main damaging invasive species for insular biota. In the Azores the negative impacts of cats in several species of seabirds have been reported. However, detailed studies that assess the impact of cats on native biodiversity, and address this predator habitat preferences and biological interactions are lacking. The aim of this study is to model feral cat's habitat preferences at landscape level, as well as to gather evidences on predator-prey interactions with other mammal species (rodents and rabbits). To evaluate the occurrence and relative abundance of cats, rodents and rabbits on Terceira Island we used a camera trapping approach, installing 65 baited-stations spread over the island territory. Multidimensionality of habitat variables (e.g., land-use cover, altitude, road density) was reduced using Principal Components Analysis (PCA) and species-habitat associations were modeled using GLM statistics and PCA factors as predictors of the response variables. The most relevant statistically significant results are: i) cats prefer areas close to human settlements, cultivated lands and coastal areas, which possibly represent high food availability areas; ii) concerning predator-prey interactions, cats showed a significant negative association with rodents' abundance but not with that of rabbits. These results suggest that cats regulate the rodent population in the vicinity of human

settlements. Inversely, however, the described preference for coastal areas has negative implications for seabird populations, as observed and reported in previous studies in the Azores. Knowledge acquired in the frame of this study has conservation implications and should be incorporated in the management plans for controlling rodents.

## Triple eradication of invasive alien species improves degraded biota on Nishijima in the Ogasawara Islands, Japan

KAZUTO KAWAKAMI



Kawakami, K. 2016. Triple eradication of invasive alien species improves degraded biota on Nishijima in the Ogasawara Islands, Japan. Pp. 487 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Ogasawara Islands, Japan; *Taxa*: birds; *Other*: avifauna, black rat, eradication, *Casuarina equisetifolia*, feral goat, predation.

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The Ogasawara Islands are subtropical oceanic islands. In 2011, the islands were designated as a UNESCO World Natural Heritage site, but are suffering from invasive alien species problems. Nishijima is an uninhabited small island, which is invaded by alien trees, *Casuarina equisetifolia*, and mammals, black rats and feral goats. The island was widely covered by pure forests of *C. equisetifolia* that was triggered in part by goat grazing and seed predation by rats. Its biodiversity was very poor and only two breeding bird species, Japanese white-eyes and blue rock-thrushes, were observed in the early 2000s. Alien species eradications have been conducted to restore the ecosystem. By 2003, the goats were eradicated, and since 2005, wedge-tailed shearwaters have subsequently colonized the islands. However, alien trees have expanded their range due to release from goat grazing. In 2007, the black rats were eradicated using rodenticides. Although the rats were rediscovered in 2009, they were again eradicated in 2010; however, they were again found in 2013 and have re-established a population on the islands. After the first rat eradication, Japanese bush warblers and White's thrush had colonized the island. However, the latter disappeared after the rats re-established their population the second time, and the rats began to prey on the shearwater's eggs. Since 2010, *C. equisetifolia* have been gradually eradicated, and the native forests have gradually recovered; Japanese wood pigeons and brown-eared bulbuls have made appearances to forage on the fruits of the recovered natives. However, the resurgent rats recently started to selectively prey on the seedlings of native trees and disturb the forest succession. While it is necessary to eradicate each alien species, eradicating a single species cannot restore the biota. Triple eradication of invasive alien species is essential for restoring the biota on this island.



## The expansion of the pantropical *Guilandina bonduc* promotes population decline of the endemic *Cyperus atlanticus* in the Trindade Island, Brazil

ANABELE S. GOMES, B.S. RABELO, G.L. PETRY & F. BORGHETTI



Gomes, A.S., B.S. Rabelo, G.L. Petry & F. Borghetti 2016. The expansion of the pantropical *Guilandina bonduc* promotes population decline of the endemic *Cyperus atlanticus* in the Trindade Island, Brazil. Pp. 488 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Trindade Island, Southern Atlantic Ocean, Brazil; *Taxa*: *Cyperus atlanticus*, *Guilandina bonduc*; *Other*: endemism, plant growth, competition, ecological services.

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Trindade is a volcanic island located in the South Atlantic at 1,200 km east of the Brazilian coast, occupying an area of 9.28 km<sup>2</sup> and altitude of 620 m. This island was threatened for years by introduced goats, which were completely removed in 2005. Currently its slopes are covered by an herbaceous layer dominated by the endemic *Cyperus atlanticus* (Cyperaceae). This sedge has relevant functions in maintenance of soil moisture, incorporation of organic matter and erosion control. However, since goats' removal many other species (re-)appeared in the island, most notably *Guilandina bonduc* (Fabaceae). This species occurs in islands of the southern Atlantic, Pacific and Indian Oceans. In Trindade it forms dense clusters of several individuals which have expanded over and displaced populations of *C. atlanticus*. Around the clusters of *G. bonduc* a ring of dead individuals of *C. atlanticus* is notorious. The expansion of *G. bonduc* and the reduction of the area occupied by the endemic have concerned authorities as it may compromise the conservation of this sedge and its environmental services. Here we investigate the rate of expansion of *G. bonduc* and how it affects the area occupied by the endemic. We selected 13 clusters of *G. bonduc*, measured their average diameter and the width of the rings formed by dead individuals of *C. atlanticus* surrounding them. These measures made possible to estimate the area under the influence of *G. bonduc*. After 14 months the populations of *G. bonduc* expanded over an area of 820 m<sup>2</sup>, representing an increase of 22% with respect to its original area. This represents a reduction of almost 60 m<sup>2</sup> per month of the area formerly occupied by the sedge which, considering a large time scale, will likely impact the environmental services provided by the endemic and its conservation.

## Vascular plant diversity of Pinhal da Paz Recreational Forest Reserve (São Miguel, Azores)

ANDRÉ TAVARES, V. MEDEIROS & L. SILVA



Tavares, A., V. Medeiros & L. Silva 2016. Vascular plant diversity of Pinhal da Paz Recreational Forest Reserve (São Miguel, Azores). Pp. 489 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: São Miguel Island, Azores; *Taxa*: vascular plants; *Other*: biodiversity, conservation, forest reserves, islands, recreation, tourism.

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Recreational Forest Reserves (RFR) are an important asset in the Azores, providing leisure activities for the local population. Moreover, they have potential interest in terms of biodiversity preservation and could still be valued in terms of nature tourism and garden tourism. In this research we performed an inventory of the vascular plant diversity present in RFR of Pinhal da Paz (49.16 ha, São Miguel Island), through identification and listing of taxa, and using quantitative sampling methods to evaluate the importance of indigenous, non-indigenous and invasive biodiversity. Several sampling approaches were used: (i) sampling of vegetation adjacent to forest trails, by using 25 x 25 m plots, and estimation of percent cover; (ii) sampling of the garden areas (Main Path, Endemic Garden, Bamboo Garden, Cactus Garden and Palmery); (iii) sampling of the different forest types identified in the Azorean Forest Inventory, by using T-square sampling and measuring tree height and basal diameter; (iv) sampling of the lawn area using 25 x 25 m plots, and estimation of percent cover. One hundred and twenty eight plant taxa were identified, which included 24% cultivated, 9% casual, 45% naturalized, 12% native and 9% of endemic plants. Therefore, the vascular flora of Pinhal da Paz predominantly corresponds to introduced species, some with forestry or ornamental use and others considered to be invasive (e.g. *Hedychium gardnerianum*). However, some native or endemic elements are still present that could be preserved. In terms of vegetation, the reserve mainly included planted *Cryptomeria japonica* and exotic woodland dominated by *Pittosporum undulatum*. We also performed a semi-quantitative analysis per study area in order to rank potential uses. Besides leisure and tourism, the reserve could be used for the demonstration of forest activities, including the energetic valorization of biomass, the control of invasive plants, or the restoration of biodiversity valuable areas.

## Tolerance of seeds of *Guilandina bonduc* (L.) to seawater

ANABELE S. GOMES & F. BORGHETTI



Gomes, A.S. & F. Borghetti 2016. Tolerance of seeds of *Guilandina bonduc* (L.) to seawater. Pp. 490 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Trindade Island, Southern Atlantic Ocean, Brazil; *Taxa*: *Guilandina bonduc*; *Other*: seed dispersal, conservation, ecological services, colonization.

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*Guilandina bonduc* occurs in islands of the southern Atlantic, Pacific and Indian Oceans. In most islands it is considered native, but in Galápagos *G. bonduc* is considered invasive, and its spread has displaced native communities. Its dispersal can be mediated by seabirds and sea currents, but may also result from human activities. In Trindade Island (Brazil) *G. bonduc* has spread progressively in the last 12 years, displacing natural populations of the endemic *Cyperus atlanticus*. *C. atlanticus* covers large areas and has relevant functions in maintenance of soil moisture, incorporation of organic matter and erosion control. As *G. bonduc* is promoting mortality of the endemic, the maintenance of its native populations and ecological services would require the removal of the leguminous. On the other hand, the occupation of the island by *G. bonduc* could be part of a spontaneous process whose benefits could involve soil nitrogen enrichment and amelioration of soil microclimate. For conservation plans of Trindade Island it becomes important to unravel how *G. bonduc* arrived in the island. Here we test whether seeds of *G. bonduc* tolerate seawater. Under lab conditions seeds of *G. bonduc* were kept immersed in seawater under constant aeration for up to 480 days. After immersion, the seeds were transferred to plates and put to germinate in chamber at 25°C. After 30 days no seed germinated. So, they were scarified with sandpaper, and after a few days the germination achieved values between 90-100%. We found that salinity does not scarify the seeds and they tolerate immersion in seawater for more than one year. So, the arrival of *G. bonduc* in Trindade Island as part of a natural process of occupation cannot be discharged, and the consequences to the island's native vegetation impose a new challenge to long-term conservation of Trindade.

## Exploring biotic and abiotic factors predicting native and alien parasitoid wasps across the Hawaiian Islands using environmental niche modeling

NATALIE R. GRAHAM, R.W. PECK & R.G. GILLESPIE



Graham, N.R., R.W. Peck & R.G. Gillespie 2016. Exploring biotic and abiotic factors predicting native and alien parasitoid wasps across the Hawaiian Islands using environmental niche modeling. Pp. 491 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hawaii; *Taxa*: Ichneumonidae, Braconidae; *Other*: parasitoid wasps, environmental niche modeling.

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In Hawai'i parasitoid wasps introduced to control pests in the lowland agricultural areas have infiltrated higher elevation native forest habitat. Alien parasitoids displace native parasitoids, and have been implicated both directly in the decline of native Hawaiian arthropods and indirectly in the decline of native birds. Although prior work has shown that elevation is clear predictor of parasitoid wasp richness on the windward side of 'Big Island', it is unclear what climatic variables best define the niche of parasitoid wasps across the archipelago. Using data with reliable absence records for 31 species from 32 sites on five islands, we explore several methods of correlative environmental niche models including regression-based and machine learning techniques. Our aim is to (1) summarize the important biotic and abiotic factors which best predict presence of parasitoid wasps (2) determine if there are differences among habitat preference for endemic and introduced species in Hawaiian forests. Climate data was drawn together by two different methods: raster and shapefile data were downloaded, imported and processed using ArcGIS® software by ESRI and BioClim rasters at 5arc minute resolution from the WorldClim data set were directly imported using the R package *dismo*. From the ArcGIS® dataset we learn that actual evapotranspiration, relative humidity, solar radiation and vegetation height appear to be important factors; from the BioClim dataset we find different measures of precipitation to be the most common predictors. We found a significant interaction between parasitoid wasp status as an alien or native species and both elevation and minimum temperature. Our results suggest that the role of elevation in predicating parasitoid wasp richness may be tightly associated with precipitation differences along the gradient. Additionally, factors such as solar radiation and vegetation height, likely associated with the ability of wasps to search for hosts, are also significant predictors of wasp niche.

