



# 1º Workshop Técnico A Conservação da Flora Endémica 1st Technical Workshop – The Conservation of Endemic Flora

## The conservation of the flora in the Canary Islands: examples from the genus *Lotus*

Dr. Juli Caujapé-Castells

Jardín Botánico Canario “Viera y Clavijo”- Unidad Asociada al CSIC  
IUCN-SSC Macaronesian islands plant specialist group

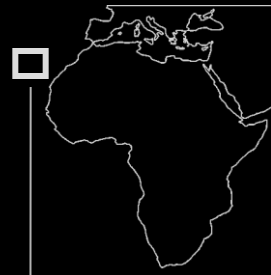


Photo credits: Felicia Oliva-Tejera and Juli Caujapé-Castells

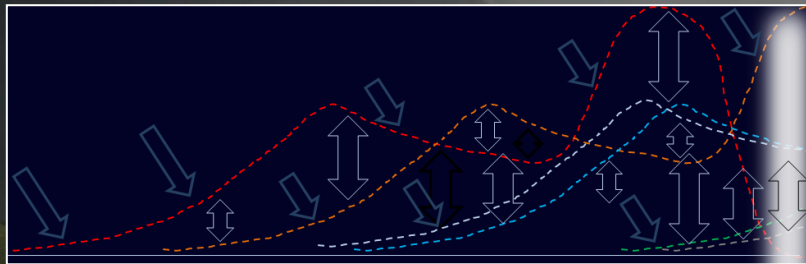


# Conservation is difficult when everything is constantly taking shape



## Caujapé-Castells et al. 2017

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



## EVOLUTION IN ACTION

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



# Conservation is difficult when everything is constantly taking shape

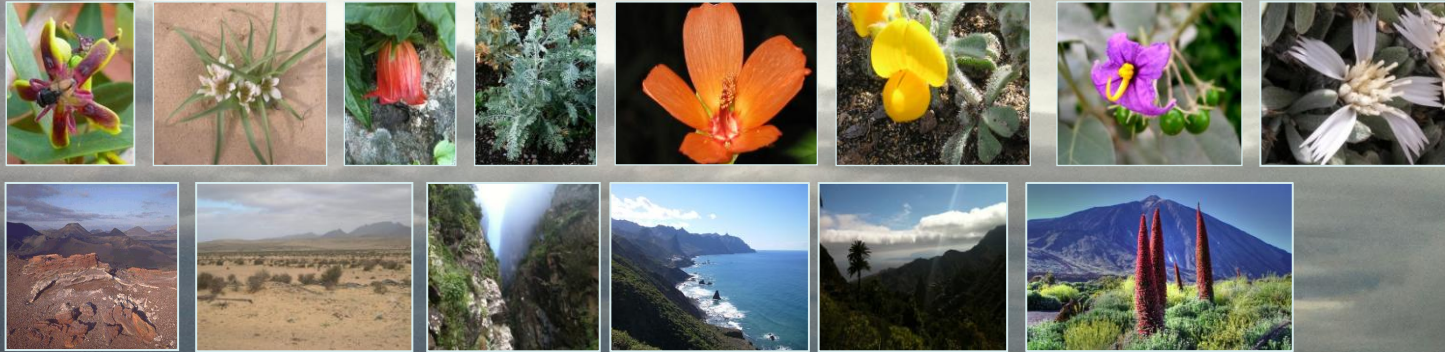
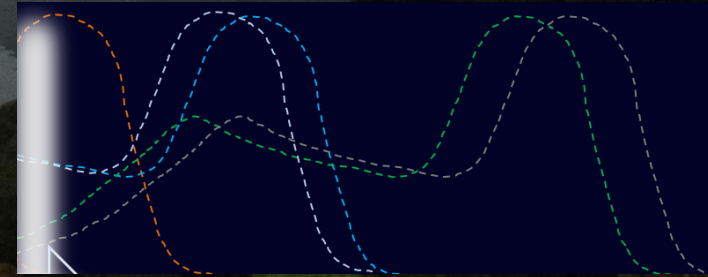


Photo credits: Felicia Oliva-Tejera and Juli Caujapé-Castells



## CONSERVATION IMPLICATIONS

- *In situ* conservation efforts should avoid artificial mixed reinforcements (islands within islands) and watch over artificial fragmentation effects, BUT ALSO
- Strive to maintain connectivity, so that adaptation to changes can be fostered to generate the endemics of the future, as it was throughout the past.

