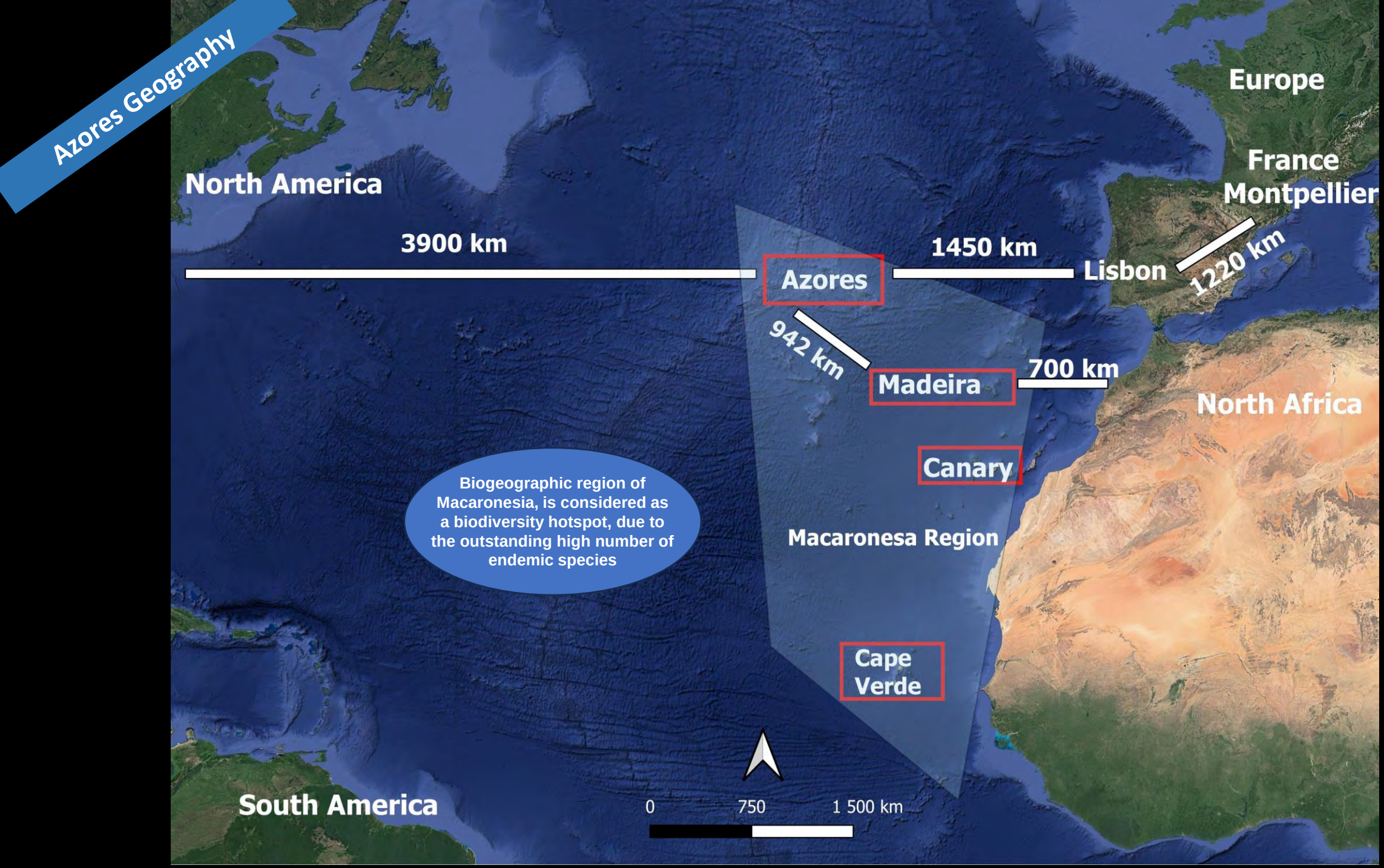
# Séminaire CBGP

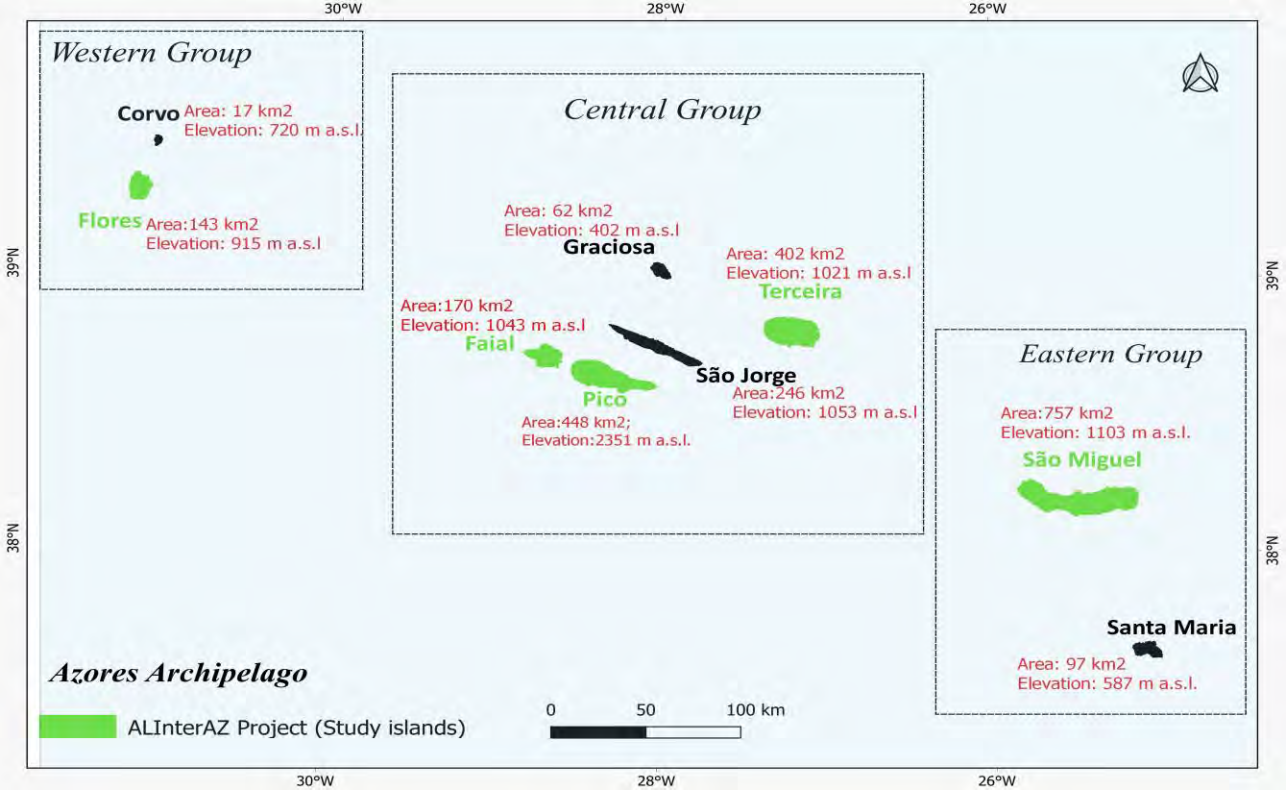
## Azores Islands as a Model System: Understanding the Biodiversity, Ecological and Genetic Patterns, along Gradients of Anthropogenic Disturbance


**Lurdes BORGES SILVA | Montpellier, France**

**09 – avril-2024**

1. Azores framework (Study area)
2. State-of-the-art (novelty of main research results)
3. Postdoc (AlInterAz Biopolis Project)


Azores Geography
North America
Europe
France
Montpellier
3900 km
1450 km
Lisbon
1220 km
Azores
942 km
Madeira
700 km
North Africa
Canary
Biogeographic region of Macaronesia, is considered as a biodiversity hotspot, due to the outstanding high number of endemic species
Macaronesa Region
Cape Verde
South America
0
750
1 500 km




| Distance among Azores islands [km] | Santa Maria | São Miguel | Terceira | Graciosa | São Jorge | Pico | Faial | Flores | Corvo |
|---|---|---|---|---|---|---|---|---|---|
| Santa Maria | 0 | 100 | 265 | 345 | 330 | 340 | 360 | 575 | 585 |
| São Miguel | 100 | 0 | 170 | 250 | 250 | 260 | 280 | 500 | 510 |
| Terceira | 265 | 170 | 0 | 95 | 120 | 125 | 145 | 360 | 370 |
| Graciosa | 345 | 250 | 95 | 0 | 75 | 80 | 85 | 270 | 280 |
| São Jorge | 330 | 250 | 120 | 75 | 0 | 20 | 40 | 250 | 260 |
| Pico | 340 | 260 | 125 | 80 | 20 | 0 | 25 | 240 | 250 |
| Faial | 360 | 280 | 145 | 85 | 40 | 25 | 0 | 235 | 245 |
| Flores | 575 | 500 | 360 | 270 | 250 | 240 | 235 | 0 | 15 |
| Corvo | 585 | 510 | 370 | 280 | 260 | 260 | 245 | 15 | 0 |

PORDATA, 2022

Population: 236,413 inhabitants (including 3346 foreigners), corresponding to an average number of 310 inhabitants per km².

# Azores Climate


Temperate or humid mesothermal climate with oceanic features:

Mild temperatures with small annual thermal amplitude

- The average annual temperature is around 17°C

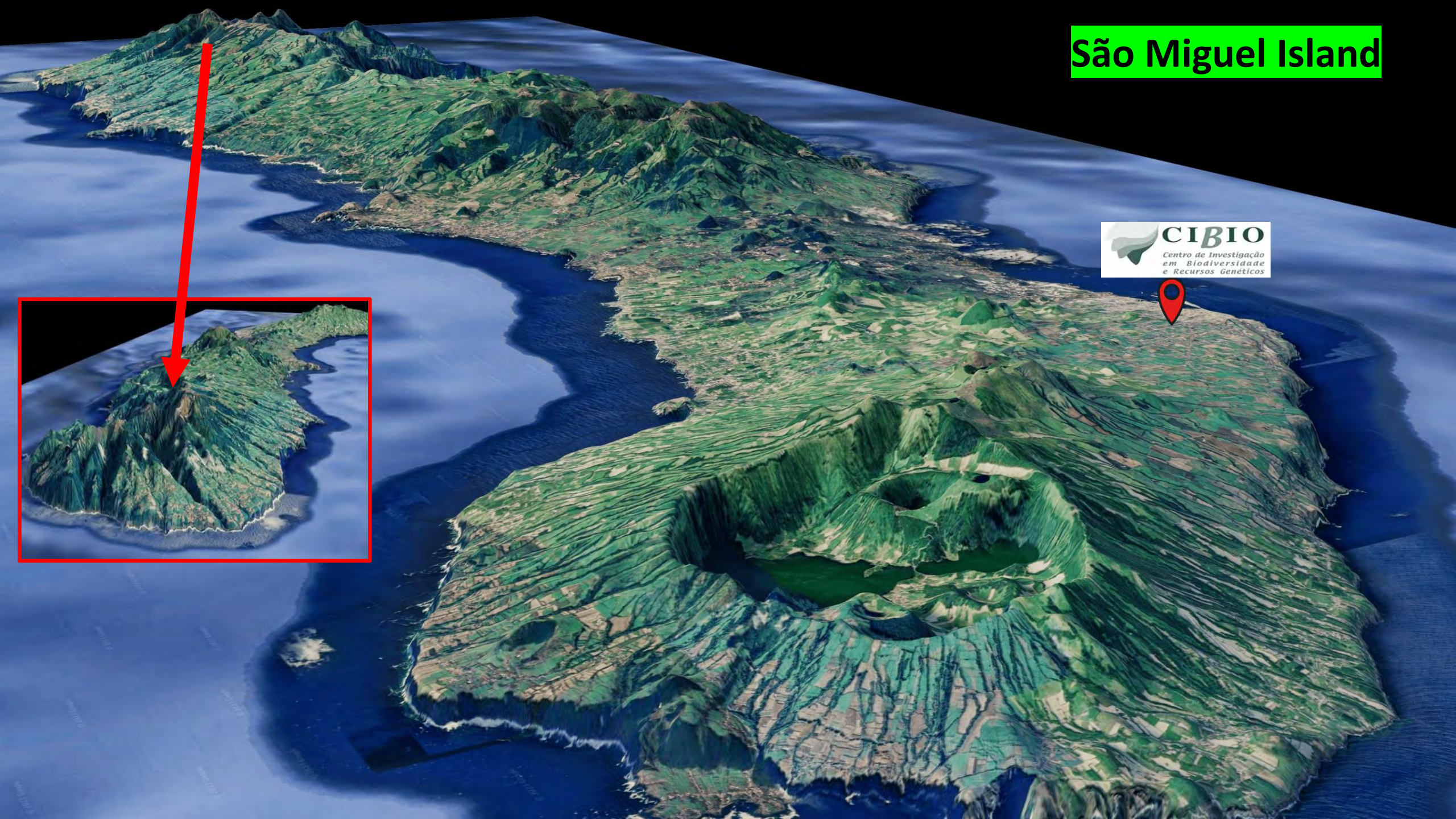
High relative humidity

- The average annual values of 73 % to 87%.