# An ecophysiological background for the dissimilar biogeographic patterns of two insular lizards?

RAQUEL VASCONCELOS, E. LOPES & M.A. CARRETERO



Vasconcelos, R., E. Lopes & M.A. Carretero 2016. An ecophysiological background for the dissimilar biogeographic patterns of two insular lizards?. Pp. 492-493 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Cape Verde; *Taxa*: reptiles; *Other*: lizards, preferred temperatures, water loss rates, fundamental niche.

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Distributions of sedentary ectotherms are strongly dependent on environmental factors such as temperature and humidity due to the low homeostatic and dispersal abilities. In particular, reptiles are considered to be strongly conditioned by their thermal environment, since their main biological functions are temperature-dependent and behavioural thermoregulation is ecologically constrained. Increasing experimental evidence also indicates their hydric environment is important, at least for those species inhabiting arid environments. Biotic interactions may also play a role in range patterns, but this is expected to be of minor importance in insular ecosystems where native species usually monopolize well-delimited niche spaces. On the arid island of São Vicente (Cape Verde archipelago), the two endemic lizard species display remarkably different spatial patterns. While the gecko *Tarentola substituta* is widely distributed across the island, the skink *Chioninia stangeri* is restricted to the eastern part, which is the coolest, and most humid and vegetated area. We hypothesized that this dissimilarity is due to differences in the fundamental niche, specifically in ecophysiology. We predict that *C. stangeri* should select for lower temperatures and lose more water by evaporation than *T. substituta*. We submitted 10 adult specimens of each species to standard experiments to assess preferred body temperatures ( $T_p$ ) and evaporative water loss rates (EWL), and examined the variation among species through time by means of repeated-measures AN(C)OVAs. Results only partially supported our initial expectations. Contrary to the prediction, skinks clearly attained higher  $T_p$  than geckos, but in the long-term, showed a trend for higher EWL as predicted. These results indicate that

while ecophysiology will certainly contribute to functional interpretation of species distribution patterns, it needs to be combined with other sources of evidence such as habitat use and evolutionary history. These findings will be useful to perform improved mechanistic models to better understand the impact of climate change on these endemic species.

## Community assembly and disassembly in a volcanic national monument in the Pacific Northwest: Island biogeography within a continental context

KATIE L. PETERSON & C.E. PARENT



Peterson, K.L. & C.E. Parent 2016. Community assembly and disassembly in a volcanic national monument in the Pacific Northwest: Island biogeography within a continental context. Pp. 494 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Craters of the Moon National Monument and Preserve, Idaho, USA; *Taxa*: Salticidae, Thomisidae, plants; *Other*: island biogeography, community assembly, spiders, plants.

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In island biogeography, geographical attributes such as age, area, and isolation are known determinants of community diversity. Craters of the Moon National Monument and Preserve (CRMO) located in southern Idaho, USA contains multiple replicates of “island” habitats; that is patches of habitat separated from each other by less-hospitable terrain. Areas of young geological activity like CRMO that have created island archipelagos are ideal systems to use the theory of Island biogeography as a tool to study patterns of community assembly and community disassembly. The insular habitats in CRMO vary in age, area, and isolation and thus, make CRMO an ideal location for investigating questions of island biogeography within a continental context. The objective of this study is to determine if there are predictable patterns of how natural communities assemble on novel habitats and disassemble through time as a consequence of fragmentation. Our study focuses on the collection of spiders (Salticidae and Thomisidae) and plants to better understand the communities currently present on lava flows at CRMO. We will quantify target lineage diversity on lava flows and kipukas. We will use this data to test the roles of age, area, and isolation on the observed diversity and abundance of the target lineages to inform the community assembly process at CRMO.



## The biogeographical regions of the Aegean archipelago (Greece)

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Triantis, K., K. Kougioumoutzis, A. Legakis, P. Lymberakis, A. Trichas, S. Simaiakis, P. Andriopoulos, C. Georgiadis, A. Parmakelis, G. Anastasiou, N. Probonas, V. Spaneli, P. Trigas & S. Sfenthourakis 2016. The biogeographical regions of the Aegean archipelago (Greece). Pp. 495 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences. Supplement 9.*

Key words: *Location*: Aegean Sea, Greece; *Taxa*: multiple taxa (Aves, Spermatophyta, Formicidae, Pulmonata, Chilopoda, Oniscidea, Orthoptera, Squamata, Tenebrionidae); *Other*: island biogeography, ecological network, connectivity, Aegean archipelago, multi-taxa approach.

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The Aegean archipelago is one of the largest archipelagos in the world, with more than 7,000 islands and islets that lie in-between three mainland systems belonging to different continents (Europe, Asia and Africa). Its high environmental and topographical heterogeneity, complex geological and palaeogeographical history, as well as its high diversity and endemism, render it an ideal system for biodiversity and biogeographical studies. The identification of biogeographical regions (geographically distinct assemblages of species and communities) is a critical step towards a better understanding of processes that have led to current patterns of species diversity. Until recently, the identification of such regions was mainly based on descriptive methods but more robust quantitative approaches have been developed in the past decade. Here we use a network approach to detect biogeographical roles and modules of islands and species, based on a large and detailed database that includes 10 groups of organisms exhibiting broad variation in ecological requirements and dispersal abilities, i.e. plants, ants, centipedes, terrestrial isopods, tenebrionid beetles, snails, Lepidoptera, Orthoptera, herpetofauna and land birds, from the major Aegean islands. The biogeographical regions identified are discussed in terms of the known palaeogeography and climate regime of the study area, and are compared to previous suggestions based on fewer taxa.

## Biogeography meets geophysics: A geophysical workflow to model relative sea levels and to reconstruct its palaeogeographic effects on islands

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Stocchi, P., E.F.M. Koene, S.M. Simaiakis, S.P. Ávila, C. Hammoud, P.A.V. Borges, J.M. Fernández-Palacios, S.J. Norder & K.F. Rijdsdijk 2016. Biogeography meets geophysics: A geophysical workflow to model relative sea levels and to reconstruct its palaeogeographic effects on islands. Pp. 496-497 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Azores, Greece; *Taxa*: -; *Other*: relative sea level rise, dynamic equilibrium theory, glacial interglacial cycles, Pleistocene, extinction.

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Since the Last Glacial Maximum (LGM; ~22 ky ago), sea levels rose up to ~130 m globally and causing reductions of island areas and sometimes fragmentation of islands into several smaller islands. The dynamic equilibrium theory predicts extinctions and lower species richness for islands that shrunk in areas and that became more isolated. Numerical modeling of the palaeogeographic effects of sea level rise allows for testing the effects of sea level rise by quantifying timings and rates of connectivity loss, fragmentation and area reduction over time steps of 1000 year for one or more glacial-interglacial cycles. However such model must take into account all the interrelated physical mechanisms that compose the glacial isostatic adjustment process: (i) the ice- and water-load induced solid Earth deformations, (ii) the change of mutual gravitational pull between continental ice sheets and ocean, (iii) the movements of the Earth's rotation axis with respect to the surface in response to

surface ice- and water-load changes. These factors give rise to regionally varying relative sea-level (RSL) changes that exponentially decay with time because of the viscous response of the Earth's mantle. We use a numerical model that is based on the solution of the gravitationally self-consistent sea level equation to reconstruct the RSL change for the Azorean region through the last four glacial-interglacial cycles (420 ky) and the last sea level rise period since 22 ky ago. These relative sea level curves can be used to assess and reconstruct area change on oceanic and continental islands globally and ultimately to quantify the effects of palaeogeographic change of volcanic islands and continental islands.

## Quantifying palaeogeographic rates of changes of continental islands in the Aegean Sea: Towards a novel framework for assessing biogeographical implications of palaeogeographic change

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Hammoud, C., S.M. Simaiakis, K.F. Rijdsdijk, E.F.M. Koene, J.H. Van Boxel, P. Stocchi, E.E. Van Loon, S.J. Norder, E. Georgopoulou, K.A. Triantis & E. Tjørve 2016. Quantifying palaeogeographic rates of changes of continental islands in the Aegean Sea: Towards a novel frame-work for assessing biogeographical implications of pal-aeogeographic change. Pp. 498-499 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Greece, Aegean Sea; *Taxa*: -; *Other*: last glacial maximum, sea level rise, paleogeography, land-bridge island, equilibrium theory, relaxation dynamic.

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We reconstructed the geographic changes affecting a set of islands in the Aegean Sea for the last sea level rise episode (22-5 kyr BP). The fragmentation of the Aegean occurred in tandem with the largest magnitude and rates in sea level rise between 17 and 7 kyr BP. The amount of surface loss for the whole archipelago is ~80%. Our per island analysis reveals a large variation in spatiotemporal response of islands, with area losses ranging from 20% to more than 90% and distance increases from the continent to more than 200% per island. In some cases, these changes were realized in only 2 kyr. We constructed an Area-Distance Change (ADC) island specific typology with higher ADC-islands

experiencing a higher degree of change. The typology can be used to test how both the magnitude and rate of changes in area and isolation affected islands biota and genetic makeup. While biogeographic and genetic effects resulting from sea level mediated geographic change on biota varies with species traits, we predict stronger effects on higher ADC-islands. These effects include higher degrees of community supersaturation of cutoff peninsulas, more local extinctions, narrower bottlenecks, more genetic variety within species pools, more multiple endemics and shared species on fragments, phylogenic expression in tandem with fragmentation sequence and higher z-values of the power-law species-area relationship. The Aegean archipelago represents an ideal playground to test, through our quantification exercise, whether and how species actually equilibrate and evolutionary changed under a wide spectrum of natural rates and magnitude of geographic changes.

## Plant diversity on oceanic islands: A computer simulation

MADLI JÖKS & M. PÄRTEL



Jöks, M. & Meelis Pärtel 2016. Plant diversity on oceanic islands: A computer simulation. Pp. 500 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hawaii, Galapagos, Canary Islands, Azores and Cape Verde; *Taxa*: seed plants; *Other*: island biogeography, computer simulations.

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Island biogeography as an old science has long used traditional methods – for example, looking for correlations between biogeographical (island area, isolation, island age) and biodiversity parameters (species richness, number of endemic species). However, this method can turn out to be insufficient if we are interested in long-term processes that have designed today's biogeographical situation. Computer simulations can prove to be a promising tool for testing different scenarios that could have been the case in the nature. We use a simple agent-based computer simulation to study the factors and processes that affect the seed plant species richness development in the oceanic archipelagos. Island area has been often showed to be the strongest determinant of island species richness. We test the influence of island area as well as island habitat diversity, immigration rate (archipelago isolation) and intra-archipelago island configuration, by using computer simulations with different combinations of parameters. We simulate the species richness dynamics in five oceanic archipelagos – Hawaii, Galapagos, Canary Islands, Azores and Cape Verde – and compare the simulation results to the empirical diversity data, to find which combination of simulation parameters provides the results that are best correlated to the empirical data. We use the total native species richness, endemic species richness and number of shared species between every two islands in an archipelago. We show that although island area has a strong influence on island species richness, the other factors are important as well. Our results suggest that habitat diversity and island configuration are both significant determinants of island total native species richness as well as of shared species patterns between islands. We also found some significant differences among studied archipelagos, which we explain with different biogeographical characteristics of the archipelagos (archipelago age, isolation, human impact). We conclude that by enabling experiments with diversity development processes, computer simulations can offer some great new insights into island biodiversity studies.