# Starting today till.....who knows?

The bio-geographical traits that generated a great diversity in the past ... are the same ones that now constitute a threat in a context of rapid, human-mediated change

- Woodiness (72%, Aldridge 1972)
- High proportion of self-incompatible species
- NATURAL isolation and fragmentation

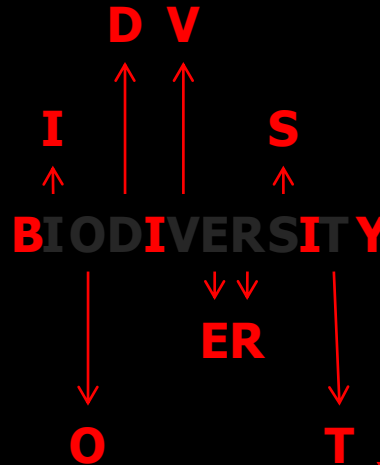


**INVASIVES**

**Global changes**

**Short time of adaptation**

**Major habitat losses**



Decrease of population sizes

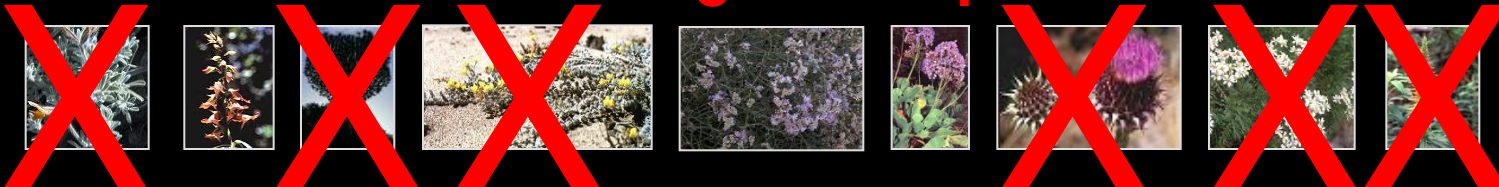
Loss of mutualisms

Genetic diversity loss

Reproductive problems

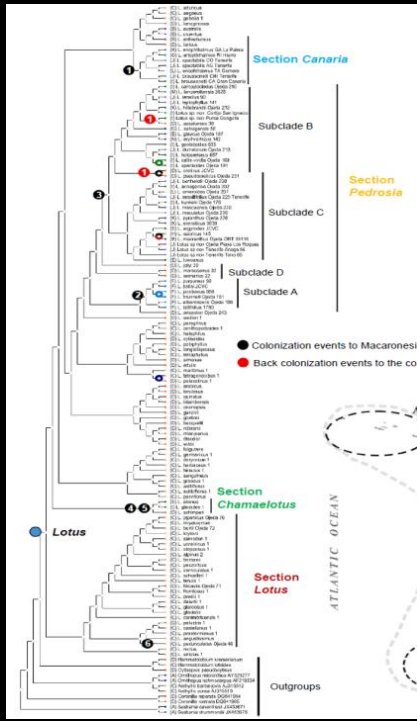
Highest threats for:

- All endemics
- Single-island endemics
- Woody plants
- Coastal biodiversity
- Summit biodiversity





# The genus *Lotus* in Macaronesia



Molecular Phylogenetics and Evolution 154 (2021) 106970

Contents lists available at ScienceDirect

**Molecular Phylogenetics and Evolution**

journal homepage: [www.elsevier.com/locate/ympev](http://www.elsevier.com/locate/ympev)