Rainfall distributed throughout the year, being more abundant in the winter months

- The average annual precipitation is 1930 mm
- increasing with altitude and from east to west of the archipelago, this is, between 966 mm on Graciosa and 2647 mm on Flores Island

The seawater temperature fluctuates between 14-15°C in February and 22-24°C in August.

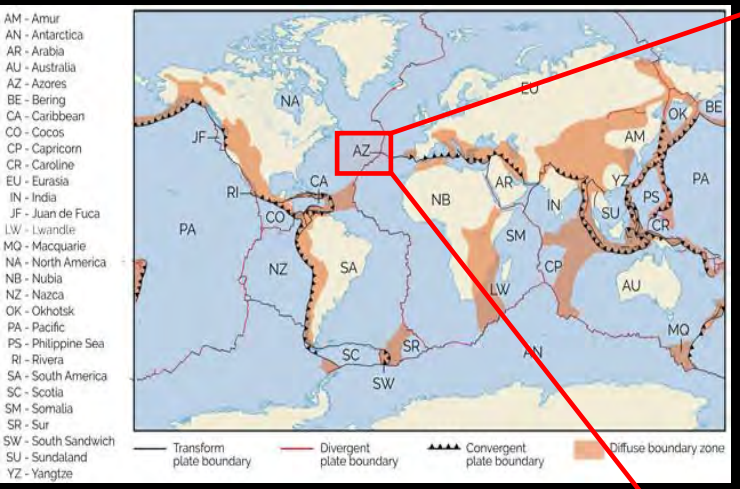

São Miguel Island
CIBIO
Centro de Investigação em Biodiversidade e Recursos Genéticos

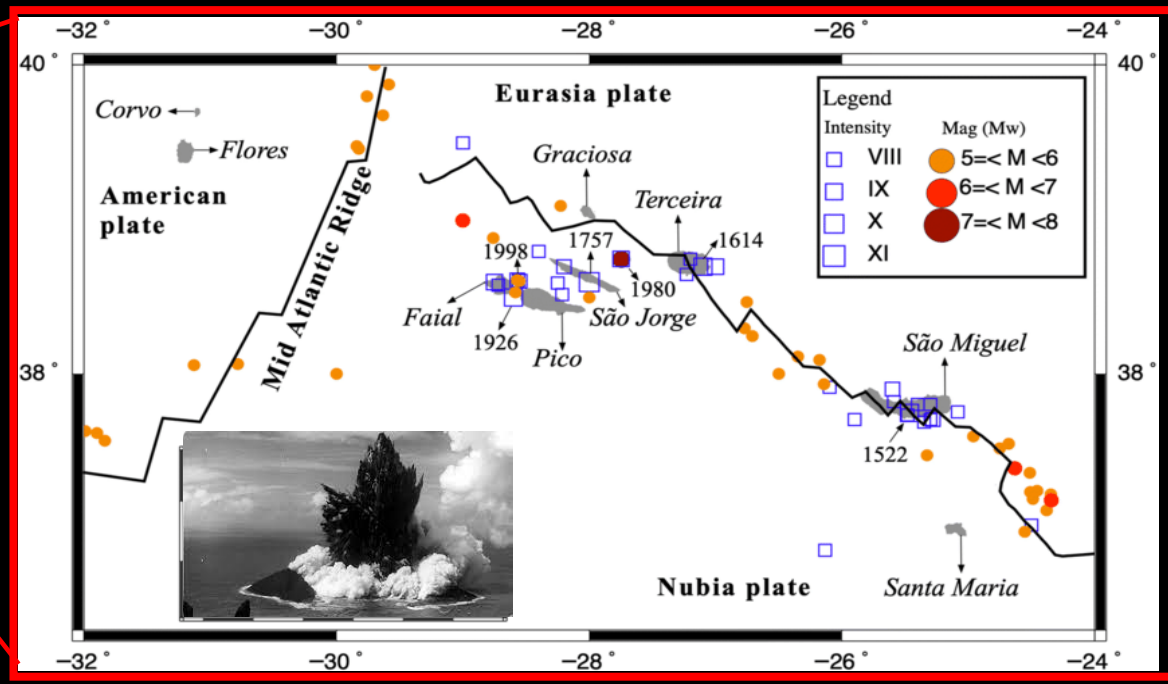
# Pico Island

# Flores Island

# From a geostructural point of view, Azores are located in the "Triple Junction of the Azores" the contact area of the Eurasian, North American and African tectonic plates.

Azores Geology



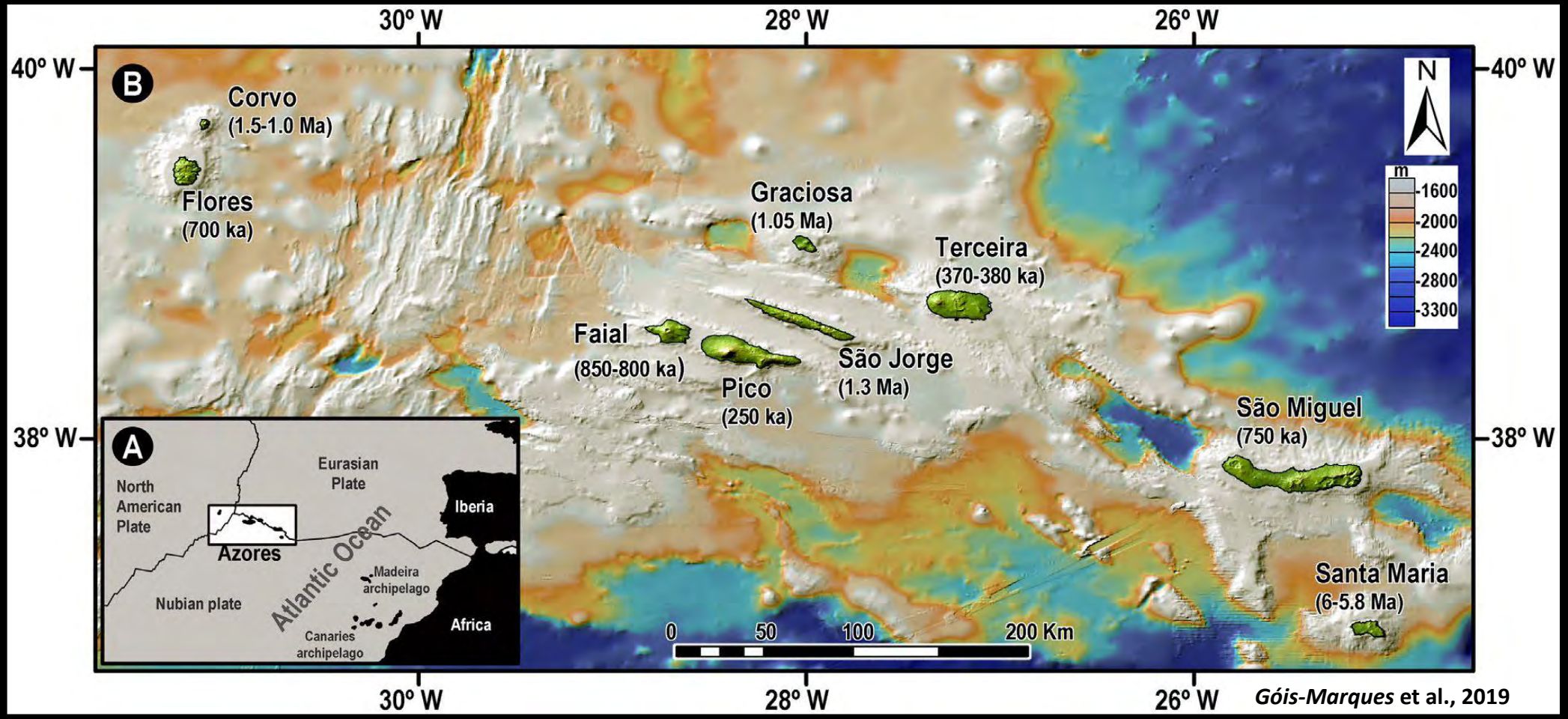




Seismicity map of the Azores archipelago. Colored circles instrumentally located seismicity with magnitude $M \geq 5$ for the period 1926–2017 and empty blue squares show historical earthquakes with $MMI \geq VIII$ since 1522 (Sources: Nunes et al. 2004; Fontiela et al. 2017). (source: Bird 2003)

**The present geomorphology of the Azorean islands results primarily from the intense volcanic activity that was at the basis of the archipelago's formation, although destructive processes have also occurred, such as subsidence, responsible for the generation of several calderas, that characterize the Azores.**








The geological age of the islands varies, with Santa Maria being the oldest, about 6.01 million years old (the only one with Miocene fossiliferous deposits), and the youngest being Pico, around 250 thousand years old (Demande *et al.* 1982). However, the ages of the islands is still a matter of controversy, while in the last ten years several papers describing /reviewing the structure and evolution of individual islands (e.g. Hildenbrand et al. 2008, 2012; Sibrant et al. 2015; Ramalho *et al.* 2017).

# Landspace changes

Before settlement the azores was dominated by forests namely the Laurissilva forest that will have occupied more than 2/3 of the territory

Human settlement ($15^{th}$) 1439

"…closed in wild bush, and completely inaccessible and impenetrable, there was no place to explore its interior."
(Gaspar Frutuoso, 1522-1591)

**1st** Orange Export (18th century)
*Coccus hesperidum* (Linnaeus, 1758)



José do Canto
G: Peter Wallace
1852-1856

2000 spp.

6000 spp.

1854

António Borges
Gardener: François J. Gabriel

1851-1858

José Jacome Correia
G: Peter Wallace

Biggest crisis in the Azorean forest (native and exotic)

1938-1945

As a source of energy, for military forces (II World War) and for pasture establishment and cereal crops


1956

Forestry Services established its activity

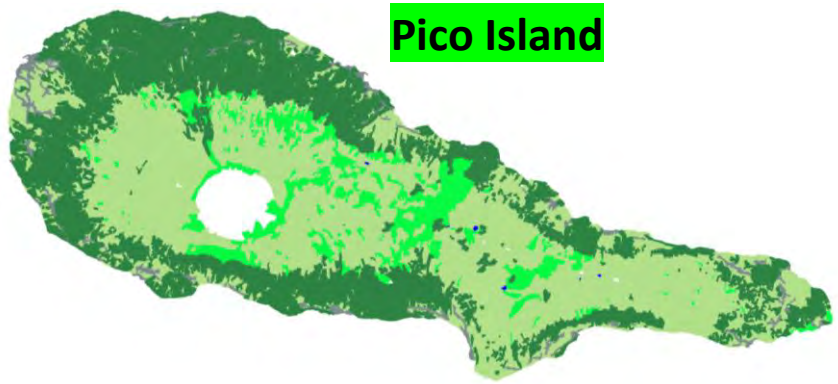

2024

**Landspace changes**

# Land Use in the Azores

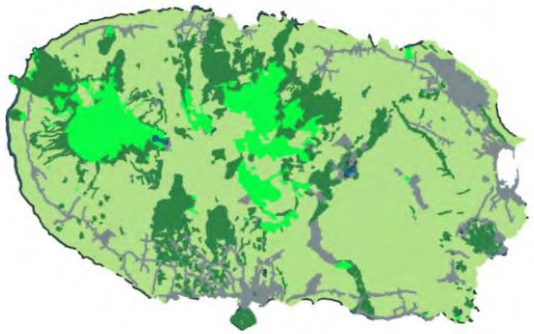
## São Miguel Island

## Pico Island

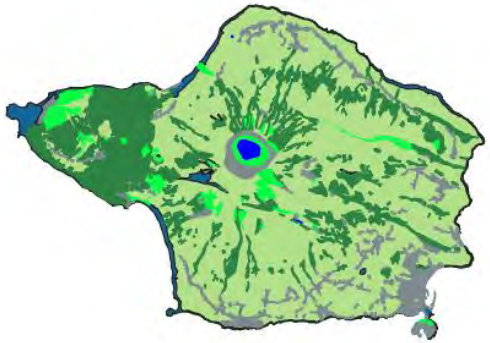


Legend
- Urban areas
- Forest areas
- Pastures
- Natural and semi-natural areas
- Water bodies

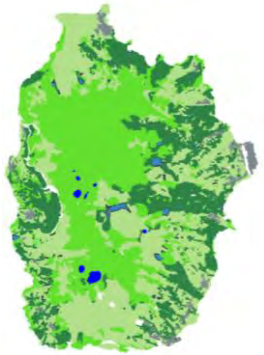
## Terceira Island



## Faial Island



## Flores Island





Pastures


Exotic woodland
*Pittosporum undulatum*


Tea Plantations
Camellia sinensis
Theaceae


Production Forest
*Cryptomeria japonica*
Cupressaceae

**MODELANDIS GROUP**

**Project funded by the Azorean Government (Florícolas)**
**Catalog database of plant species in the Azores**

GOVERNO DOS AÇORES

*2019-2022*

**Updated list of the vascular plant flora of the Azores**
(Floriculture Companies "produce and distributors", Gardens, Parks, Farms, Woods, Viewpoints, Garden squares etc..)