POSTER SESSION 4  
22 July 2016

EVOLUTION, ECOLOGY AND CLIMATE



## The more the merrier: The use of NGS for the development of new markers for parasitic nematode phylogenetics in the Canary Islands

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Tomé, B., K. Mulder, M.F. Jorge, A. Sousa, A. Perera & D.J. Harris 2016. The more the merrier: The use of NGS for the development of new markers for parasitic nematode phylogenetics in the Canary Islands. Pp. 502 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Canary Islands, Azores and Cape Verde; *Taxa*: *Spauligodon*, *Thelandros*, *Parapharyngodon*; *Other*: Nematoda, oxyurids, parasites, NGS, mitogenomes, phylogenetics.

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Methods for parasite identification have traditionally relied on morphology, which unfortunately is limited by the parasites' intrinsic characteristics, namely their small size, conservative features, developmental stages and life cycle complexity. However, the use of molecular methods is revolutionizing the study of parasites, and Sanger sequencing has allowed for more accurate detection, differentiation and characterization. The implementation of genomic approaches in Parasitology is a relatively new, but yet rewarding field. Data generated using NGS (Next Generation Sequencing) tools can be used to develop new molecular markers and, at the same time, in a comparative framework, might provide clues regarding evolutionary processes such as genome reduction and rearrangement, host-parasite gene exchanges and adaptation. Moreover, parasites generally have small genomes, making data collection highly cost-effective. Recent studies of parasites in the Canary Islands have uncovered high levels of undescribed diversity. However, the lack of markers and comparative data are a limiting factor for further studies. To overcome this, we used whole-genome sequencing approach to sequence the genomes of the more common pinworms genera infecting reptiles in the Canary Islands: *Thelandros*, *Spauligodon* and *Parapharyngodon*. Nextera-style shotgun libraries were prepared on pools of individuals belonging to the target groups, whose identity was previously confirmed by COI Sanger sequencing. Libraries were sequenced on a single HiSeq Illumina lane. Here, we present the preliminary results of the mitogenome assembly, and a list of candidate mitochondrial primers for different genes to be used in phylogenetic studies. These will help disentangle the phylogenetic relations of these nematode parasites, and further characterize them as taxonomic independent units using a multiple-marker approach. Moreover, we expect that this genome-scale data of non-model organisms will contribute to the general knowledge of the order Nematoda, and provide additional tools to better understand the origins and evolution of parasitism in this group.

## Geology and ecology interact to drive evolutionary radiations and declines on Hawaii

JUN YING LIM & C.M. MARSHALL



Lim, J.Y. & C.M. Marshall 2016. Geology and ecology interact to drive evolutionary radiations and declines on Hawaii. Pp. 503 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hawaii; *Taxa*: endemic plant and animal clades; *Other*: diversity dependence, island ontogeny, diversification.

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Determining the drivers of species richness change through time remains a central challenge in evolution and ecology. Oceanic islands such as Hawaii, however, are ideal systems for examining the interplay between diversification dynamics and landscape dynamism. Firstly, the islands of hotspot archipelagoes such as Hawaii are formed in sequence, and thus capture a record of evolutionary radiations at different stages of their unfolding. Secondly, the physical environment of the islands changes dramatically over short geologic time spans, directly influencing their biota. Here, we compile species diversities for 15 endemic plant and animal radiations on each of the four high islands of the Hawaiian archipelago using published checklists and floras. By using a geologically-informed diversification model that takes into account island-specific geological histories, we predict current species richnesses of endemic clades better than do ontogeny-independent models, suggesting the importance of geologic history in the diversification (and decline) of island clades. The model enables us to infer the temporal diversification trajectories for each group examined – most of the endemic clades show rises and then falls in species richness that are coupled to the growth and decay of the islands. In fact, just over half the clades are no longer radiating on the older islands, and (even ignoring human impacts) are in evolutionary decline on these islands. Less commonly we see some clades continuing to diversify, albeit slowly, on even the oldest islands, with species richnesses that are below their inferred island-specific carrying capacities. Our results show how large-scale landscape dynamism can drive evolutionary dynamics on islands on broad time scales.

## On the phylogenetic diversity of Azorean beetles

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Terzopoulou, S., A. Parmakelis, I.R. Amorim, F. Rigal, R.J. Whittaker, P.A.V. Borges & K.A. Triantis 2016. On the phylogenetic diversity of Azorean beetles. Pp. 504 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: Coleoptera; *Other*: phylogeny, phylogenetic diversity, oceanic islands.

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Biotas of oceanic islands are the result of immigration and speciation, featuring unique characteristics such as disharmony and high endemism. However, due to human activity, oceanic islands also hold high proportions of exotic species. Here, we focus on the beetle fauna of the Azorean archipelago and investigate patterns of phylogenetic diversity (PD) among endemic, indigenous and exotic species. Azores is among the most isolated oceanic archipelagoes in the world, holding a great variety of exotic and indigenous beetle species, 1/3 of the latter being endemic to the archipelago. In the current study, we reconstruct the phylogenetic relationships among all beetle species of the Azores (n=524) and look for differences in phylogenetic diversity patterns among exotic, indigenous and endemic species. To do so, we retrieved sequences of 18S rRNA, 16S rRNA and Cytochrome Oxidase Subunit I from GenBank for 362 taxa and performed Bayesian analyses to obtain a backbone phylogenetic tree. We further extended this tree using taxonomic information to include taxa for which molecular data were unavailable. The resulting tree was calibrated using fossil data. Finally, we calculated phylogenetic diversity (PD) per island for i) indigenous, ii) endemic, iii) non-endemic indigenous, iv) exotic and v) all species, and tested the effect of 6 abiotic factors (area, age, distance to Iberian Peninsula, distance to the oldest island, topographic complexity and temperature) after including them in a global model. This study is the first to address phylogenetic relationships among all beetles of an oceanic archipelago and to investigate phylogenetic diversity patterns and assembly processes of coleoptera with distinct biogeographical origin. Our results agree with the current literature: area, age and distance to the oldest island were included in the best models explaining PD for all groupings except for endemics, for which only area and age were included.

## Screening for potential hybrids reveals new insights about *Laurus* phylogeography in the Azores

ÂNGELA F.A.L. VIEIRA, M. MOURA, C. SILVA & L. SILVA



Vieira, A.F.A.L., M. Moura, C. Silva & L. Silva 2016. Screening for potential hybrids reveals new insights about *Laurus* phylogeography in the Azores. Pp. 505 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: *Laurus* L. (Lauraceae); *Other*: hybrids; *Laurus azorica*; *Laurus nobilis*; phylogeography.

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The genus *Laurus* L. (Lauraceae) is currently restricted to refugia in the southern Black Sea area, Mediterranean Basin, southern Morocco, and the Macaronesian archipelagos. Some authors have recognized the existence of three species, *Laurus azorica* in the Azores, *Laurus novo-canariensis* in Madeira, the Canary Islands and southern Morocco, and *Laurus nobilis* across the Mediterranean region. Others recognize *L. nobilis* and *L. azorica* only. Molecular data indicate that even this distinction might not be supported. The formal taxonomic description of the three species is based mostly on continuous, overlapping traits (e.g. leaf shape, tomentum), and many specimens cannot be unequivocally ascribed to one of the species. *Laurus azorica* is characteristic of the Azorean natural forests. Specimens have been found showing morphological traits considered to be more akin to exotic forms (*L. nobilis*), namely markedly lanceolate and undulated leaves. The present work was undertaken to identify the possible existence of hybrids. The analyzed plant material was sampled in the Special Protected Area “Pico da Vara & Ribeira do Guilherme” (São Miguel island) and also included accessions deposited at AZB herbarium from eight islands. After DNA extraction and amplification of recommended regions, the following results were obtained: (i) for *trnK-matK* one Azorean haplotype was found, similar to the H4 haplotype previously defined for Terceira; *trnK-matK* clearly separated all the Azorean accessions from a *L. nobilis* morphotype accession collected at Pinhal da Paz (São Miguel) with the H6 haplotype, defined for the Iberian Peninsula and the Mediterranean; (ii) for *trnD-trnT*, three haplotypes were found in the Azores, the H3 haplotype defined for Madeira, the Canary Islands and Morocco, the H4 haplotype defined for Terceira, all previously found, and a new haplotype (H7), only for São Miguel. Although the research provided interesting insights about the phylogeography of *Laurus* in the Azores, no evidence of hybridization was found.

## Ancient DNA analysis of the Caribbean ‘Island Shrew’ (*Nesophontes*)

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Woods, R.H., I. Barnes, M.J.F. Brown & S.T. Turvey 2016. Ancient DNA analysis of the Caribbean ‘Island Shrew’ (*Nesophontes*). Pp. 506 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Caribbean; *Taxa*: *Nesophontes zamicrus*, *Nesophontes paramicrus*; *Other*: *Nesophontes*, Ancient DNA, island radiations, biogeography, taxonomy, insular mammals.

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The Caribbean is a biodiversity hotspot and unique in the respect that it was successfully colonized by land mammals. Islands systems are often used as “Laboratories” to study evolution. The Caribbean provides an opportunity to study a mammalian island evolution. However, the Caribbean islands have experienced the world’s highest level of historical mammal extinction. Holocene terrestrial mammal fauna previously consisted of over 120 endemic species of insectivores, rodents, sloths and primates. Only a handful of species in two endemic families (Capromyidae and Solenodontidae) now survive. These extinctions coupled with the rarity and cryptic natures of surviving fauna have hampered the study of Caribbean mammal island biogeography and evolution. Our understanding of diversification of the recently extinct Caribbean land mammal fauna now relies on severely degraded ancient DNA. Next generation sequencing techniques have revolutionized the field of ancient DNA, giving us a tool that can be used to better understand species and populations from the past. The focus of this study is *Nesophontes* or the ‘island shrew’. This extinct shrew-like mammal is thought to be most closely related to the only surviving Caribbean member of Eulipotyphla, *Solenodon*. Previous studies have suggested that morphological difference between groups can be explained either: by multiple co-distributed species, or by sexual size dimorphism. Using specialist ancient DNA techniques we have been able to extract and sequence DNA from zooarchaeological specimens of *Nesophontes* (species: *N. zamicrus* and *N. paramicrus*) of late Holocene (pre-European) age, collected from Cueva de Bosque Humido, Hato Mayor Province in the Dominican Republic. This study has shown for the first time, with molecular data, that multiple sympatric species occupied the island of Hispaniola and suggests a much wider Greater Antillean radiation. Generating a molecular phylogeny for *Nesophontes* species will allow us to look at the divergence dates between species and to study their radiation in relation to geological events.

## The genomics of parallel adaptation to temperature-divergent niches in Macaronesian *Echium* (Boraginaceae)

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Graham, R., M. Carine, M. Rius & M. Chapman 2016. The genomics of parallel adaptation to temperature-divergent niches in Macaronesian *Echium* (Boraginaceae). Pp. 507 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Macaronesia; *Taxa*: *Echium* (Boraginaceae); *Other*: climate, phylogenetics, genomics, transcriptomics.