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

Ruth Jaén-Molina<sup>a,\*</sup>, Águedo Marrero-Rodríguez<sup>a</sup>, Juli Caujapé-Castells<sup>a</sup>, Dario I. Ojeda<sup>b</sup>

<sup>a</sup> Jardín Botánico Canario "Viera y Clavijo"-Unidad Asociada CSIC, Cabildo de Gran Canaria, Las Palmas, Gran Canaria, Spain  
<sup>b</sup> Norwegian Institute of Bioeconomy Research, Høgskoleveien 5, 1433 Ås, Norway

- **Multiple founder events**
- **Very dynamic inter- and intra-island colonization**
- **Independent colonizations of the same island, followed by hybridization**
- **Multiple habitat shifts**
- **Progression rule rejected:**
  - Colonization of older islands from younger ones
  - Mainland back-colonization



# Canarian endemic *Lotus* (sect. *Pedrosia*) (Oliva-Tejera et al. 2005)

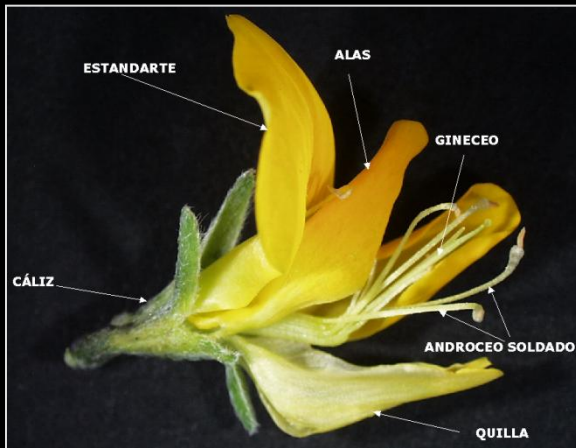
- 7 taxa (so far...)
- High morphological and genetic variation
- Probably associated with independent colonizations of Gran Canaria followed by hybridization
- Taxonomic confusion

Heredity (2005) 94, 199–206  
© 2005 Nature Publishing Group All rights reserved 0018-067X/05 \$30.00  
www.nature.com/hdy

Population genetic differentiation in taxa of *Lotus* (Fabaceae: Loteae) endemic to the Gran Canarian pine forest

F Oliva-Tejera<sup>1</sup>, J Caujapé-Castells<sup>1</sup>, J Naranjo-Suárez<sup>1</sup>, J Navarro-Déniz<sup>1</sup>, JR Acebes-Ginovés<sup>2</sup> and D Bramwell<sup>1</sup>

Photo credits: Felicia Oliva-Tejera







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© 2005 Nature Publishing Group All rights reserved 0018-067X/05 \$30.00  
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## Could a combination of morphological and molecular data help us circumscribe taxonomic relationships?