**Indigenous Taxa**

250 Taxa → 100 endemic

**Non-indigenous Taxa**

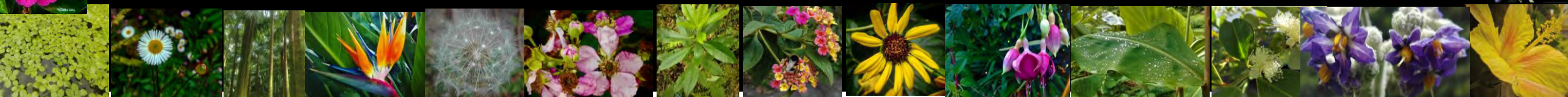
3801 Taxa
- 2901 cultivated
- 322 casual
- 326 naturalized

→ 150 Invasive

*Risk Assessment*

*Hawaii/Pacific Weed Risk Assesment*

*Australian Weed Risk Assessement*



# AZORES AS A MODEL

**Interesting region to be used as a model, in studies devoted to diversity pattern changes, associated with anthropogenic activity, and to the potential ecosystem services originated by different vegetation types.**


**2007 Graduate**

**Biotechnology Engineering**



**2012 Master**

**Biodiversity and Plant Biotechnology**

"Population genetics and phylogenetic study of the genus *Tolpis* in the Azores and Madeira"

Supervisor: Dr Mónica Moura


**2018 Doctorate**

**Biology**

"Contribution of tree age determination and biomass estimation models for management of exotic woodland in the Azores"

Supervisor: Dr Luís Silva


**2024-2026**

**Post-Doc**

**Main research results**

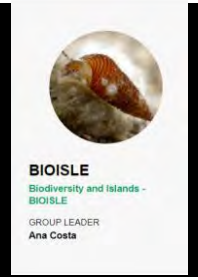
BIOPOLIS | cibio

**Research Centre in Biodiversity and Genetic Resources is to develop world-class research in the areas of biodiversity and evolutionary biology.**


## Research Groups

**Biodiversity, Ecology & Conservation**

**Sustainability, Ecosystems & the Environment**




INVASIONS
Invasion Science - InvasionS

CIBIO-Açores,

MODELANDIS - Modelling and Land Management on Island Systems


DIVERGE - Systematics and Evolution of Insular Lineages

# Framework: Invasive Plant Species on Islands (Azores Archipelago)

# Contribution of tree age determination and biomass estimation models for management of exotic woodland in the Azores



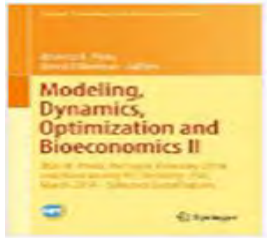
## PhD Project (3 years)

- ⇧ Higher calorific values
- ⇩ Low ash content

Funded

CIBIO Centro de Investigação em Biodiversidade e Recursos Genéticos

UAc UNIVERSIDADE DOS AÇORES



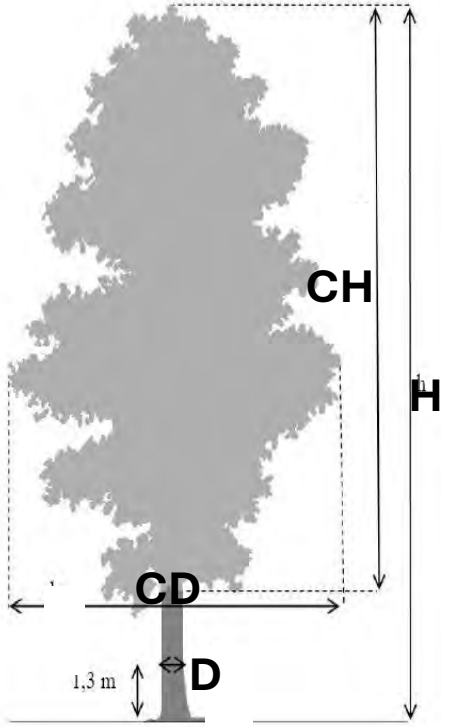

International Conference on Dynamics, Games and Science
DGS 2014: Modeling, Dynamics, Optimization and Bioeconomics II pp 463-484 | Cite as

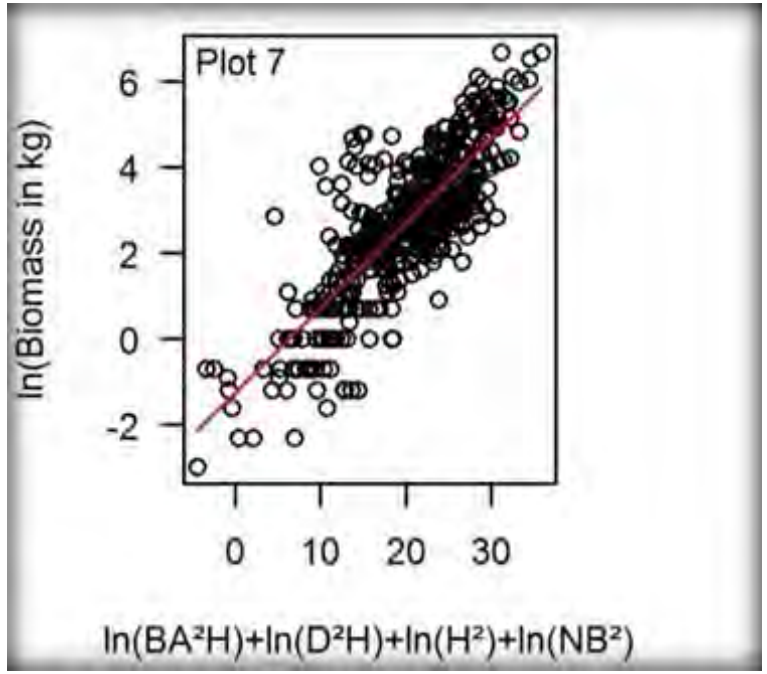
# Development of Allometric Equations for Estimating Above-Ground Biomass of Woody Plant Invaders: The Case of *Pittosporum undulatum* in the Azores Archipelago

Authors Authors and affiliations

Lurdes Borges Silva ✉, Patrícia Lourenço, Nuno Bicudo Ponte, Vasco Medeiros, Rui Bento Elias, Mário Alves, Luís Silva

Dendrometric Approach



Forest Ecology and Management 400 (2017) 457–467

Contents lists available at ScienceDirect

Forest Ecology and Management

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

# Tree age determination in the widespread woody plant invader *Pittosporum undulatum*

L. Borges Silva [a,b,c,*], A. Teixeira [a], M. Alves [b], R.B. Elias [d], L. Silva [a]

Dendrochronology Approach

Biomass and Bioenergy 109 (2018) 155–165

Contents lists available at ScienceDirect

Biomass and Bioenergy

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

Research paper

# Biomass valorization in the management of woody plant invaders: The case of *Pittosporum undulatum* in the Azores

L. Borges Silva[a,b,c,*], P. Lourenço[d,e], A. Teixeira[a], E.B. Azevedo[f], M. Alves[b], R.B. Elias[g], L. Silva[a]

Annual Total biomass ((Mg.year−1 dry weight)

Economic feasibility study

MODELANDIS GROUP


FOREST ECO2

GOVERNO DOS AÇORES

# *Assessment of biodiversity and Azorean forests ecosystem services*

## Community level (Taxonomic and Strutural Diversity)

- ✓ Evaluate the structure/composition of forest community – reveal the ecological integrity, variation along the gradient, and the contribution of each forest type

## Ecosystem level: Total Carbon Stock (trees/soil/leaf litter )

- ✓ Estimate the biomass and the carbon accumulation, along a gradient of forest types.
- ✓ A characterization of the soil and leaf litter.

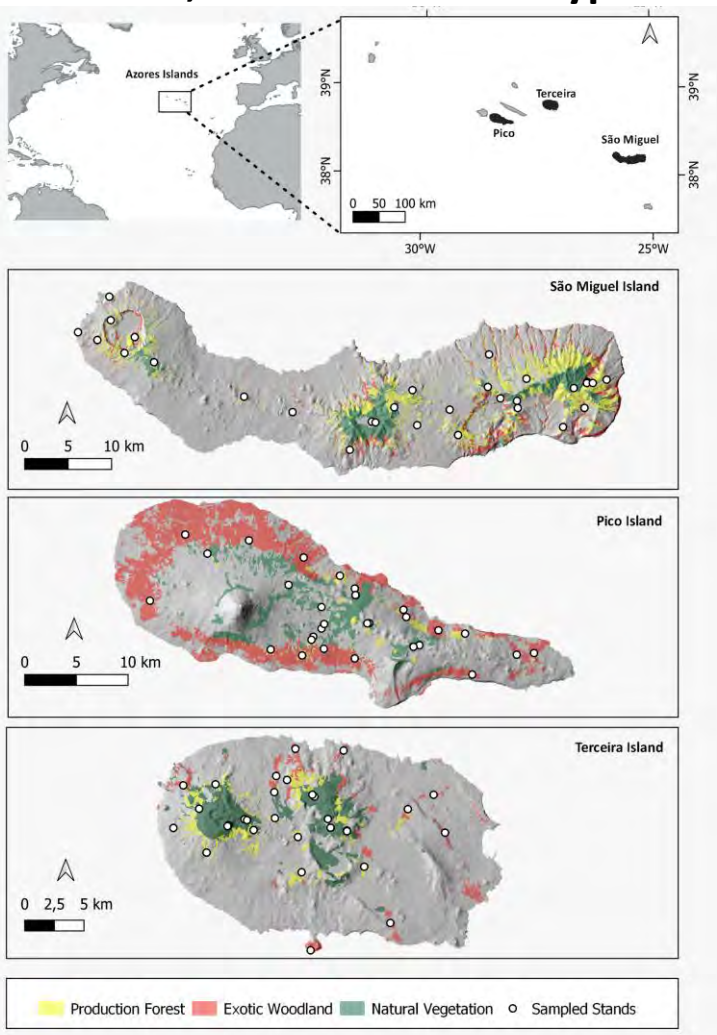
# Ecological Services | Total Carbon Stock

scientific reports Borges Silva et al., 2022

OPEN **Taxonomic, structural diversity and carbon stocks in a gradient of island forests**

Lurdes C. Borges Silva[1,2✉], Diogo C. Pavão[1,2], Rui B. Elias[3,4], Mónica Moura[1,2], Maria A. Ventura[1,2] & Luís Silva[1,2]