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In a time of changing climate we need to better understand how plants adapt to shifts in temperature. Recently evolved island lineages that exhibit a broad range of ecologies are particularly suitable model systems for addressing such issues. The 29 species of *Echium* endemic to Macaronesia display a diverse range of growth forms and occupy almost every ecological zone on the islands. The morphological and ecological diversity of this plant radiation makes it a great model system for studying island evolution and ecological adaptation. Several Canarian endemic *Echium* species are restricted to the sub-alpine zones on Tenerife and La Palma. The evolution of these taxa is associated with a marked shift in temperature niche, and their contrasting morphologies suggest that multiple independent shifts to the sub-alpine zone have occurred in the genus. However, previous phylogenetic work on *Echium* has failed to fully resolve relationships among the island clade, and there is conflict in the placement of some taxa in phylogenies based on different genomic regions. This project aims to address the question: how was the sub-alpine zone colonized by *Echium*? Specifically it aims to determine: how many times was it colonized; where was it colonized from; when was it colonized and what is the genetic basis of the adaptation to high altitude in *Echium*? Do we observe the same genetic mechanisms involved in parallel shifts to the sub-alpine zone? To address these questions, next generation sequencing is being used to establish phylogenetic relationships of Macaronesian *Echium* with which to investigate geographic and temporal patterns of evolution. Genomic and transcriptomic data will be used to identify loci with signatures of divergent selection and expression between sister species with temperature-divergent niches. Comparison of these species pairs will reveal whether similar genetic mechanisms are involved in independent shifts to the sub-alpine zone.



## An endemic radiation of deer in the Late Pleistocene of Malta

LEILA C. D'SOUZA, A.M. LISTER & D.A. RICHARDS



D'Souza, L.C., A.M. Lister & D.A. Richards 2016. An endemic radiation of deer in the Late Pleistocene of Malta. Pp. 508 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Central Mediterranean: Malta and Sicily; *Taxa*: Cervidae: red, fallow and giant deer species; *Other*: deer, insular dwarfism, Pleistocene, morphology.

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The 'Island Rule' is a familiar yet intriguing phenomenon widely seen in insular mammals, whereby large animals tend to evolve smaller body sizes while small animals typically grow larger than their mainland counterparts. Numerous fossils exemplifying this insular body size trend have been excavated from Mediterranean Quaternary deposits, revealing a remarkable history of islands inhabited by dwarfed populations of elephants, mammoths, hippopotamuses and deer during the Late Pleistocene. Although the majority of these taxa are well documented, poor dating and inadequate sampling means that few studies have managed to chart the origin and radiation of these endemic species. The present research aims to provide a full account of an island mammal radiation using Malta's endemic dwarf deer as a case study. My morphological and taxonomic analyses will be integrated with new dating and stratigraphic information from our wider project to provide a chronological context for the evolutionary patterns observed. Hundreds of fossils recovered from Għar Dalam Cave (Malta) show exceptional variation in size and form that deviates from any likely European mainland ancestors. It is hypothesized that they migrated to Malta from Italy via Sicily, where they diversified into at least four size classes; this contrasts with the single size category found on the considerably larger island of Sicily. Antler, tooth and bone measurements and morphological characters - established to separate red, fallow and giant deer (the most plausible mainland ancestors) - are used to determine whether changes in size and shape signify taxonomic diversity. Early findings indicate that Maltese deer are not simply smaller, isometrically-scaled versions of larger modern species; some possess the reduced and robust distal limb proportions commonly seen in island dwarfs. Dental mesowear analyses suggest that all size groups contain both browsing and grazing individuals, but mixed feeders remain restricted to smaller size classes.



## Genetic variation of *Terminalia catappa*, pantropical plants with sea-drifted seeds, in the Bonin Islands

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Setsuko, S., M. Ohtani, K. Sugai, T. Nagamitsu, H. Kato & H. Yoshimaru 2016. Genetic variation of *Terminalia catappa*, pantropical plants with sea-drifted seeds, in the Bonin Islands. Pp. 509 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: The Bonin Islands; *Taxa*: plants, *Terminalia*; *Other*: conservation unit, sea almond tree, The Ogasawara Islands, oceanic island.

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The Bonin Islands are endowed with endemic species, however they are at the risk of extinction due to the exuberance of invasive alien plants. Thus, revegetation using native plant species is required after eradication of alien plants. We investigated the genetic variation of *Terminalia catappa* (Sea Almond Tree) populations in the Bonin Islands using nuclear (n) microsatellite (simple sequence repeat: SSR) genotypes and chloroplast (cp) DNA sequences. There were no significant differences in genetic diversity in nSSRs among 22 populations, although recent bottlenecks were detected in three populations on Chichijima Island. Both nSSR variation and cpDNA haplotypes suggest the presence of two genetically distinct groups of populations, in the Mukojima/Chichijima Island Groups and in the Hahajima Island Group. Similar genetic structure has been found in other plants and animals in the Bonin Islands. Furthermore, populations on three islands separated from other islands within each island group by water with a depth of 50 m were differentiated in nSSRs from other populations, suggesting that historical changes in the connection between islands during the Pleistocene have affected the genetic substructuring. These results suggest that different factors contribute to the genetic structure of *T. catappa* at different geographical scales. At the whole-Bonin-Island level, genetic structure would be determined by long-distance seed dispersal by ocean current. Within island-group level, historical changes of islands' connection caused by changes in sea-level due to glacial-interglacial transition would reflect the genetic structure. These findings contribute to locate the borders of transplantation zones of *T. catappa* for revegetation in the Bonin Islands.

## Gene flow between genetically differentiated groups of *Elaeocarpus photiniifolia* (Elaeocarpaceae) on Chichijima Island, Japan

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Sugai, K., S. Setsuko, T. Nagamitsu, N. Murakami, H. Kato & H. Yoshimaru 2016. Gene flow between genetically differentiated groups of *Elaeocarpus photiniifolia* (Elaeocarpaceae) on Chichijima Island, Japan. Pp. 510 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Bonin (Ogasawara) Islands, Japan (the northwestern Pacific Ocean); *Taxa*: *Elaeocarpus photiniifolia* (Elaeocarpaceae); *Other*: ecological speciation, gene flow, microsatellites, oceanic island.

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The Bonin (Ogasawara) Islands is a typical oceanic island group in the northwestern Pacific Ocean. Ecological speciation on an oceanic island is a well-known evolutionary phenomenon. In ecological speciation, diversification via the evolution of barriers to gene flow between populations occurs as a result of divergent natural selection under different environmental conditions. *Elaeocarpus photiniifolia*, an endemic tree species in the Bonin Islands, grows among different vegetation types even within a single island, including dry scrubs to mesic forests, although no morphological differentiation has been reported. However, in our previous study, two genetically differentiated groups of *E. photiniifolia* associated with dry scrub and mesic forest habitats in the Chichijima Island Group in the central part of the Bonin Islands were recognized. Then, we focused on *E. photiniifolia* populations in dry scrub and mesic forest areas on Chichijima Island to clarify the gene flow between and within the two genetically differentiated groups. First, we examined the flowering phenology of the species. The peak of flowering phenology in each population was separated by approximately three weeks and flowering phenology had limited overlap. The flowering phenology data indicated that the populations in the two habitats are incompletely reproductively isolated. Second, in order to investigate the presence or absence of post-reproductive isolation, the paternity analysis was conducted using the simple sequence repeats derived from expressed sequence tags. As a result, the low gene flow between dry and mesic groups was present. Therefore, post-reproductive isolation between the two groups appeared to be incomplete. These findings suggest that *E. photiniifolia* is undergoing ecological speciation associated with habitat differences between dry scrubs and mesic forests.

## Morphological adaptations to insularity in the Azorean Blackbird (*Turdus merula azorensis*)

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Martins, F.S., P.A.M. Andrade, T.M. Rodrigues & D. Gonçalves 2016. Morphological adaptations to insularity in the Azorean Blackbird (*Turdus merula azorensis*). Pp. 511 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: *Turdus merula*; *Other*: island rule, avian skeletal morphology, ecomorphology.

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Morphological trends may vary with the geographic distribution of taxa. Several factors like immigrant selection, ecological release, resource limitation and increased intraspecific competition may be strong selective pressures on island vertebrates. Also, other particular morphological traits related to shifts in ecology (e.g. loss of migratory behavior, feeding shifts) may also occur on island taxa. For this study we assessed the occurrence of morphological patterns associated with insularity in the Common Blackbird (*Turdus merula*). We took external and skeletal measurements from both live specimens and fresh road casualties Azorean (*T. m. azorensis*; São Jorge island, n=91) and Common Blackbirds (*T. m. merula*; mainland Portugal, n=33). Principal component analyses were conducted to summarize biometric data, allowing a better biological interpretation, and non-parametric ANOVA were performed to assess differences in multivariate indices of size and shape between the insular and mainland subspecies. Results indicate that the Azorean Blackbird has longer limb elements, which may be due to differences in the ecological conditions found in Azores. Azorean Blackbird also has relatively shorter wing phalanxes, which agrees with the external morphology that points towards more rounded wings. These may be adaptations to the loss of migratory behaviour in islands. On the other hand, the longer legs of the Azorean Blackbird can reflect changes of the foraging niche. Bill measurement analysis does not show significant differences in size; however there seems to be a tendency towards longer and thinner bills in the insular subspecies, which may also be a result of niche adaptation. Future diet analysis can help determine if shifts in feeding ecology could lead to morphological adaptation in this island taxon.

# The evolutionary history of talitrid amphipods (Crustacea) from Atlantic and Mediterranean Islands

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Davolos, D., E. De Matthaeis, L. Latella & R. Vonk 2016. The evolutionary history of talitrid amphipods (Crustacea) from Atlantic and Mediterranean Islands. Pp. 512 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Mediterranean and North East Atlantic area, including the Canary, Madeira, and Azores Islands; *Taxa*: Talitridae, Amphipoda (Crustacea); *Other*: *Cryptorchestia*, *Orchestia*, phylogeny, cytochrome oxidase I; cytochrome oxidase II, histone H3.

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Talitrid amphipods are particularly intriguing crustaceans because of their adaptations for a semi-terrestrial life on marine (supralittoral), freshwater (riparian), and terrestrial (forest litter) ecosystems. Moreover, the taxa of the Talitridae family show a wide and disjunctive geographic distribution, a large number of species are endemic either to restricted areas or to a single island. In the present work, we analysed talitrid amphipods of the Mediterranean and North East Atlantic area with well-known geological history. In order to gain further insight into the evolutionary relationships of species belonging to this peculiar crustacean group, we investigated both mitochondrial and nuclear genes (cytochrome oxidase I and II, and histone H3, respectively). We analysed talitrid amphipods belonging to the genera *Africorchestia*, *Britorchestia*, *Cryptorchestia*, *Deshayesorchestia*, *Macarorchestia*, *Orchestia*, *Palmorchestia*, *Platorchestia*, *Sardorchestia*, and *Talitrus*. In particular, we focused on terrestrial species associated with freshwater-soaked leaf litter belonging to the genus *Cryptorchestia* (a recent split off from *Orchestia*), including *C. canariensis*, *C. chevreuxi*, *C. gomeri*, *C. guancha*, *C. monticola*, and *C. stocki* from the Canary, Madeira, and Azores Islands, *C. cavimana* from Cyprus island, *C. garbinii* from Mediterranean regions, and with a recent northward expansion, and a newly proposed *Cryptorchestia* species from Rhodes (Davolos *et al.*, 2015). A phylogenetic modelling revealed an interesting clustering with a clear separation between morphologically recognised species. For instance, *O. montagui* and *O. stephensi*, two species endemic to the Mediterranean basin, appear to be more closely related to each other than to other *Orchestia* species. Moreover, the Bayesian inference demonstrated that terrestrial species from the Canary, Madeira, and Azores Islands of this study do not belong to the new genus *Cryptorchestia*. However, our analyses confirmed the need for a taxonomic revision of the species *D. deshayesii* and *T. saltator*. Future studies are aimed at investigating the evolutionary roles played by gut microbiome in marine, freshwater, and terrestrial talitrid amphipods.