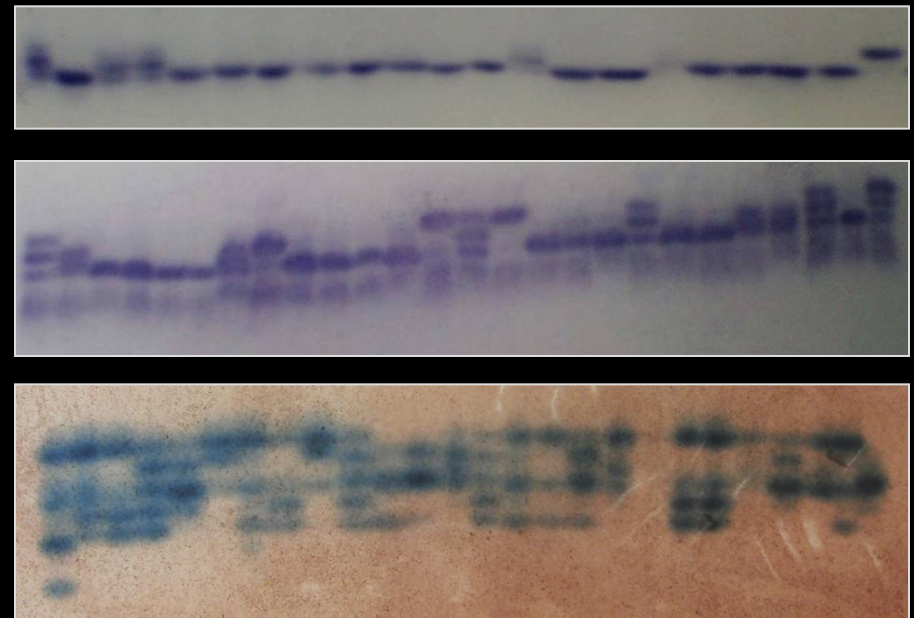
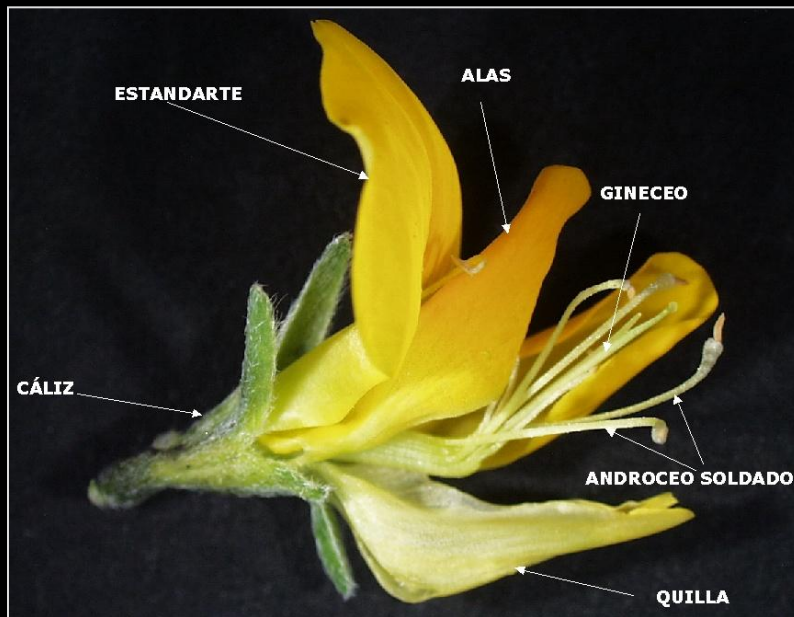