## Distribution of the 90 selected stands, from each forest type




| 30 plots | 30 plots | 30 plots |
|---|---|---|

**Production Forest** — ***Cryptomeria japonica***

**Exotic Woodland** — ***Pittosporum undulatum***

**Natural Forest**

| | | Exotic Woodland | | | | | | Natural Forest | | | | | | Production Forest | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pico | | São Miguel | | Terceira | | Pico | | São Miguel | | Terceira | | Pico | | São Miguel | | Terceira | |
| ALT (m) | m | 272.4 | a | 349.8 | ab | 202.2 | a | 683.8 | de | 616.2 | cde | 711.1 | e | 491.7 | bc | 538.3 | cde | 507.9 | bcd |
| | se | 13.7 | | 44.6 | | 37.6 | | 57.7 | | 33.2 | | 33.5 | | 47.9 | | 55.0 | | 35.4 | |
| TMEA (°C) | m | 16.7 | d | 15.2 | bc | 16.5 | cd | 13.8 | ab | 13.1 | a | 13.0 | a | 15.1 | bc | 13.6 | a | 14.3 | ab |
| | se | 0.3 | | 0.3 | | 0.4 | | 0.4 | | 0.3 | | 0.2 | | 0.4 | | 0.4 | | 0.2 | |
| PMEA (mm) | m | 2059.1 | abc | 1644.8 | ab | 1254.5 | a | 3117.1 | d | 2616.5 | cd | 2695.4 | cd | 2732.7 | cd | 2349.5 | bcd | 2208.6 | bc |
| | se | 214.1 | | 159.7 | | 82.7 | | 267.5 | | 158.9 | | 135.3 | | 249.1 | | 179.8 | | 116.3 | |
| RHMEA (%) | m | 87.7 | a | 91.8 | b | 90.0 | ab | 95.4 | cd | 95.8 | cd | 97.9 | d | 92.4 | bc | 95.5 | cd | 95.8 | cd |
| | se | 1.1 | | 0.7 | | 0.9 | | 0.8 | | 0.6 | | 0.3 | | 1.1 | | 1.0 | | 0.3 | |

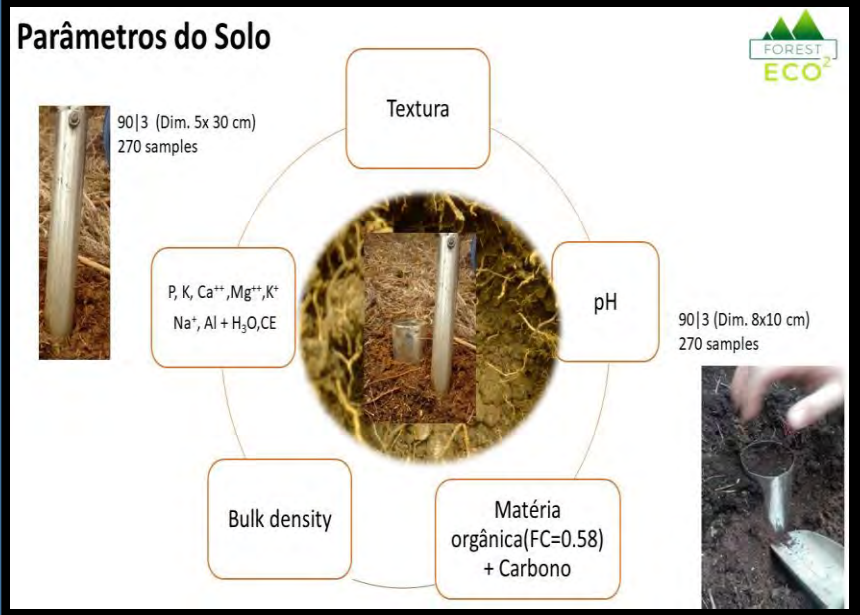
**Table 4.** Environmental variables found at 90 forests in the Azores, from three islands (Pico, São Miguel, and Terceira) and three forest types (Exotic Woodland, Natural Forest, and Production Forest). Mean and standard error for each environmental parameter. For each row, different letters indicate significant differences ($p < 0.05$) according to the results of a Tukey test applied after ANOVA.

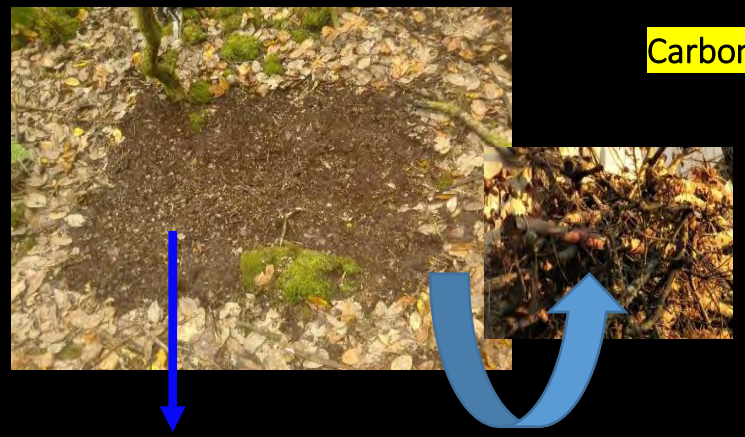
# Ecological Services | Total Carbon Stock

scientific reports Borges Silva et al., 2022

OPEN Taxonomic, structural diversity and carbon stocks in a gradient of island forests

Lurdes C. Borges Silva[1,2✉], Diogo C. Pavão[1,2], Rui B. Elias[3,4], Mónica Moura[1,2], Maria A. Ventura[1,2] & Luís Silva[1,2]



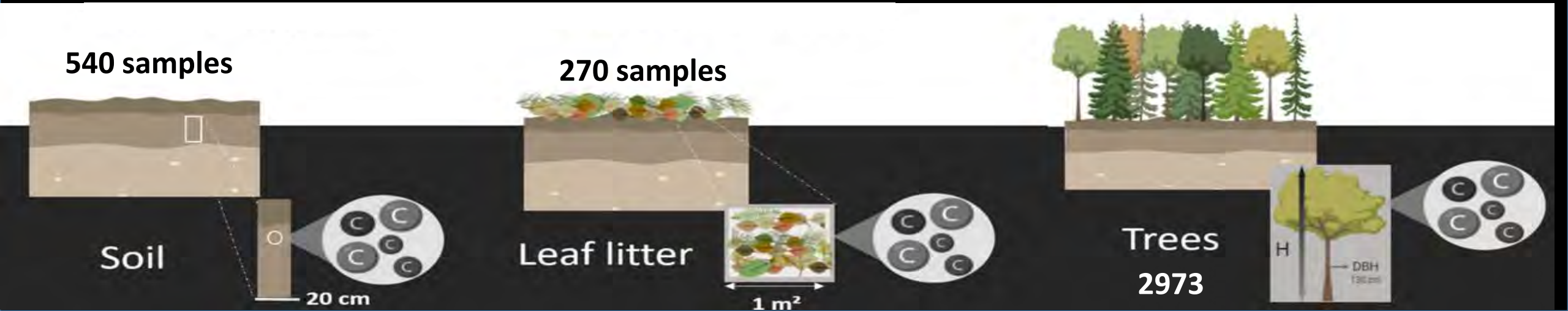
Woody debris

.Bulk Density
.Fisical and chemical parameters
Carbon

Carbono Total* (Mg C $ha^{-1}$) = Total Biomass** x Teor de C árvore***

* Above and below ground biomass (IPCC-Temperate)
**Species-specific allometric equations
(eg. Borges Silva *et al.*, 2018)

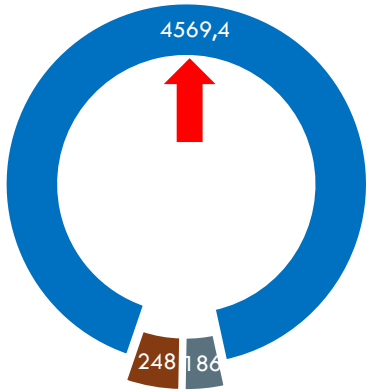
*** Default values (IPCC): Tempearte forest (48%)
Conifers (51%)



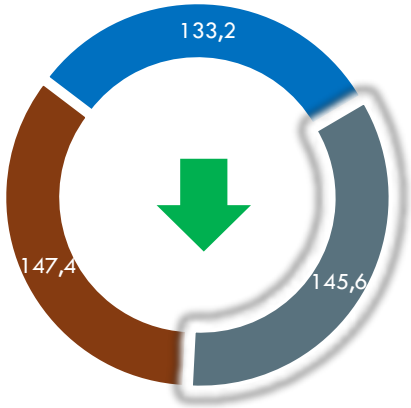
## Trees

(P<0.01) between forest types + Islands

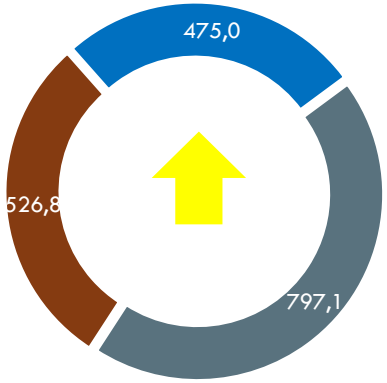
### Exotic Woodland




### Natural Forest

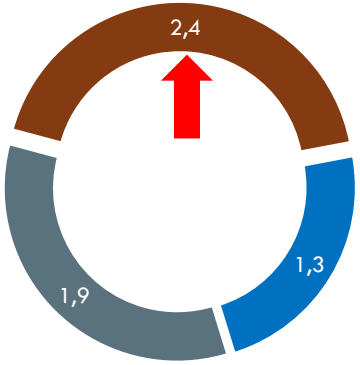


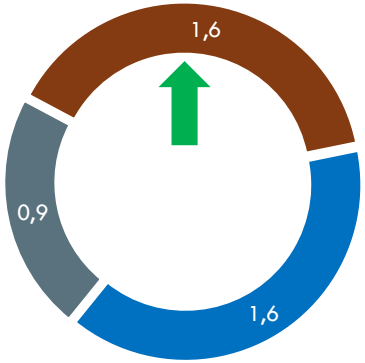

### Production Forest

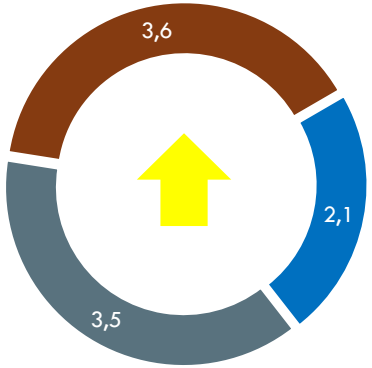



## Leaf

(P<0.01) between forest types + Islands

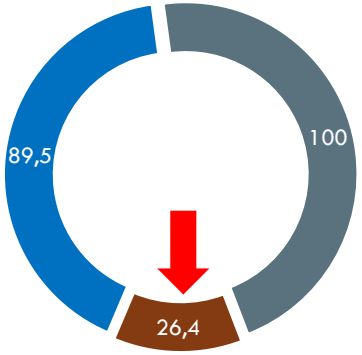


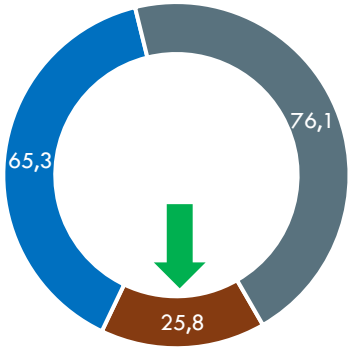



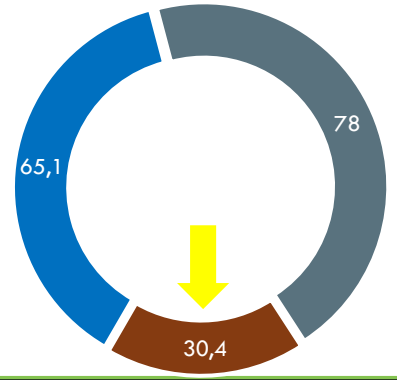




## Soil

(P<0.01) between islands




Islands:

- Pico
- S. Miguel
- Terceira

# Taxonomic Diversity

scientific reports Borges Silva et al., 2022

OPEN Taxonomic, structural diversity and carbon stocks in a gradient of island forests

Lurdes C. Borges Silva[1,2✉], Diogo C. Pavão[1,2], Rui B. Elias[3,4], Mónica Moura[1,2], Maria A. Ventura[1,2] & Luis Silva[1,2]

| Island | Taxa | | | | | | |
|---|---|---|---|---|---|---|---|
| | Endemic | | Native | | Exotic | | Total |
| | N | % | N | % | N | % | |
| São Miguel | 24 | 30 | 24 | 30 | 32 | 40 | 74 |
| Terceira | 20 | 41 | 17 | 35 | 12 | 24 | 45 |
| Pico | 30 | 44 | 26 | 38 | 12 | 18 | 62 |

**Table 1.** Plant species richness at the three types of forests sampled on three islands in the Azores archipelago. Endemic taxa only occurring in the Azores; Native taxa that colonized the Azores without human intervention, also occurring in other regions; and Exotic taxa that were intentionally or accidentally introduced by human activities[59].