## Transcriptome sequencing and Simple Sequence Repeat (SSR) marker development for three Macaronesian endemic plant species

OLIVER WHITE, M. CARINE & M. CHAPMAN



White, O., M. Carine & M. Chapman 2016. Transcriptome sequencing and Simple Sequence Repeat (SSR) marker development for three Macaronesian endemic plant species. Pp. 513 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Macaronesia; *Taxa*: *Argyranthemum*, *Echium*, *Descurainia*; *Other*: Simple Sequence Repeats (SSRs), transcriptomes.

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Oceanic islands offer unparalleled opportunities to investigate evolutionary processes such as adaptation and speciation. However, few genomic resources are readily available for oceanic island endemic lineages. In this study, we sequenced, assembled and annotated the transcriptomes of *Argyranthemum broussonetii* (Pers.) Humphries, *Echium wildpretii* H.Pearson ex Hook.f. and *Descurainia bourgaeana* (E.Fourn.) Webb ex O.E.Schulz, three Macaronesian endemic plant species that are representative of lineages that have radiated in the region. Transcriptome sequences from each of these species were used to identify Simple Sequence Repeat (SSR) sequences that can be employed as molecular markers. SSRs are advantageous over other PCR based markers since they are codominant, often highly polymorphic and are transferable to closely related species. Using this approach, between 1,287 and 2,303 SSRs were identified for each species. Primers were designed for 30 of the candidate SSRs identified in *Argyranthemum*. Of the 12 primer pairs which produced a clear and specific PCR product, 8 (67%) were polymorphic when tested across 10 DNA samples representing four members of the genus, including *A. frutescens* (L.) Sch.Bip subsp. *frutescens*, *A. frutescens* subsp. *succulentum* Humphries, *A. broussonetii* subsp. *broussonetii* and *A. tenerifae* Humphries. A large number of polymorphic SSR loci can be identified using transcriptomes as a genetic resource. The SSRs developed in this way are applicable to a wide range of questions relating to the evolution of island lineages. Transcriptomes are cost effective resource for SSR development which hold promise for future genetic studies of island endemic lineages.

## Patterns of reproductive isolation in Sardinian orchids of the subtribe Orchidinae

MICHELE LUSSU, A. COGONI, M. MARIGNANI & P. CORTIS



Lussu, M., A. Cogoni, M. Marignani & P. Cortis 2016. Patterns of reproductive isolation in Sardinian orchids of the subtribe Orchidinae. Pp. 514 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Sardinia (Italy); *Taxa*: *Ophrys*, *Anacamptis*; *Other*: orchids, speciation, pre and post zygotic barriers.

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Sardinia is the second largest island in the Mediterranean basin, and it is classified as one of the 34 most important 'biodiversity hotspots' in the world. In Sardinia there are 16 endemic species among 68 taxa of orchids. Within the subtribe *Orchidinae*, the genera *Anacamptis*, *Ophrys* and *Orchis* are the objects of this thesis: *Anacamptis* and *Orchis* as examples of food deception and *Ophrys* as an example of sexual deception. Our main objective is to investigate the pre- and post-zygotic barriers among species within each group, including hybrid fitness. For the food-deceptive orchids, we also examine the strategies used by these species to attract pollinators. For the sexual-deceptive genus *Ophrys* we examine the morphologic and karyotypic variation of the species currently ascribed to the genus. For Sardinian species in particular, we defined the volatile compounds used to attract pollinators and use phylogenetic analyses to compare the Sardinian results with the previous data in previous studies. In both cases we use biochemical analyses to define molecular compounds used to attract pollinators, manual and natural pollination to test seeds viability and finally phylogenetic analyses to build the first tree-of-life of Sardinian orchids. These analyses will provide the relation between species especially focused on endemism, this study also aims to suggest these species as model to explain the mechanisms of speciation in insularity conditions of a complex and yet debated taxonomic groups.



## Sensory competition and acoustic niche partitioning: island/mainland comparisons

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Robert, A., T. Lengagne, M. Melo, R. Covas, D. Gomez & C. Doutrelant 2016. Sensory competition and acoustic niche partitioning: island/mainland comparisons. Pp. 515 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Gulf of Guinea and Macaronesia; *Taxa*: Aves; *Other*: communication, acoustic competition, birdsong, evolution, island.

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Signaling plays a primary role in intra and interspecific communication and understanding the organization of acoustic networks is a major goal in ecology. In communities, sympatric species have to share the same signaling space. Using similar signals may hamper species recognition and it is predicted that partitioning the limited signaling space by avoiding temporal/spectral song overlap maintains the efficiency of communication, which is crucial for survival and reproduction. This understudied process of acoustic interspecific competition could lead to relaxation of acoustic niche in communities with poor species diversity. Islands offer an interesting setting to test this hypothesis. It has been shown that, in similar habitats, reduced species diversity and interspecific competition on islands lead to broader ecological niches. We will investigate if the same process occurs for the acoustic niche, a result recently suggested by comparative analyses on bird song. Here we present context, methods and expected results of a study which aim to i) determine if acoustic competition exists, highlighted by a niche congestion in continental site with high species-diversity and by a relaxation in island site with lesser biodiversity. ii) explore the sensitivity of different acoustic features (syntaxes, frequency, timing) to sensory competition. Fieldwork (already funded) will consist on comparisons of island/mainland acoustic niche. We will measure the acoustic niches of forest birds communities in two island/mainland pairs: São Tomé (22 species singing)/Mount Cameroon (about 100 species singing). Madeira (10 species singing)/Portugal (about 40 species singing). We will measure the different features of acoustic niche: frequencies, duration and syntax. Paired comparisons of the song of the same resident species (about 10) on both continental and island sites will be performed. We predict acoustic niche congestion under competition in mainland but not in islands and thus that island species have broader acoustic niche than mainland species.



# A screening for putative hybridization in Azorean *Ilex* provides phylogenetic support for an endemic species status

ÂNGELA F.A.L. VIEIRA, L. SILVA, C. SILVA & M. MOURA



Vieira, A.F.A.L., L. Silva, C. Silva & M. Moura 2016. A screening for putative hybridization in Azorean *Ilex* provides phylogenetic support for an endemic species status. Pp. 516 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Azores; *Taxa*: *Ilex azorica*; *Ilex perado*; *Ilex aquifolium*; *Other*: *Ilex*, Macaronesia, *matK*, *rbcL*, ITS.

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*Ilex azorica* Gand. (Aquifoliaceae) is considered a characteristic tree of the *Laurus* forest and of the *Ilex* forest, and is also frequently associated to *Juniperus brevifolia*. It was considered a variety of *Ilex perado* Aiton by Loesener (1901), and later a subspecies, *Ilex perado* Aiton subsp. *azorica* (Loes.) Tutin (1933). It was referred by Rivas-Martínez and colleagues under the name *I. azorica* Loes., but a valid species name was designated by Gandoger in 1918. At the population genetics level, the taxon has already been shown to have differences towards other Macaronesian *Ilex* taxa. The occurrence of individuals with uncharacteristic leaf morphology led to a molecular screening for putative hybrids. Plant material was sampled in the Special Protected Area of “Pico da Vara & Ribeira do Guilherme” in São Miguel Island and also included accessions from other Azorean islands, deposited at AZB. Molecular analyses indicated that: (i) for ITS, the Azorean haplotypes differed from that of *I. aquifolium* in five to six base pair (bp) substitutions; (ii) for *matK*, the most common haplotype found in the Azores coincided with one of the *I. aquifolium* haplotypes, while two accessions from Pico differed in one bp substitution; (iii) for *rbcL*, one Azorean haplotype was obtained, differing from the *I. perado* subsp. *perado* and *I. aquifolium* haplotype in one bp substitution. Although the research provided further arguments to consider the Azorean *Ilex* as an endemic species, under the name of *Ilex azorica* Gand., no clear evidence of hybridization was found.

## The impact of crabs (*Pachygrapsus* spp.) on intertidal algal communities of cobble beaches

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Moreu, I., N.V. Álvaro, J.M.N. Azevedo, A.I. Neto & T.M. Costa 2016. The impact of crabs (*Pachygrapsus* spp.) on intertidal algal communities of cobble beaches. Pp. 517 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Azores; *Taxa*: *Pachygrapsus*, *Ulva*, *Gelidium*, *Polysiphonia*, *Halopteris*; *Other*: succession, diet, consumption rate.

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Crabs of genus *Pachygrapsus* are distributed in marine rocky shores of temperate and tropical regions where they have a relevant ecologic role in shaping the structure of intertidal assemblages and contributing to the energy flows towards adjacent ecosystems. The present study assesses the impact in algal communities of the feeding activity of two *Pachygrapsus* species, using field and experimental analysis. Field work was carried out in three intertidal cobble beaches on Terceira Island (Azores). Crabs of both species were collected for stomach content analysis. The frequency of occurrence and the abundance of each algal taxon were recorded, and a Food Index (FI) computed. The algal communities at each sampling site were also characterized. Algae consumption rate was estimated experimentally in a mesocosm, by offering the algae with higher FI to individual crabs (after 48 hours of starvation). The amount consumed after 6 hours was expressed in mm<sup>2</sup>hour<sup>-1</sup>, obtained by measuring the initial and the final area of alga on graph paper. The algal communities at the sampling sites were dominated by *Ulva* spp. and non-calcareous multispecific turf. Twenty-five algal taxa were identified in the stomach contents, belonging to the algae divisions Cyanophyta, Rhodophyta, Heterokontophyta (Phaeophyceae) and Chlorophyta. The most frequent algae belonged to the genus *Ulva*, *Gelidium*, *Halopteris* and *Polysiphonia*. From these, *Ulva* spp. had the highest value of FI, being the most important food item for both crab species, followed by *Gelidium* and *Halopteris*. *Ulva* consumption rates suggests that *Pachygrapsus* populations can affect the first stages of succession in which green algae are dominant.

## The Macaronesian Laurel forest as a model system to analyse pollen rain dynamics in island ecosystems

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Nogué, S., L. Nascimento, L.A. Gómez González, R.J. Whittaker, J.M. Fernández-Palacios & K.J. Willis 2016. The Macaronesian Laurel forest as a model system to analyse pollen rain dynamics in island ecosystems. Pp. 518 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipélago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Macaronesia; *Taxa*: multiple; *Other*: laurel forest, forest dynamics, pollen dispersal, pollen rain, productivity, traits.