Photo credits (*Lotus* flower): Felicia Oliva-Tejera



# Canarian endemic *Lotus* (sect. *Pedrosia*) (Oliva-Tejera et al. 2005)

La Palma

Lanzarote

La Gomera

Fuerteventura

Tenerife

Gran Canaria

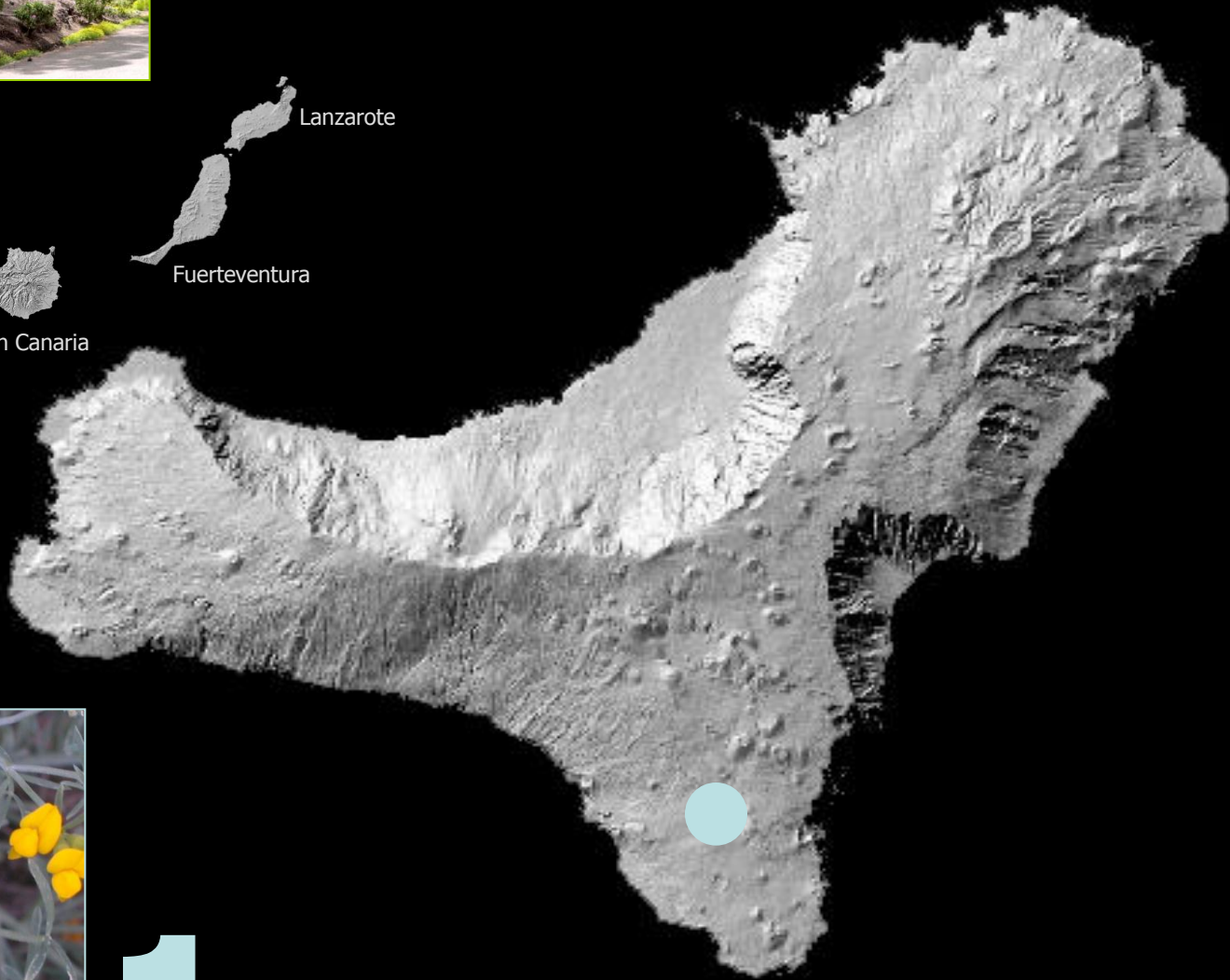
# El Hierro

Photo credits: Felicia Oliva-Tejera



# 1

● *Lotus sp*







# Canarian endemic *Lotus* (sect. *Pedrosia*) (Oliva-Tejera et al. 2005)



Photo credits: Felicia Oliva-Tejera



◆ *Lotus hillebrandii*

2



# Canarian endemic *Lotus* (sect. *Pedrosia*) (Oliva-Tejera et al. 2005)

La Palma