- São Miguel ( for the 3 forest types), shown the highest number of taxa, although with the highest proportion of exotic elements.
- Pico Island forests, present high contribution of endemic and native taxa.

## Diversity Indices and Eveness

Local diversity - Effect of forest type

Effect of island and forest type

Evenness Effect of forest type

| Diversity | | Exotic Woodland | | | | | | Natural Forest | | | | | | Production Forest | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pico | | São Miguel | | Terceira | | Pico | | São Miguel | | Terceira | | Pico | | São Miguel | | Terceira | |
| α | m | 4.8 | a | 7.1 | a | 3.8 | a | 20.6 | b | 16.8 | b | 16.3 | b | 4.2 | a | 5.7 | a | 3.4 | a |
| | se | 0.5 | | 0.8 | | 0.3 | | 1.2 | | 2.6 | | 0.6 | | 0.5 | | 0.7 | | 0.4 | |
| β | m | 1.8 | a | 4.2 | bcd | 1.6 | a | 6.9 | e | 6.4 | de | 4.9 | cde | 2.2 | ab | 3.1 | abc | 2.4 | ab |
| | se | 0.3 | | 0.6 | | 0.3 | | 0.3 | | 0.9 | | 0.2 | | 0.3 | | 0.6 | | 0.5 | |
| γ | m | 6.6 | a | 11.3 | a | 5.4 | a | 27.5 | c | 23.2 | bc | 21.2 | b | 6.4 | a | 8.8 | a | 5.8 | a |
| | se | 0.8 | | 1.6 | | 0.4 | | 1.4 | | 3.1 | | 0.5 | | 0.7 | | 1.2 | | 0.9 | |
| H | m | 1.5 | abc | 1.9 | c | 1.3 | ab | 3.0 | d | 2.8 | d | 2.8 | d | 1.3 | ab | 1.6 | bc | 1.1 | a |
| | se | 0.1 | | 0.1 | | 0.1 | | 0.1 | | 0.2 | | 0.0 | | 0.1 | | 0.2 | | 0.1 | |
| E | m | 0.8 | cd | 0.8 | bcd | 0.8 | abc | 0.9 | d | 0.9 | d | 0.9 | d | 0.7 | ab | 0.8 | abc | 0.7 | a |
| | se | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 0.0 | | 0.0 | |

**Table 2.** Plant taxonomic diversity found at 90 forests in the Azores, from three islands (Pico, São Miguel, and Terceira) and three forest types (Exotic Woodland, Natural Forest, and Production Forest). Alpha, beta and gamma diversities, Shannon diversity (H) and Evenness (E). Mean and standard error for each diversity parameter. For each row, different letters indicate significant differences ($p < 0.05$) according to the results of a Tukey test applied after ANOVA.


Regarding taxonomic diversity, there was ample evidence that Natural forests harbored the highest plant diversity levels and Production forests the lowest.

**MODELANDIS GROUP**

# Regional Strategy for the Control and Prevention of Invasive Alien Species within the scope of the project "LIFE IP AZORES NATURA (LIFE17 IPE/PT/0000010)"

GOVERNO DOS AÇORES

Direção Regional do Ambiente e Alterações Climáticas

## Modelling the effects of climate change on the risk of expansion of seven invasive plant species in oceanic islands (Azores)

*Gunnera tinctoria* (Gunneraceae)

*Pittosporum undulatum* (Pittosporaceae)

*Hydrangea macrophylla* (Hydrangeaceae)

*Hedychium gardnerianum* (Zingiberaceae)


*Solanum mauritianum* (Solanaceae)

*Leycesteria formosa* (Caprifoliaceae)

*Arundo donax* (Solanaceae)

# Methodology

Data from GBIF

Data treatment
only georeferenced data
coordinate error < 1 km
registration < 30 years

Presences

Establishing geographic space occupied

Pseudo absences

Data set

Biomod 2
ensemble of multiple algorithms
(e.g. GLM,GAM, RF)

Climatic Modeling

Evaluation of climatic models

Climatic variables
19 Bioclimatic variables

Temperature + Precipitation
annual trends
seasonality
extreme/limiting
environmental factors

Worldclim (http://www.worldclim.org/).
Resol. 1km

World wide

(PCA tests) colinearity

Selection of climatic variables

Azores

CMIP6 Projections of Species Distribution

RCP 4.5 RCP 8.5

2021 -2040 | 2041-2060 | 2061-2080 | 2081-2100

| Taxa | TSS | AUC | Boyce |
|---|---|---|---|
| Gunnera tinctoria | 0.70 ± 0.024 | 0.92 ± 0.009 | 0.85 ± 0.113 |
| Hedychium gardnerianum | 0.92 ± 0.003 | 0.99 ± 0.001 | 0.98 ± 0.025 |
| Solanum mauritianum | 0.92 ± 0.004 | 0.99 ± 0.001 | 0.92 ± 0.072 |
| Leycesteria formosa | 0.61 ± 0.007 | 0.88 ± 0.004 | 0.99 ± 0,007 |
| Pittosporum undulatum | 0.90 ± 0.001 | 0.98 ± 0.002 | 0.97 ± 0,031 |
| Arundo donax | 0.87 ± 0.006 | 0.98 ± 0.001 | 0.99 ± 0,004 |
| Hydrangea macrophylla | 0.83 ± 0.006 | 0.97 ± 0.002 | 0.98 ± 0,022 |

Risk Groups

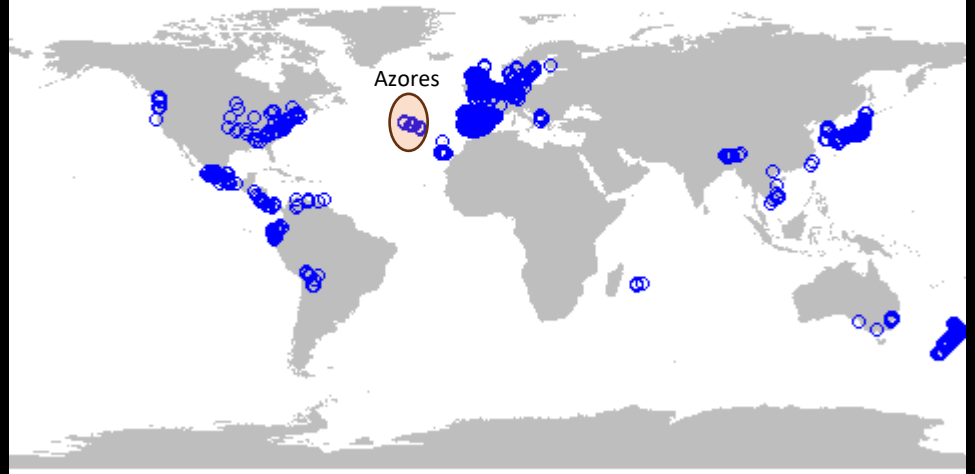
high risk
> 80%

Medium risk
50- 80%

lower risk
< 50%

# *Hydrangea macrophylla* (Thunb.) Ser.

GBIF occurence data




**Native (**Asia: China, Japan, Korea**) Invasive (**North Spain, NZ**)**

high risk
> 80%

**↑ probability of occurrence ( all scenarios, all islands, Natural Parks)**
**↑ values of habitat suitability (all scenarios, all islands)**

**Current Distribution (Azores)**


Preferential habitats: laurel forest, juniperus forests, margins of lakes, peat bogs, hedgerous along roads and agricultural trails (up to 1000 m altitude)

**MODELANDIS GROUP**

✓ **Colaborations**
- South Africa
- Czech Republic



✓ **Cleaning actions**

DIVERGE GROUP

# Azorean endemics

**Lower numbers of endemic plant species** in the Azores compared to other Macaronesian archipelagos such as, the Canary Islands.

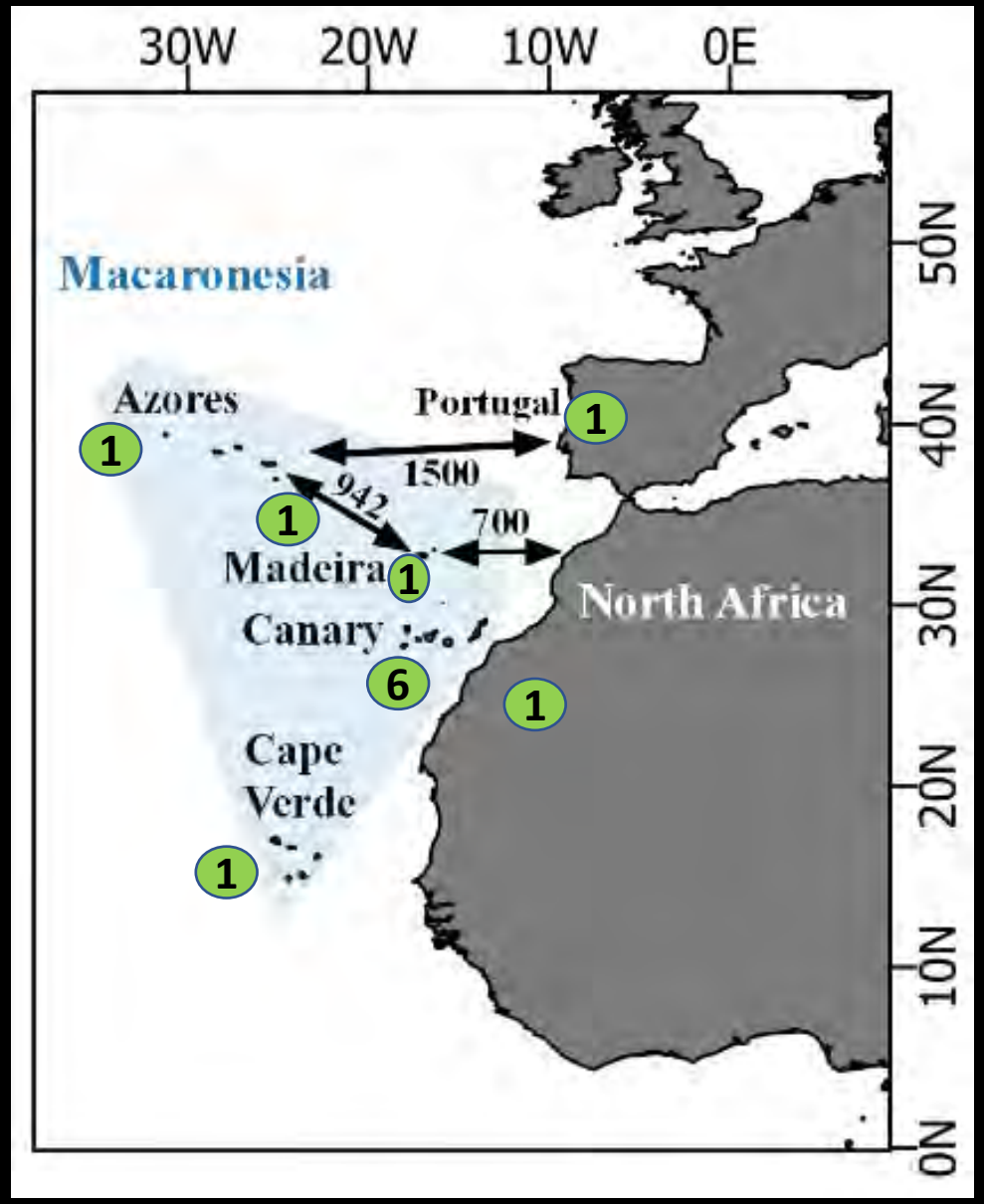
One potential cause of the perceived lower number of Azorean endemics is the **lack of detailed, multifaceted studies of morphological variation** and/or gene flow within and among different Azorean lineages.

Morphological and molecular studies of several genera have suggested that **more species should be recognized** than were included in the floristic review of the Azores.

( Mónica Moura and Luís Silva )

**DIVERGE GROUP**

Genus *Tolpis* is remarkable biogeographically because, most of these species are Macaronesian endemics.