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This project aims to assess the impact of the spatial configuration, vegetation structure, reproductive behavior, and multiple stressors on pollen rain in the Macaronesian Laurel forest. We sampled pollen rain from Garajonay National Park, La Gomera (Canary Islands) during two years. We placed pollen traps in the forest understory and collected vegetation cover in 13 forest plots representing different community composition within the Laurel forest. This dataset is mainly composed of pollen taxa variation through time in the Laurel forest communities, which will provide the baseline to: (1) measure a key forest trait: pollen productivity and how is responding to altitudinal gradients; (2) capture both the functional composition of the pollen rain spectra and the pollen dispersal capacity and (3) determine the association between plant traits and pollen traits. We will also identify the taxonomic components of Laurel forest pollen rain that are the most variable and therefore may be most sensitive to any disturbance e.g. climatic variability.

## Endemic mutualistic interactions between geckos and the dragon blood's tree in Socotra Island (Yemen)

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García, C. & R. Vasconcelos 2016. Endemic mutualistic interactions between geckos and the dragon blood's tree in Socotra Island (Yemen). Pp. 519 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Socotra Island; *Taxa*: *Dracaena cinnabari*, *Hemidactylus dracaenacolus*, *Hemidactylus granti*, *Haemodracon riebeckii*; *Other*: Indian Ocean Island, Natural World Heritage site, pollen dispersal, relic species, threatened species.

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The study of biodiversity has steadily moved from listing species to depicting biotic interactions among species that provide crucial ecological services without which plant populations and entire ecosystems would collapse. The study of biotic interactions among endemic and restricted-range taxa in highly diverse ecosystems is essential to predict their fate in a changing world. The archipelago of Socotra (Yemen) hosts one of the richest endemic flora with a high number of threatened species and it is considered one of the most environmentally distinctive hotspots declared Biosphere Reserve in 2003 and Natural World Heritage site by UNESCO in 2008. Among its unique plant communities we find arboreal relic forests from the Mio-Pliocene, the dragon's blood trees *Dracaena cinnabari*. *D. cinnabari* is classified as Vulnerable and it is now threatened by goat grazing, increased aridity, and the potential loss of biotic interactions that strongly limit its natural regeneration. Among other biotic interactions, those entailing pollen and seed dispersal are crucial to fulfill the demographic cycle of plant species. Bird species have been observed feeding on fleshy berries produced by *D. cinnabari* but we still ignore whether this tree has pollen vectors among vertebrates. Lizards are reported as major pollen dispersers on islands where their diets include flowers, fruits, nectar, and pollen grains. In order to explore the role of endemic geckos (*Hemidactylus dracaenacolus*, *Hemidactylus granti*, and *Haemodracon riebeckii*) as pollen vectors of *D. cinnabari*, a field trip to Socotra Island was conducted in 2014 during the flowering time of dragon's blood trees (March and April) granted by The Mohamed bin Zayed Species Conservation Fund. Here we present some striking results that show the relevance of lizards as pollinators in Socotra Island. We discuss the importance of protecting mutualistic interactions that provide key services that sustain unique ecosystems.

## Can local assemblages mediate the recruitment of limpets and barnacles? A time-series survey in Azores (NE Atlantic)

IGNACIO MOREU, M. PASTOR A.I. NETO, G.M. MARTINS & J. FARIA



Moreu, I., A.I. Neto, G.M. Martins & J. Faria 2016. Can local assemblages mediate the recruitment of limpets and barnacles? A time-series survey in Azores (NE Atlantic). Pp. 520 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: São Miguel, Azores; *Taxa*: *Patella candei*, *Chthamalus stellatus*; *Other*: intertidal assemblages, algal turfs, canopies, species turnover, succession, marine, benthic.

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The recruitment of rocky intertidal organisms is known to be an important determinant in shaping the spatial and temporal patterns of coastal communities. Yet, recruitment itself can be influenced by many biotic and abiotic factors (e.g. larval supply, settlement processes, physical disturbances, species interactions and/or habitat complexity) operating at different intensities and scales. Here, we examine the recruitment of the limpet *Patella candei* and the intertidal barnacle *Chthamalus stellatus* in the coastal rocky shore of São Miguel island in Azores (NE Atlantic). During 2014, monthly survey counts of early recruits were performed in basaltic plates (7×7cm) distributed across four locations. Coverage of coastal biotic assemblages was determined from transect photographs using random point count methodology. A seasonal peak in the recruitment rate of *C. stellatus* occurred in late summer when sea surface temperatures get warmer and a phytoplankton bloom peak is known to take place. Recruitment in *P. candei* peaked in the winter months, when water mixing is higher. The relationship between intertidal assemblages and the spatial and temporal variation in barnacle and limpet recruitment is considered.

## Surf's up: Structure of decapod communities in cobble beaches varies with wave exposure

NUNO V. ÁLVARO, J.M.N. AZEVEDO & A.I. NETO



Álvaro, N., J.M.N. Azevedo & A.I. Neto 2016. Surf's up: Structure of decapod communities in cobble beaches varies with wave exposure. Pp. 521 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Terceira Island, Azores; *Taxa*: Crustacea, Malacostraca, Decapoda; *Other*: hydrodynamics, community structure, coastal ecology, intertidal, macroinvertebrates, diversity.

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The cobble beaches remain subject to little attention from the scientific community. A few crab species dwell between cobbles, but there is little information regarding the relation between population distribution and abundance with hydrodynamics. An 18 month study was conducted at Terceira Island. Abundances of crab populations were determined monthly in four beaches, two on the north coast (more exposed to wave action) and two on the east coast (more sheltered). Three shore levels were considered. The community structure varied between sampling sites and shore levels. *Pachygrapsus marmoratus* and *P. maurus* were the most abundant species in all sites, being present at all shore levels. The former was more abundant in the mid littoral level, the later in low shore. *Lophozozymus incisus*, *Eriphia verrucosa*, *Microcassiope minor* and *Percnon gibbesi* were collected only at low shore. The most protected of all studied beaches showed the highest species richness and abundance of individuals, revealing a high influence of hydrodynamics in crab community structure.



## Evolutionary ecology of microbial communities in Hawaii

BENOÎT PEREZ, H. KREHENWINKEL & R.G. GILLESPIE



Perez, B., H. Krehenwinkel & R.G. Gillespie 2016. Evolutionary ecology of microbial communities in Hawaii. Pp. 522 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hawaii; *Taxa*: microbial communities; *Other*: gut microbiota, intracellular endosymbionts, Hawaiian *Ariamnes* spiders, progression rule, coevolution.

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Microbiota are well-known for their central roles in the functioning of multicellular life. Interactions between symbiotic bacteria and their host are incredibly variable and present at multiple levels: nutrition, development, health, and behaviour are affected by these microbial communities. While many of these bacteria are randomly acquired from the environment during the life of the host, some particular microbes can be intimately associated with the host, transmitted across generations, and co-evolve with their host. In this project, we focused on the microbiota of eight populations of the Hawaiian spiders (Theridiidae, *Ariamnes*). The spiders follow the classic “progression rule” across the Hawaiian archipelago metazoans, the youngest islands being occupied by the most derived species with the lowest levels of genetic diversity. Our study showed that, like other arthropods that have been studied to date, Hawaiian *Ariamnes* spiders are characterized by two main bacterial pools: the gut microbiota and the intracellular endosymbionts. Our study demonstrated that gut microbial diversity is higher on the oldest geological substrates in the Hawaiian Islands, paralleling the genetic diversity of the host. The suggestion is that gut bacterial communities, whether acquired from the environment or more intimately associated with the host, follow the progression rule characteristic of macro-organisms. Moreover, the analyses of the bacterial community revealed clear patterns of coevolution in particular populations between host and bacteria, especially for endosymbionts.



## Changes in precipitation with climate change in Europe

BARTOSZ KAŻMIERCZAK & M. WDOWIKOWSKI



Kaźmierczak, B. & M. Wdowikowski 2016. Changes in precipitation with climate change in Europe. Pp. 523 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Europe; *Taxa*: -; *Other*: Kendall test, precipitation trends, Poland, IPCC, climate change.

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The climate warming observed in the 20th century affects the amount and the intensity of the rainfalls. The increase of the average annual globe temperature causes, among others, increased water circulation in the hydrological cycle. As well as it intensifies extreme weather phenomena (droughts, floods, cyclones). Current relationships between the precipitation amounts, durations and occurrence frequencies, established for many geographical regions of Europe are similar in terms of their quality. It does not mean that they are equal when it comes to their quantity, especially on a local scale. Among other, as in other countries in Europe and the world, in Poland, observed climate changes, are manifested by an extreme weather events frequency increase. According to the IPCC reports, there was an increase in mean annual temperature of the globe by 0.74°C in the period 1960–2005. Thus the temperature increase about 0.16°C per decade. In accordance with to projections based on the IPCC global climate model, in the current century, global temperature could increase by a further 1.7–4.4°C, and for each increasing degree of temperature, around 7% increase of intense rainfall events is expected. There is also predicted more often appearance of short-term but heavy storm rainfall. In the present study there were analyzed the trends of changes in the maximum amount of daily rainfall recorded in Poland in the period of 1961–2005 at several meteorological stations: Kłodzko, Legnica, Opole, Wrocław and Zgorzelec. For this purpose a non-parametric Mann-Kendall test was examined. It gives an answer to the question whether the measured values (maximum amount of precipitation in this case) trends to gradually increase or decrease. Identification of long-term period precipitation trends allows to evaluate the rate of changes of water resources in the context of drought, water needs of plants or even biological life of the investigated region. Our findings coincide with studies of other European researches. Between 1961 and 2005 decreasing trends were detected on all analyzed stations, but it were statistically insignificant (statistical significance level varied from 75 % to 85 %). In the years from 1970 to 1999 on all stations, significant decreasing trends were detected (nearly 99%). Our study methods can be also used in islands precipitation analysis.

## 37 Years of climate change on islands

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O. CONRAD ET AL.



Karger, D.N., L. Mo, P. Weigelt, H. Kreft, N. Zimmermann, J. Böhner, O. Conrad, R.W. Soria-Auza, H.P. Linder & M. Kessler 2016. 37 Years of climate change on islands. Pp. 524 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: global; *Taxa*: -; *Other*: climate change velocity, climatologies, climate reanalysis, island.

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Understanding the impact of recent climatic change on biotic communities is one of the major challenges macroecological and biogeographical research has to face in the next decades. In particular, the often isolated, endemic biotas of islands will face severe challenges in the near future. Understanding the velocity of recent climate change on islands is therefore crucial to predict the future of island communities. Detailed climatic data which could inform us about recent trends in changes of temperature and precipitation on islands is however scarce. If available, such data is either too coarse in spatial resolution, or only covers the time spans of around 15 years (as it is the case with most satellite based data). Here, we present a comparison of the velocity of climate change between islands and mainland's, using the newly developed, and freely available climatology CHELSA - Climatologies at High Resolution for the Earth Land Surface Areas. CHELSA is a quasi-mechanistically downscaled global circulation model on a 1 x 1 km resolution that is based on the ERA-Interim climate reanalysis, spanning 37 years of recent climate change from 1979-2015. Novel data like this can be used to detect the dynamics of recent climate change on islands and allows a direct comparison between the velocity of climate change on islands as well as on mainland's.