Jarvis (1980), recognized that 10 of the 12 species

Genus *Tolpis* morphological characters:

- usually anual or perenial
- herbaceous
- rosulate leaves
- capitula arranged in corymbs or panicles
- yellow florets, styles short
- cypselas possess long pappus setae
- Coastal vegetation, higher altitude

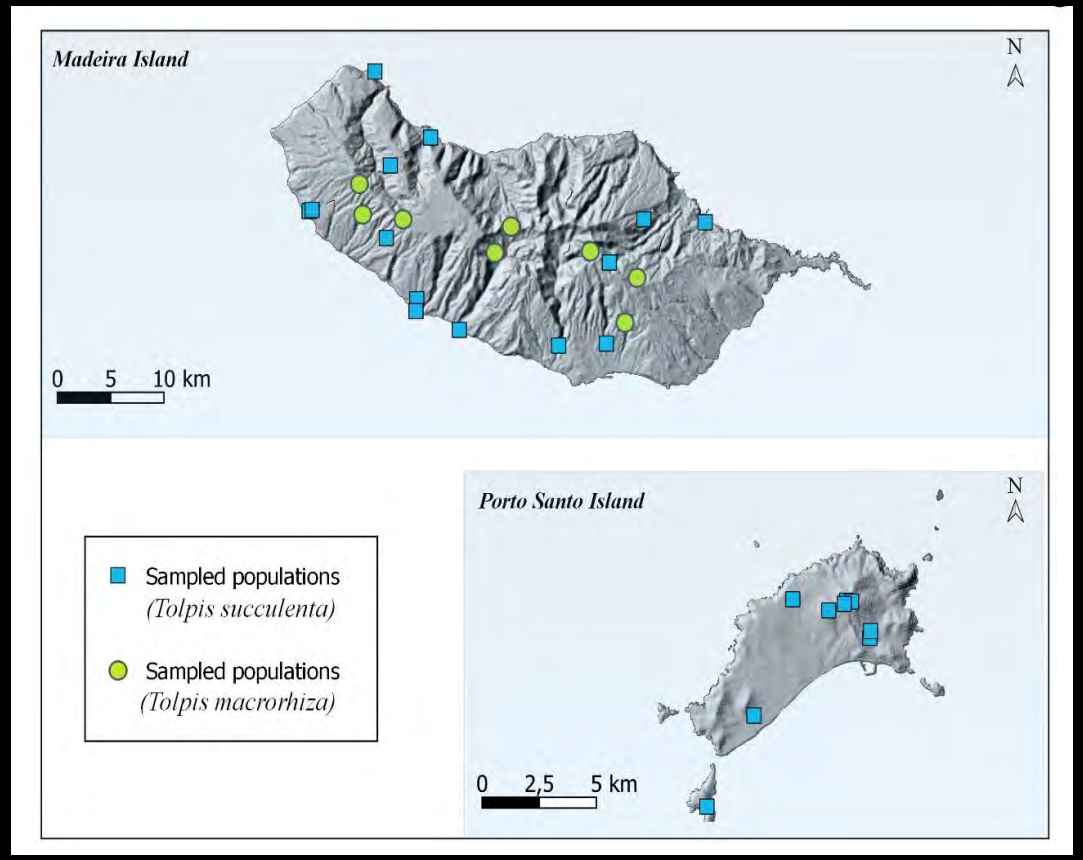
**DIVERGE GROUP**

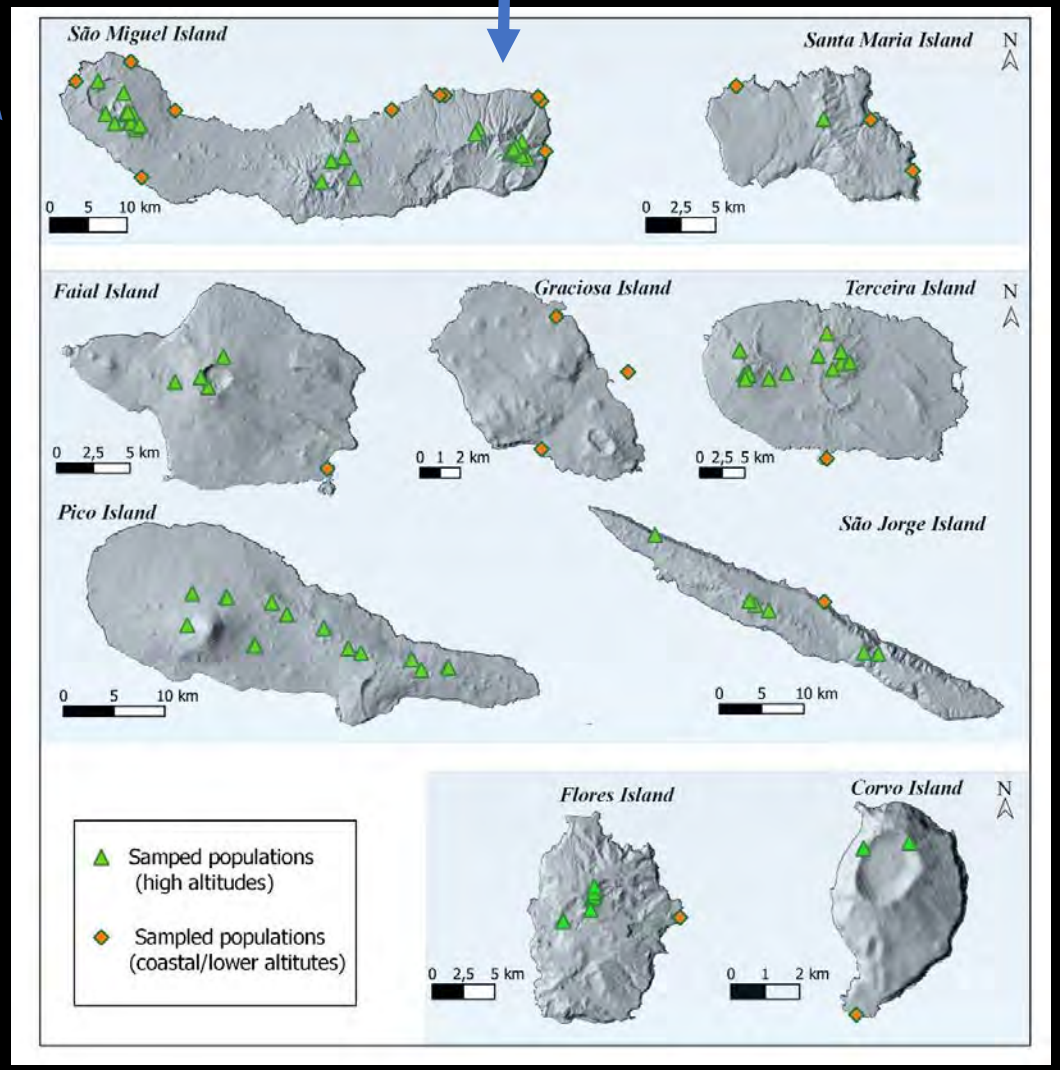
# Genus *Tolpis* Madeira and Azores (until now)

*Tolpis macrorhiza*

*Tolpis succulenta (sensu lato)*

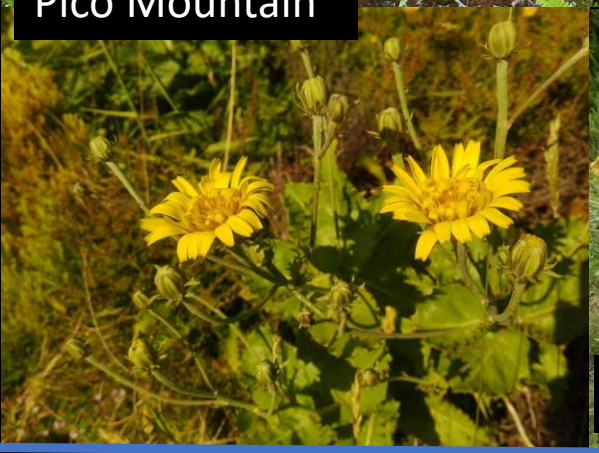
*Tolpis azorica (sensu lato)*



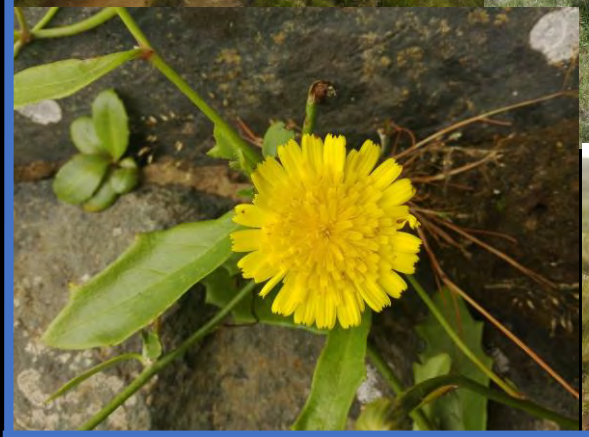
# Genus *Tolpis*


Pico Mountain




Terceira-St. Bárbara


São Miguel Island





Flores-Morro Alto

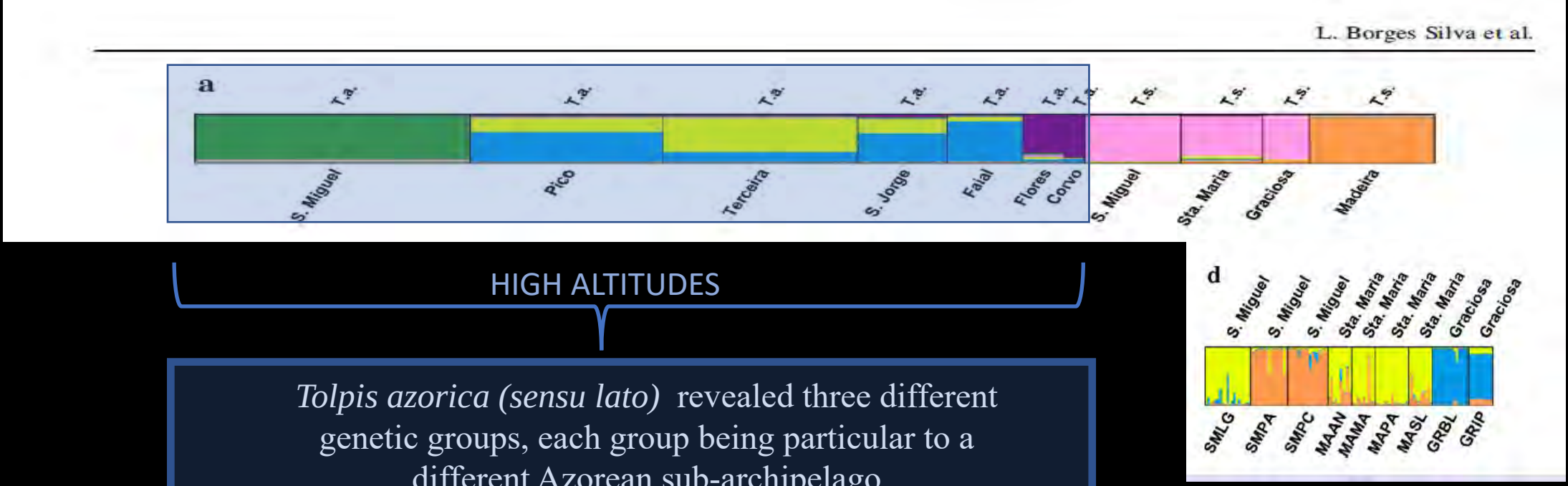

Graciosa Island


São Miguel Island

**DIVERGE GROUP**

# *Borges Silva et al., 2012 & 2016 (SSRs)*

Bayesian analysis performed with STRUCTURE




HIGH ALTITUDES

*Tolpis azorica (sensu lato)* revealed three different genetic groups, each group being particular to a different Azorean sub-archipelago

COASTAL /LOWER ALTITUDES

*Tolpis succulenta (sensu lato)* confirmed the occurrence of a differential grouping between individuals from Azores and Madeira populations

**DIVERGE GROUP**

Plant Syst Evol
DOI 10.1007/s00606-015-1267-1

ORIGINAL ARTICLE

**Borges Silva et al. 2015**

## Master Thesis

### Understanding intra and inter-archipelago population genetic patterns within a recently evolved insular endemic lineage

L. Borges Silva[1] · J. Sardos[2] · M. Menezes de Sequeira[3] · L. Silva[1] · D. Crawford[4] · M. Moura[1]

Plant Syst Evol
DOI 10.1007/s00606-015-1210-5

ORIGINAL ARTICLE

**Crawford et al. 2015**

### Breeding systems in *Tolpis* (Asteraceae) in the Macaronesian islands: the Azores, Madeira and the Canaries

Daniel J. Crawford[1] · Gregory J. Anderson[2] · Lurdes Borges Silva[3] · Miguel Menezes de Sequeira[4] · Mónica Moura[3] · Arnoldo Santos-Guerra[5] · John K. Kelly[6] · Mark E. Mort[1]

Plant Systematics and Evolution
https://doi.org/10.1007/s00606-019-01573-7

ORIGINAL ARTICLE

**Crawford et al. 2019**

### The transition to selfing in Azorean *Tolpis* (Asteraceae)

Daniel J. Crawford[1] · Mónica Moura[2] · Lurdes Borges Silva[2] · Mark E. Mort[3] · Benjamin Kerbs[3] · Hanno Schaefer[4] · John K. Kelly[3]

**Crawford et al. 2016**

### Breeding Relationships in Macaronesian *Tolpis* (Asteraceae-Cichorieae): $F_1$ Hybrid Pollen Fertility Within and Among Populations from the Azores, Canary Islands, and Madeira

Author(s): Daniel J. Crawford, Donald P. Hauber, Lurdes Borges Silva, Miguel Menezes de Sequeira, Mónica Moura, Arnoldo Santos-Guerra, John K. Kelly, and Mark E. Mort

ORIGINAL RESEARCH

**Crawford et al. 2020**

### How rapidly do self-compatible populations evolve selfing? Mating system estimation within recently evolved self-compatible populations of Azorean *Tolpis succulenta* (Asteraceae)

Benjamin Kerbs[1] | Daniel J. Crawford[1,2] | Griffin White[1,3] | Mónica Moura[4] | Lurdes Borges Silva[4] | Hanno Schaefer[5] | Keely Brown[1] | Mark E. Mort[1] | John K. Kelly[1]

RESEARCH ARTICLE

**Mort et al. 2022**

### Multiplexed shotgun genotyping (MSG) data resolve phylogenetic relationships within and among archipelagos in Macaronesian *Tolpis*

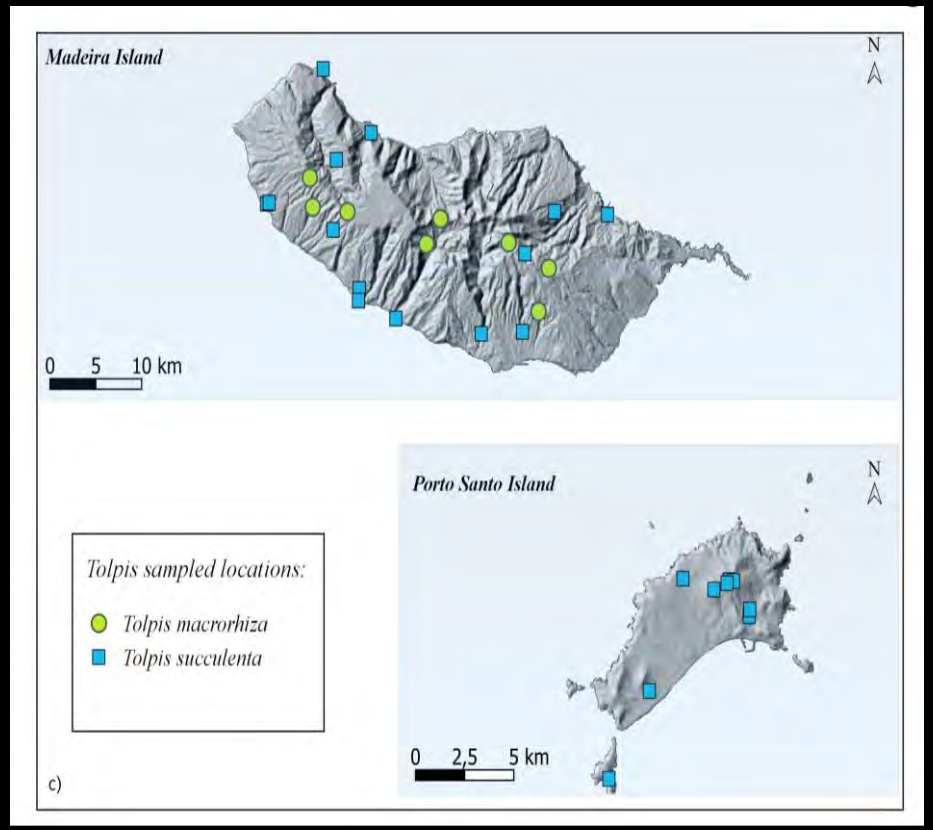
Mark E. Mort[1] | Benjamin R. Kerbs[1] | John K. Kelly[1] | Lurdes Borges Silva[2] | Mónica Moura[2] | Miguel Menezes de Sequeira[3,4] | Arnoldo Santos-Guerra[5] | Hanno Schaefer[6] | J. Alfredo Reyes-Betancort[7] | Juli Caujapé-Castells[8] | Daniel J. Crawford[1,9]

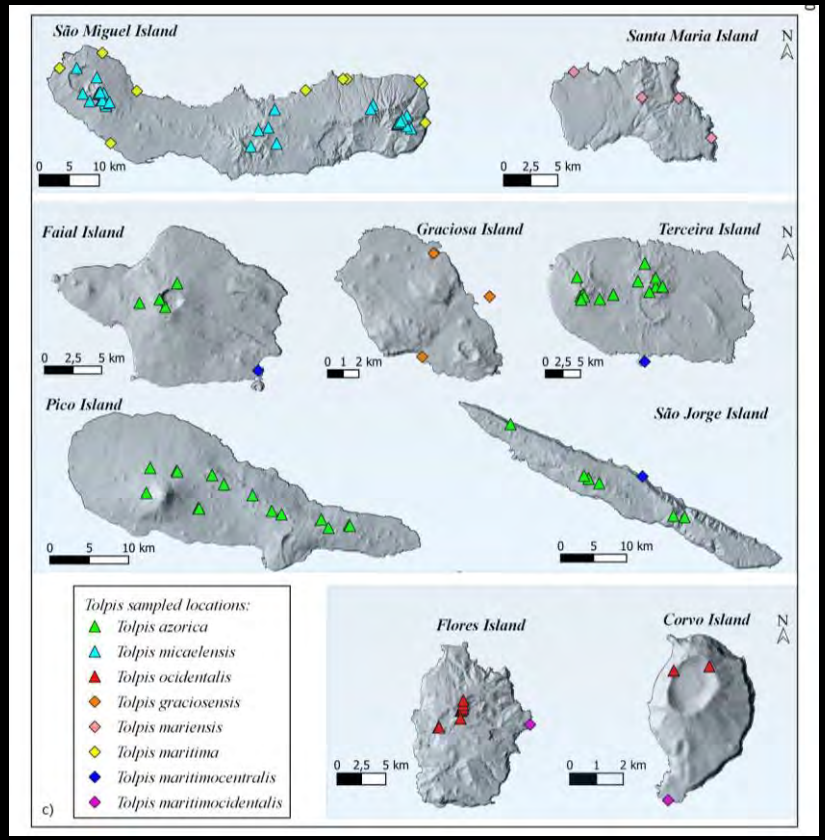

**Taxonomic reassessment of Tolpis (Asteraceae) in the Azores and Madeira archipelagos with description of 7 new species**

## Morphological Measurements

**Seventy-six quantitative and qualitative morphological characters, from a total of 349 specimens corresponding to 122 populations. (9 Azores islands + 2 Madeira islands)**

Here we propose **a taxonomic and nomenclatural revision** of the Azorean *Tolpis* species, including **seven new** species never before described for the archipelago.

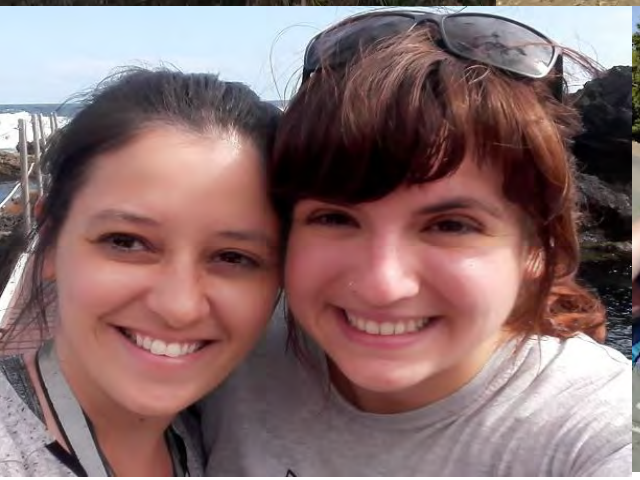




# Acknowledgements

*Thank you for all!*





FOREST ECO²

INSTITUTO SUPERIOR DE AGRONOMIA
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UNIVERSIDADE DOS AÇORES

cE3c
centre for ecology, evolution and environmental changes

AÇORES 2020
PROGRAMA OPERACIONAL
FEDER FSE

GOVERNO DOS AÇORES

PORTUGAL 2020

UNIÃO EUROPEIA
Fundo Europeu de Desenvolvimento Regional

InBIO
REDE DE INVESTIGAÇÃO em Biodiversidade e Biologia Evolutiva

CIBIO
Centro de Investigação em Biodiversidade e Recursos Genéticos

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Fundação Gaspar Frutuoso

eef European Ecological Federation

SPECO
SOCIEDADE PORTUGUESA DE ECOLOGIA

*“Transfer of skills and capacity building”*

The BIOPOLIS project:

- ✓ funded European H2020 Teaming program;
- ✓ aims to transform the CIBIO research laboratory in Porto into a Center of Excellence for Research, in the fields of biodiversity, agrobiodiversity and ecosystem services;
- ✓ the University of Montpellier as a partner, support the BIOPOLIS research center in this skills transfer project.

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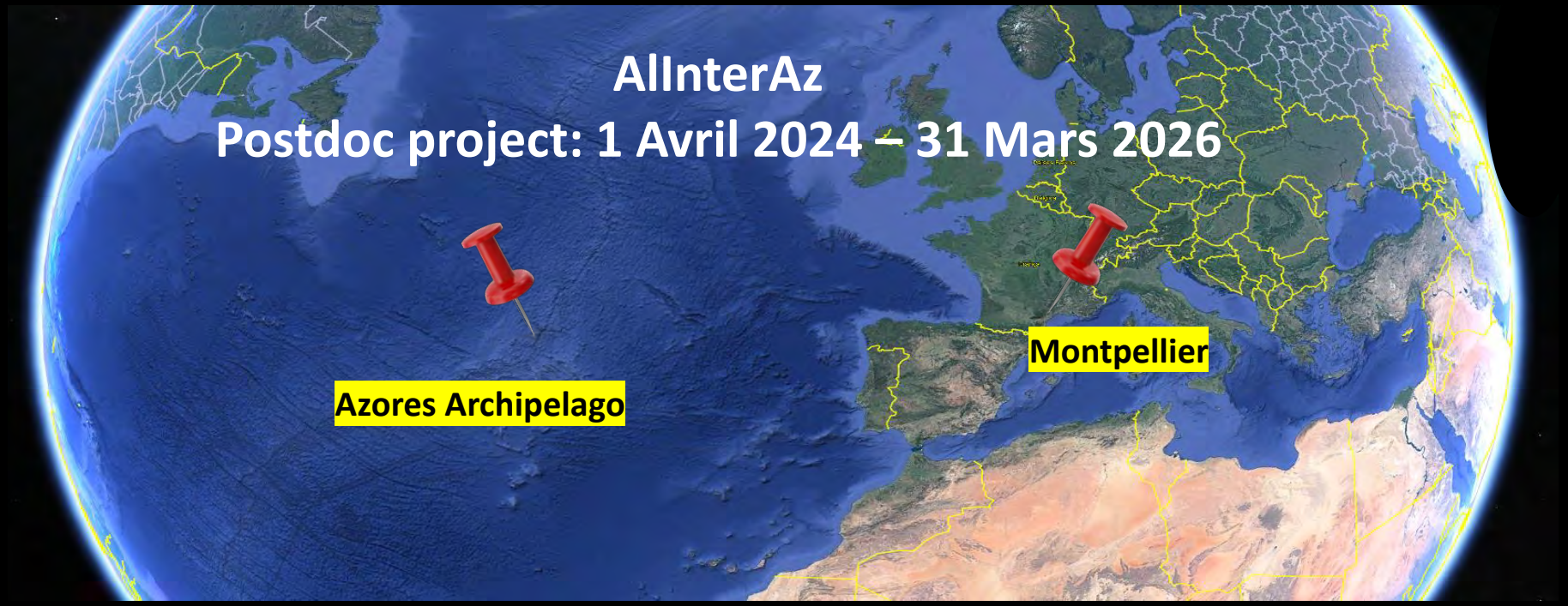
# ‘Close encounters in Atlantic islands’ - Unravelling arthropod-alien plant multitrophic interactions in the Azores islands




Team: Denise NAVIA ; Luís SILVA, Carole KERDELHUE; Jean-Pierre ROSSI, Jean-Claude STREITO, Alian MIGEON, Phillipe AUGER, Emmanuelle JOUSSELIN, Marie-Stephane TIXIER, Armelle COEUR D'ACIER, Eric PIERRE, Lurdes BORGES SILVA.