## FIELD TRIPS



View from the volcanic pit “Algar do Carvão”, Terceira Island, Azores (Photo: Paulo A.V. Borges)

### Pre-conference

FIELD TRIP TO PICO AND FAIAL ISLANDS (12-17 JULY 2016)

### Mid-conference

NATIVE FORESTS AND CAVES OF TERCEIRA ISLAND, AZORES (20 JULY 2016)

WETLANDS OF PRAIA DA VITÓRIA – TERCEIRA ISLAND, AZORES (21 JULY 2016)

### Post-conference

FIELD TRIP IN TERCEIRA ISLAND (23-26 JULY 2016)

## FIELD TRIP 1 - PRE-CONFERENCE

### FIELD TRIP IN FAIAL AND PICO ISLANDS (12-17 JULY 2016)

RUI B. ELIAS & FERNANDO PEREIRA

July, 12

Flight from Terceira Island to Faial Island. Check-in in Hotel Horta. 13th of July

July, 13

The day will be spent in Faial Island. In the morning we will leave the City of Horta to visit the Caldeira do Faial Nature Reserve, where we may see many endemic plants species and the best preserved native vegetation of the Island. We will then proceed west to visit the site of the 1957 eruption of Capelinhos. Afterwards we will take the south main road back to Horta, stopping in the Protected Area for the Management of Habitats or Species of Varadouro - Castelo Branco. After lunch we will visit the Faial's Botanical Garden.

July, 14

By early morning we will cross, by boat, the Faial-Pico channel to Madalena village (in Pico Island). After checking-in at Hotel Caravelas, the rest of the morning will be spent in the village. After lunch we will visit the Landscape of the Pico Island Vineyard Culture Interpretation Centre and proceed to Gruta das Torres, to see the visitor's center and the inside of the cave.

July, 15

We will start with a visit to the Mountains House, located at about 1230 m a.s.l., at the beginning of the trail to the summit of Pico Mountain (2351 m a.s.l.), the highest in Portugal. The mountain's House is at the edge of the Nature Reserve of Montanha do Pico home to the only Alpine habitat of the Azores. We will then take the south main road to Lajes village. After lunch we will proceed to the center of the island, to the Caminho dos Burros trail. The trail starts at the place where the historical eruption of 1562 - 64 (the longest historical eruption of the Azores) started. We will go through part of the trail and will have the chance to see native scrubs and forests, and several endemic species. After dinner at São Roque village we will return to Madalena.

July, 16

In the morning we will take the center of the island main road to the eastern part of Pico, going through many protected areas including Lagoa do Caiado, the Nature Reserve of Mistério da Praínha and the Nature Reserve of Caveiro. After lunch, we will visit the eastern tip of the island and take a walk in the Ponta da Ilha trail. Return to Madalena will take place through the north main road.

July, 17

On this final day, we will take the flight back to Terceira Island.

## Field Trip 2- Mid-conference

### NATIVE FORESTS AND CAVES OF TERCEIRA ISLAND, AZORES

RUI B. ELIAS, PAULO A.V. BORGES, ISABEL R. AMORIM, ROSALINA GABRIEL, ENÉSIMA MENDONÇA & FERNANDO PEREIRA

#### July, 20

The field trip in Terceira Island will be an excellent opportunity for all conference participants to get acquainted with the Azorean landscape and nature. You will be taken on a three hours guided tour to the island's Natural Park, including a visit to the Show Cave "Algar do Carvão" and a short hike in the "Mistérios Negros" trail.

The Show Cave "Algar do Carvão" is an empty volcano, with silica stalactites, and one of the most impressive landmarks of Terceira Island. Several troglobial species live there, including the endemics *Turinyphia cavernicola* (a spider of just 2 mm!) and the beetle, *Trechus terceiranus*. The rocky walls at the entrance, are covered with a dense carpet of bryophytes, including the rare *Plagiochila longispina* and *Thamnobryum rudolphianum*. In the neighbourhood of the cave, there is a small *Sphagnum* bog, a common feature at middle – high elevations in the Azores.

In "Mistérios Negros" you will have the chance to see semi natural vegetation, natural pioneer scrubs occupying lava domes from the 1761 eruption. These are the most recent inland eruption of Terceira island. In some locations, it is possible to see mature *Juniperus brevifolia* natural forests, with a typical dense .

During the visit, it will also be possible to see the traditional grasslands (intensive and semi-natural), divided with stone walls, exotic *Criptomeria japonica* plantations, and the iconic, although exotic, *Hydrangea macrophylla*.

The field trip will be offered on July 20, and the participants will travel in three shifts, one in the morning and two in the afternoon.

For those who appreciate reading about biodiversity, there are some fieldguides that may be useful during your explorations in the Archipelago. You may consider some of the ones presented below.

- Bannerman, D.A. & W.M. Bannerman 1966. A History of the Birds of the Azores - Birds of the Atlantic Islands. (Vol. 3). Edinburgh: Oliver & Boyd.
- Borges, P.A.V. & R. Gabriel 2009. Predicting extinctions on oceanic islands: Arthropods and bryophytes. Angra do Heroísmo: Universidade dos Açores,. [Available at [http://www.azoresbioportal.angra.uac.pt/files/publicacoes\\_Brochura%20BIODIVERSIDAD E%20AORES%20vFINAL.pdf](http://www.azoresbioportal.angra.uac.pt/files/publicacoes_Brochura%20BIODIVERSIDAD E%20AORES%20vFINAL.pdf)].
- Homem, N. & Gabriel, R. 2008. Azorean rare bryophytes. Estoril, Príncipe Editora, Lda.
- Pereira, C. 2010. Aves dos Açores. SPEA, Sociedade Portuguesa para o Estudo das Aves.
- Rodrigues, P. & G. Michielsen 2010. Observação de aves dos Açores. Ponta Delgada: Artes e Letras.
- Schäfer, H. 2005. Flora of the Azores – a field guide. (2<sup>a</sup> Ed.) Weikersheim, Margraff Publishers.

- Sjögren, E. 1984. Açores - Flores. Plants and flowers of the Azores. Horta, Direcção Regional de Turismo.

The Azorean Biodiversity Portal (<http://azoresbiportal.uac.pt/>) has information on the taxonomy of the species, their common names (in Portuguese and English), images for many, and also detailed distribution maps.

The Portal SIARAM – Sentir e Interpretar o Ambiente dos Açores (<http://siaram.azores.gov.pt/>) has images and videos of striking landscapes and images and audios of iconic species of the Azores.

## Field Trip 3 - Mid-conference

### WETLANDS OF PRAIA DA VITÓRIA – TERCEIRA ISLAND, AZORES

SOFIA F.P. GOULART, MARIANA REIS BRITO, CÉSAR PIMENTEL, SÓNIA SANTOS &  
ROSALINA GABRIEL

July, 21

The wetlands of Praia da Vitória, are best known for their migrant avifauna, since many nearctic species are drawn to the Azores, especially during Winter. However, due to strong human pressures – mostly urbanization and land use change, they are in need of a specific program of conservation. The LIFE + European Programme candidacy aimed to recover, restore and reorder a wet green infrastructure in Praia da Vitória coastal edge, formed by three wetlands, namely: “Paul da Praia da Vitória”, “Paul do Belo Jardim” and “Paul da Pedreira do Cabo da Praia”. At the ecological level, it is expected that the creation of a network of wetlands and the renaturalisation of these strongly humanized areas, will result in an increase in biodiversity indicators (richness and abundance of native species), as well as the improvement of the ecological conditions to support migratory birds species. Besides the ecological benefits, it is also expected that the restoration process will have a positive impact on the socio-economic sustainability of the city, for instance increasing the number of national and international birdwatchers visiting the area, and the development of a more environmentally aware society.

During this short fieldtrip, the participants will be able to visit the “Paul da Praia da Vitória”. This is the largest of the three wetlands, and has a long history of land use change. In the XX century, most of that area was converted into a grassland, but after the restoration interventions, it is now possible to see typical marshy vegetation, and the bird species are also recovering. One of the most striking bird species of this marsh is the common moorhen. At some point, it was considered as an endemic subspecies (*Gallinula chloropus correiana* Murphy & Chapin, 1929), however, presently, there is no genetic study to support this hypothesis. Although neither the season, nor the time of day are the best for the observation of birds, the researchers of the LIFE – CWR project will accompany you on a visit, showing the best features of “Paul da Praia da Vitória”. We hope you will come back and see the full potential of these areas! For further knowledge, you may be interested in some studies concerning the wetlands of Praia da Vitória and the birds of the Azores. See a selection below.

- Barata, F. 2002. *A avifauna aquática nas zonas húmidas da costa leste da Ilha Terceira – um contributo para a sua conservação*. Dissertação de Mestrado em Gestão e Conservação da Natureza. Angra do Heroísmo, Universidade dos Açores.
- Brito, M.R. 2013. *Contributo para o estudo e conservação da espécie Galinha d'água* (*Gallinula chloropus Linnaeus, 1758*). Mestrado em Gestão e Conservação da Natureza. Angra do Heroísmo: Universidade dos Açores, Departamento de Ciências Agrárias. [Available at: <http://repositorio.uac.pt/handle/10400.3/2001>]
- Goulart, S.F.P. 2015. *Impacto da poluição luminosa nas aves marinhas da ilha Terceira*. Mestrado em Gestão e Conservação da Natureza. Universidade dos Açores, Departamento de Ciências Agrárias. Angra do Heroísmo. [Available at: <http://hdl.handle.net/10400.3/3405>]
- Leal, C. 2011. *Paul da Pedreira do Cabo da Praia - Contributo das percepções ambientais para a sua preservação*. Dissertação de Mestrado em Educação Ambiental. 171pp. Angra do Heroísmo, Universidade dos Açores. [Available at: <http://hdl.handle.net/10400.3/1657>]
- Morton, B., J.C. Britton & A.M.F Martins 1997. The former marsh at Praia da Vitória, Terceira, Azores, and the case for the development of a new wetland by rehabilitation of the quarry at Cabo da Praia. [Available at: [http://www.azoresbiportal.angra.uac.pt/files/publicacoes\\_MortonBrittonMartins\\_1997.pdf](http://www.azoresbiportal.angra.uac.pt/files/publicacoes_MortonBrittonMartins_1997.pdf)]. *Açoreana*, 8(3): 285-307.



## Field Trip 4 - Post-conference

### FIELD TRIP IN TERCEIRA ISLAND (23-26 JULY 2016)

RUI B. ELIAS & FERNANDO PEREIRA

July, 23

In the morning, participants may take the chance to check-in in Angra Marina Hotel and spend some relaxing time exploring the World Heritage Historic Centre of the Town of Angra do Heroísmo. After lunch we will leave Angra do Heroísmo to the Western part of the island and the summit of Santa Bárbara volcano crater (at 1023 m a.s.l., the highest point of the Island) in the Santa Bárbara and Mistérios Negros Natural Reserve. We will then take a walk along the crater's ridge to the edge of the caldera and have the chance to see the most pristine forests of the Azores. On the way back to Angra we will take the coastal main road passing through several small villages of the west and north of the island (Serreta, Raminho, Altares), stopping at the bathing area in the coast of Biscoitos.

July, 24

The day will start with a boat ride of about 3 hours where we may have the opportunity to observe some of the cetacean species common around the island. After lunch we will go north to the coastal trail of Baías da Agualva. After a 2 hours walk along the beautiful northern coast, we will return to Angra.

July, 25

In the morning we will proceed to center of the island and walk through the Rocha do Chambre trail. In this trail we will be able to see many typical landscapes of Azores, passing through pastures and planted woods, as well as natural pioneer scrubs (on basaltic rocks from the 1761 A.D. eruption) and the native Montane Forests of the Biscoito da Ferraria and Pico Alto Nature Reserve. After lunch we will proceed east to the city of Praia da Vitória. After a stop at the city, we will take the center of the island main road back to Angra, stopping at the viewpoint of Serra do Cume where, from the ridge of the crater of the oldest volcano of the Island, we may have a magnificent view over the center and western parts of Terceira.

## “RAVE - MISTÉRIOS NEGROS”

This is an initiative of the Portuguese Ecological Society (SPECO) and the Azorean Biodiversity Group (cE3c/ABG) and it aims to promote the aesthetic values and the knowledge of Azorean biodiversity. The participants will enjoy the beauty of Mistérios Negros trail and will have the opportunity to photograph both landscapes and/or species along the hike. This is third RAVE promoted by the Azorean Biodiversity Group in Terceira Island. A RAVE, short for Rapid Assessment Visual Expedition, is a way to obtain biodiversity information of a specific area. The idea is that many people go to a place and photograph what strikes them as most interesting, in a relatively short time. In the end, there will be a high number of photographs, portraying many different biological groups, thus contributing to the knowledge of a region.

**Date for taking the pictures:** The photographs must have been taken during the field trip of the “II Island Biology Conference”, on Wednesday, the 20th of July 2016.

**Location:** The area we chose for the Rapid Assessment Visual Expedition (RAVE) is “Mistérios Negros” - Terceira Island.

**Participants:** conference attendants and companions who will take part in one of the field trips on Wednesday, the 20th of July, at Terceira Island.

**Categories:** There are three categories of submission: Biodiversity, Landscape and Human presence.

**Photographs types and format:** Camera/phone photographs in JPEG format and at least 1 MB.

**Maximum number of photographs per participant:** only two photographs per person.

**Name of the file:** To ease the processing of the photographs, files should be submitted in a specific way: CATEGORY\_First and Last name of the author\_NUMBER OF THE IMAGE. For example, if the participant Celia Lopez Cañizares wants to submit the photograph of a landscape, she should name the file as: LANDSCAPE\_CeliaCanizares\_1.

**Image processing:** Images digitally modified will not be accepted. However, it is possible to make small adjustments, such as the correction of brightness and saturation or the removing of little spots.

**Delivery term:** Thursday, the 21st of July, until 12:30 am.

**Delivering the photographs:** The photographs have to be sent to the email [islandbiology2016@gmail.com](mailto:islandbiology2016@gmail.com) with the subject “IB2016 RAVE” considering the rules and the formats indicated, together with the application form in PDF format. This application form is available in: <https://www.docdroid.net/xYedst1/application-form.docx.html>. Photographs sent after the date and hour indicated or without the application form will not be considered in the competition.

**Jury:** A jury formed by three persons – a member of the Scientific Committee of the Conference, a member of the SPECO - Portuguese Ecological Society and an independent photographer, will choose the winner of each category.

**Prizes:** The best photo of each category will receive a special Commemorative Azorean Tile and a Winning Certificate.

**Exhibition and Awards:** A slideshow, with all submitted photographs, will be exhibited on Friday, the 22<sup>nd</sup> of July at the Cultural Centre of Angra do Heroísmo. The awards will be presented at the closing.

Island Biology 2016  
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## ADDENDA

Island Biology 2016  
2nd International Conference on Island Evolution, Ecology and Conservation

## Geological evolution of the Gulf of Guinea Islands – possible constraints on biodiversity

RITA CALDEIRA



Caldeira, R. 2016. Geological evolution of the Gulf of Guinea Islands – possible constraints on biodiversity. Pp. 535 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago. Life and Marine Sciences*. Supplement 9.

Key words: *Location*: Gulf of Guinea (mainly São Tomé and Príncipe Islands); *Taxa*: -; *Other*: biodiversity, Cameroon Volcanic Line, geology, geomorphology.

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Geology and biodiversity are related in many ways and here I will point out their possible links on the Gulf of Guinea Islands. These are part of the “Cameroon Volcanic Line” (CVL). This 1600 km long NE-SW volcanic alignment straddles the continental and oceanic lithosphere, from the interior of West Africa to the Island of Annobón (formerly Pagalú). It resulted from intraplate alkaline volcanism generated in the mantle. Bioko Island is on the continental-oceanic crust border, whereas Príncipe, São Tomé and Annobón lie on the oceanic crust (130 to 83 Ma). When climate favors rock weathering, the geo-logical factors influencing the nature of the substrata gain importance in determining biodiversity. This is the case of the CVL Islands where rock characteristics such as chemical composition, texture and structure (e.g. lava types, pyroclasts) play a key role in the types of soil generated. All islands of the CVL are composed of basaltic rocks (Mg, Fe, Ca-rich) and variable % of felsic rocks - phonolite and trachyte (Si, Al, Na, K-rich). Geomorphology may also constrain soil formation, whilst particular land-forms from volcanic activity (e.g. lava tubes) are certainly linked to specific types of habitats. Other main aspects to consider are those related with catastrophic events (e.g., age/frequency and type of eruptions; mass movements). Historical volcanism has been reported for Bioko; on Annobón and São Tomé, well preserved pyroclastic cones indicate recent volcanic activity, whereas Príncipe, the oldest island (31 Ma) shows no signs of recent volcanic activity. On São Tomé, land mass movements have been documented and there are indications of a phreatomagmatic eruption in the last 1 Ma. These and other geology ties with biodiversity on the Gulf of Guinea Islands, particularly on São Tomé and Príncipe, will be characterized and discussed bearing in mind the identification of future research objectives.

Presented in the Symposium: Bd1. Biodiversity in the Gulf of Guinea Islands

## An unknown Scops-owl in the genus *Otus* discovered in the remote forests of Príncipe Island (Gulf of Guinea, West Africa)

PHILIPPE VERBELEN, C. DO BOM JESUS, SÁTIRO, F. SPINA & M. MELO



Verbelen, P., C. do Bom Jesus, Sátiro, F. Spina & M. Melo 2016. An unknown Scops-owl in the genus *Otus* discovered in the remote forests of Príncipe Island (Gulf of Guinea, West Africa). Pp. 536 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Príncipe Island, São Tomé and Príncipe, Gulf of Guinea; *Taxa*: Birds; *Other*: discovery, oceanic islands, owls, Strigiformes.

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Speculation on the presence of an unknown scops-owl (*Otus* sp.) species on Príncipe Island is almost ninety years old. José Correia, ornithological collector for the American Museum of Natural History, reported in 1928 that inhabitants of the island indicated the presence of a small and very rare owl species, but conclusive evidence was lacking until now. In 1998, M Melo collected several testimonials of local parrot trappers who described seeing a scops-owl like bird in tree holes in the dense rainforest. In 2002, M Melo recorded the calls of what was probably a scops-owl. The calls had the same frequency as the calls of other scops-owls, while being distinct from any known species. A 2007 survey identified a small area where that song could be heard frequently. Evidence supporting the existence of an unknown owl on Príncipe was summarized in a 2009 paper by M Melo & Martin Dalllimer (Is there an undiscovered endemic scops owl *Otus* sp. on Príncipe Island? *Malimbus* 31: 109-115). In July 2016, an expedition led by Philippe Verbelen was organized to search for the putative owl. The unidentified calls were heard in the previous locality and, as before, came from high up in the canopy. High quality recordings of the song were obtained and used to attract the caller into view. This was successful on the third night (July 4) when the existence of a scops-owl on Príncipe Island was confirmed for the first time. At least two birds were observed and birds were photographed at very close range. The unique call and its association with high canopies strongly suggest that it is an undescribed species. Work is underway to confirm this hypothesis and eventually describe the new species. A photo of the owl is available here: [http://www.hbw.com/sites/default/files/news/principe\\_scops-owl\\_watermark.jpg](http://www.hbw.com/sites/default/files/news/principe_scops-owl_watermark.jpg)

Presented in the Symposium: Bd1. Biodiversity in the Gulf of Guinea Islands



## Impacts of volcanic activity on bird pollination system in an island ecosystem

HARUE ABE & MASAMI HASEGAWA



Abe, H. & M. Hasegawa 2016. Impacts of volcanic activity on bird pollination system in an island ecosystem. Pp. 537 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Izu Islands (Miyake-jima and Ni-jima) in Japan; *Taxa*: *Camellia japonica*; *Other*: *Zosterops japonica*, genetic analysis, insect damage, volcanic damage.

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The ecological observation of interspecies interactions during and after volcanic activity provides indispensable opportunities to study how organisms respond to environmental devastation. *Camellia japonica* satisfy the criteria for key plants of forest recovery on Miyake Island, which erupted in 2000, because this species is more resistant to volcanic gases than are other tree species. A small passerine bird, *Zosterops japonica*, is the main pollinator of *C. japonica*. Therefore, we examined the effects of volcanic activity on their plant–pollinator systems. We also compared the effect of insect herbivore on Niiijima Island adjacent to Miyake Island. In areas with low flower density due to volcanic activity and insect damage, *Z. japonica* ranged over larger areas to satisfy their energy demands rather than moving to areas with higher flower density. Genetic differentiation among pollen pools within the mother tree was decreasing while the rate of unique pollen donors were increasing as flower densities decreased. Low flower density also raised the efficiency of maternal reproductive success in *C. japonica* (i.e. fruit set rate) on both islands and the genetic diversity of pollen grains adhering to pollinators on Miyake (e.g. Abe et al. 2011). The results were consistent with previously published data on the movement of *Z. japonica* elucidated by radio tracking. Compared between islands, indirect effects on fruit set rate through the bird pollination system were larger on Miyake under the volcanic activity. Overall, our results indicate that compensation mechanisms ensure better reproductive success at sites that are more affected by volcanic activity.

Presented in the Symposium: Bg1. Biogeography of species interactions in the Japanese Izu Islands

## Phylogenetics of a hyper-diverse Hawaiian moth radiation yield insight into the timing and tempo of adaptation in speciation

DANIEL RUBINOFF



Rubinoff, D. 2016. Phylogenetics of a hyper-diverse Hawaiian moth radiation yield insight into the timing and tempo of adaptation in speciation. Pp. 538 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstracts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. *Arquipelago*. Life and Marine Sciences. Supplement 9.

Key words: *Location*: Hawaii; *Taxa*: Hyposmocoma, Cosmopterigidae, Lepidoptera; *Other*: adaptive radiation, conservation, insects.

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The endemic Hawaiian moth genus *Hyposmocoma* is a radiation with over 400 species, all single island endemics including many species on the ancient, dwindling, Northwestern islands and atolls (some of which are over twenty million years old) and others on the youngest, largest island. The case-bearing larvae have remarkably diverse ecologies ranging from lichenivory, to aquatic algae-feeders, to carnivorous species. Recent additional species from the Northwest islands and the tiny, virtually unsampled, island of Kahoolawe, have been added to a multi-gene Phylogeny with hundreds of taxa and all major case types. This new dataset is the most complete range analysis of any radiation in Hawaii and yields new insights into how time and island size help to drive, or limit, speciation and ecological diversity.

Presented in the Symposium: Ev4. Invertebrate evolution on islands

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2nd International Conference on Island Evolution, Ecology and Conservation

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