# AllInterAz

## Multitrophic interactions involving terrestrial arthropods

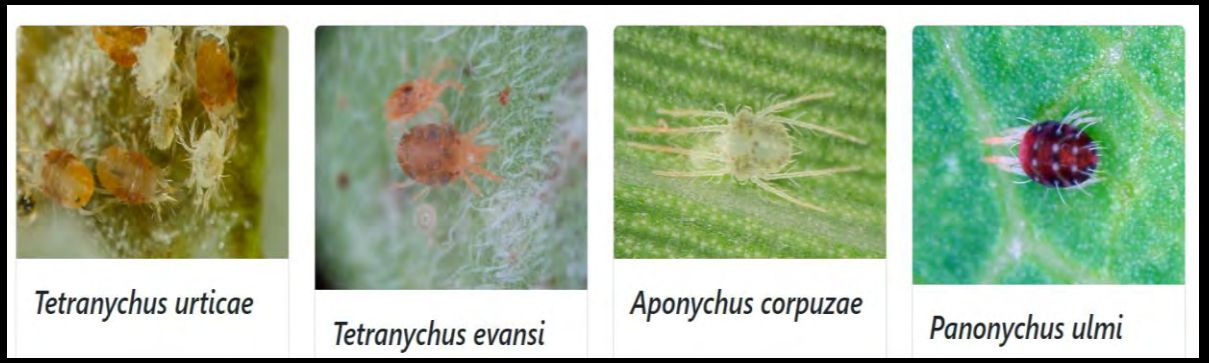
**Phytophagous and its associated Predators/parasitoids**

### Hemipterous

© INRAE, Jean-Claude Streito

https://ephytia.inra.fr/

### Mites




https://www1.montpellier.inra.fr/CBGP/spmweb/index.php

**Alien plants (invasive or not) and close related plants (or phenotypically similar)**

# AlInterAz

## Alien plants (invasive or not) and close related plants (or phenotypically similar)

*Gunnera tinctoria*
(Gunneraceae)

*Pittosporum undulatum*
(Pittosporaceae)

*Hydrangea macrophylla*
(Hydrangeaceae)

*Hedychium gardnerianum*
(Zingiberaceae)

*Laurus nobilis*
Lauraceae

*Solanum mauritianum* (Solanaceae)

*Leycesteria formosa* (Caprifoliaceae)

*Arundo donax* (Solanaceae)

*Laurus azorica*
Lauraceae

Along a gradient of increasing anthropogenic impact in the Azores archipelago

**Coastal vegetation**
**Disturbed areas**

**Mountain forests**
**Disturbed areas**

Terra Nostra Garden
*Camelia Japonica* (Theaceae)

**Old Orange Crops**

**A - Arhtropod communities associated with alien plants:**

**1-Do alien plants present in the Azores island host alien herbivore arthropods and what is the associated diversity (including natural enemies)?**
**2-Have endemic phytophagous arthropods adapted to invasive plants in the Azores islands and what is the associated diversity?**

**B - Tritrophic interactions (host plants-phytophagous-predators/parasitoids):**
**1) Are tritrophic interactions similar on alien & endemic/naturalized host plants?**
**2) Do the arthropods that successfully colonized the exotic plants exhibit high genetic diversity? What is the distribution of the genetic diversity of the phytophagous species that successfully colonized alien plants in the Azores?**
**3) Are ecosystem traits affecting interactions?**
**4) Do ecosystem anthropogenic influences affect communities and its multitrophic interactions and how?**

**C- On ecological services provided by arthropods:**
**1) What regulation service offer the local phytophagous in terms of invasive plant management? 2) Could some arthropod species be managed to help on invasive plant management? (an approach of conservation biological control).**

**D- On biosecurity issues:**
**1) Are there biosecurity issues regarding invasive arthropods present for the Azores (expansion), Portugal and other areas in Europe (invasion)?**

# AllInterAz

**Two main actions**

## Action 1 (Exploratory 1st year )

Taxonomic characterization of arthropods communities, associated with invasive plants in the Azores (at species/genus levels).

- ✓ Azores Field Expeditions ( 1st | 23 april - 6 may )
- ✓ Morphological analysis
- ✓ DNA bardocing/Phylogenetic analysis

## Action 2 (2nd year)

Ecological studies

Unravelling genetic diversity and ecosystem factors influencing interactions in arthropod communities associated with alien plants in the Azores

*Detailed planning of this action will depend on **Action I** results

# *“Transfer of skills and capacity building”*

**BIOPOLIS project**

**BIOISLE and UMR CBGP colaboration**

- ✓ a ‘new compartment’ for the CIBIO-Azores research line on plant invasion ecology;
- ✓ increase CIBIO skills in functional group analysis;
- ✓ enhancing the knowledge of the Azorean diversity ;
- ✓ the enrichment of reference entomological and acarological collections in Portugal and France;
- ✓ better targeting of the areas and plants to be monitored as part of the early detection of biological invasions.

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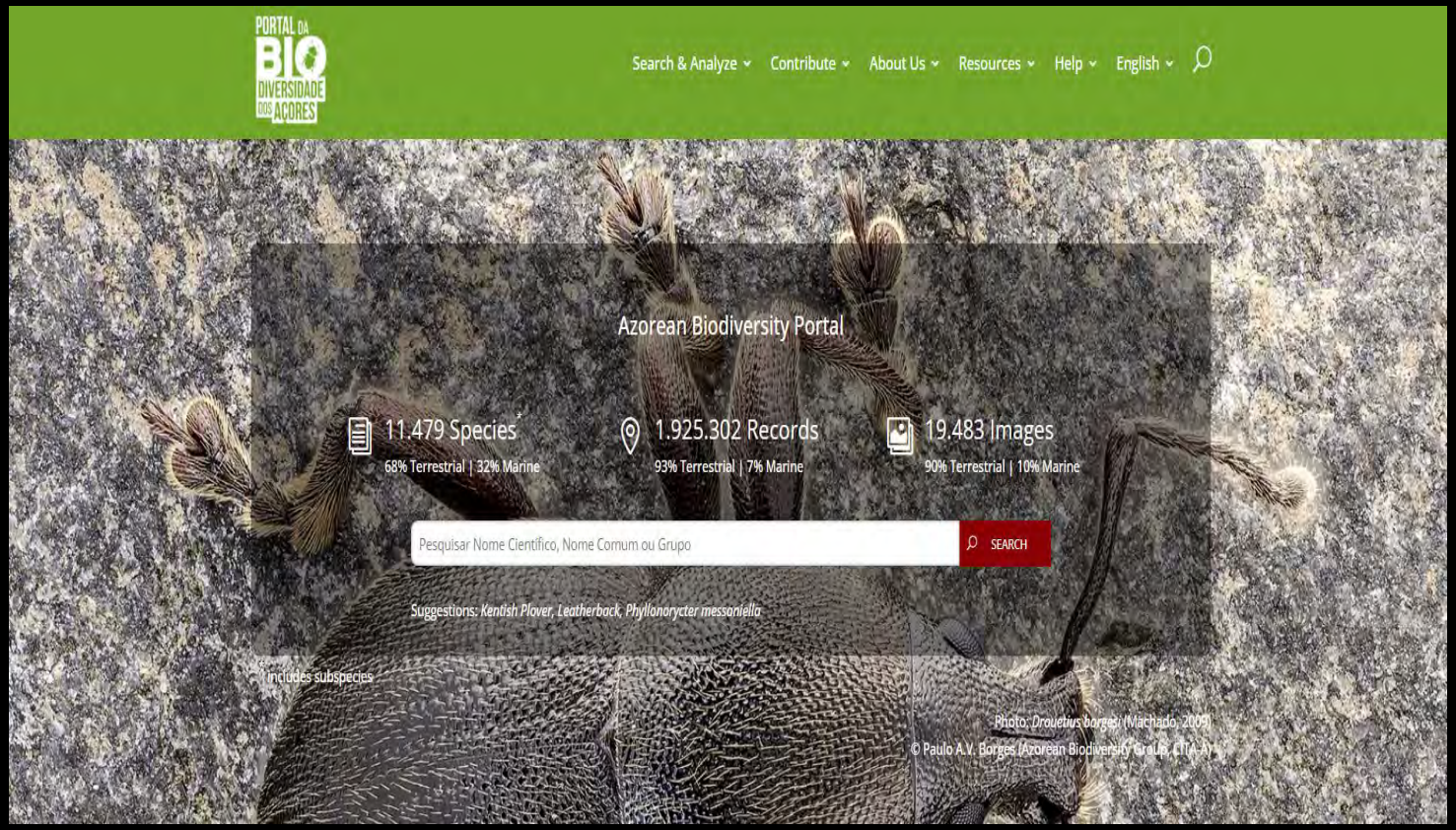
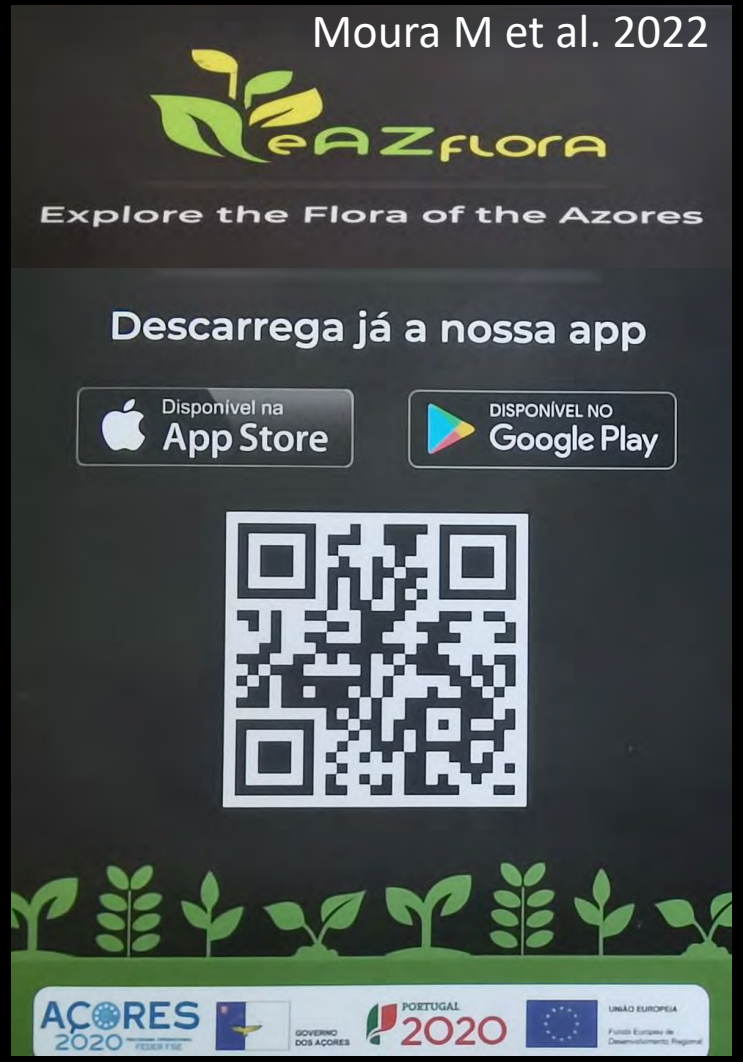
# Azorean Biodiversity Platforms




https://azoresbioportal.uac.pt

Moura M et al. 2022



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# Merci beaucoup

CIBIO Centro de Investigação em Biodiversidade e Recursos Genéticos

Centre for Biology and Management of Populations
CBGP
Centre de Biologie pour la Gestion des Populations

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InBIO RESEARCH NETWORK
Biodiversity and Evolutionary Biology

INRAE

GASPAR FRUTUOSO FUNDAÇÃO

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BIOPOLIS