Lanzarote

La Gomera

Fuerteventura

El Hierro

Gran Canaria

# Tenerife

Photo credits: Felicia Oliva-Tejera



# 2

 *Lotus campylocladus*





# Canarian endemic *Lotus* (sect. *Pedrosia*) (Oliva-Tejera et al. 2005)

La Palma



La Gomera



Tenerife



El Hierro



Lanzarote



Fuerteventura

# Gran Canaria

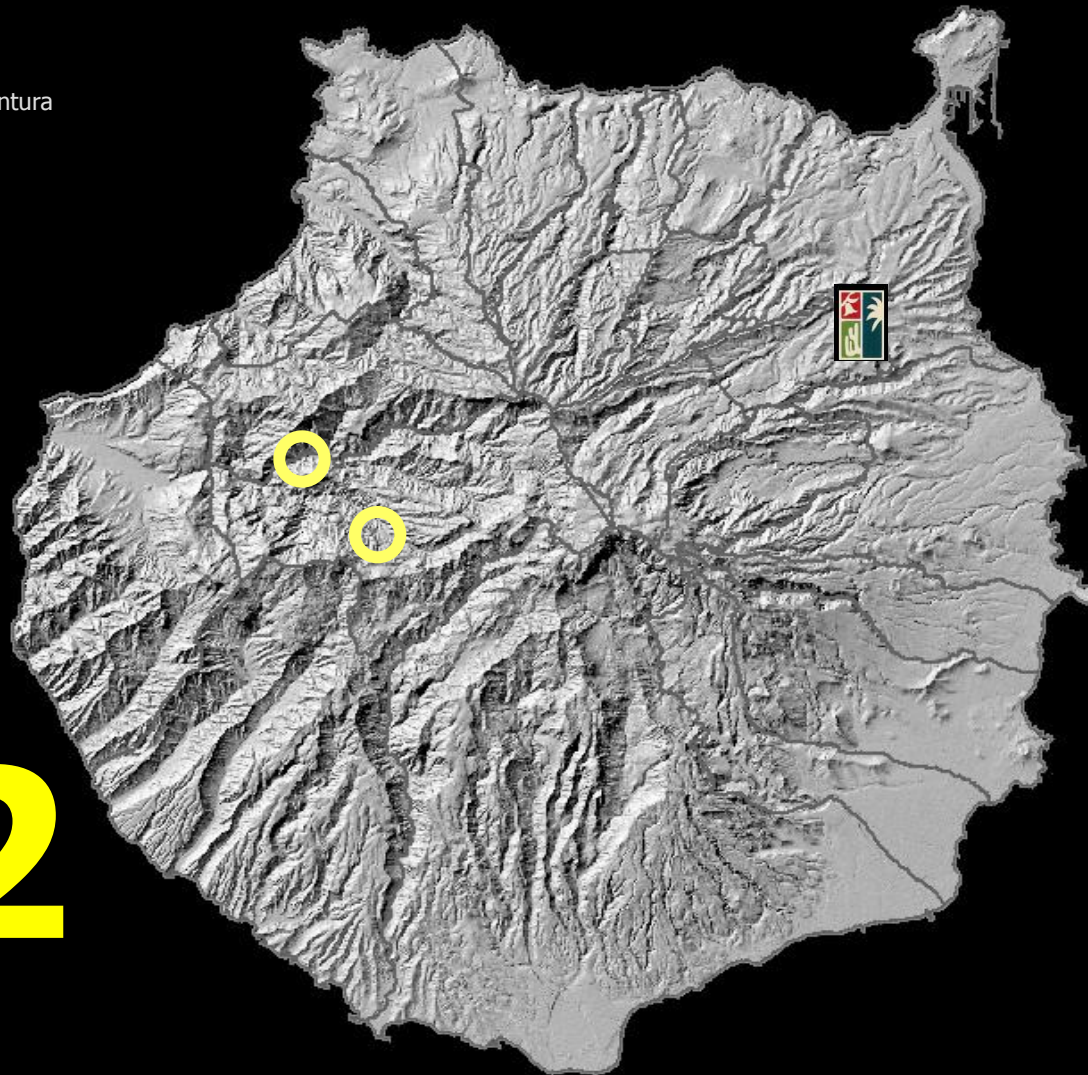


Photo credits: Felicia Oliva-Tejera



# 2

○ *Lotus spartioides*





# Canarian endemic *Lotus* (sect. *Pedrosia*) (Oliva-Tejera et al. 2005)

# Gran Canaria

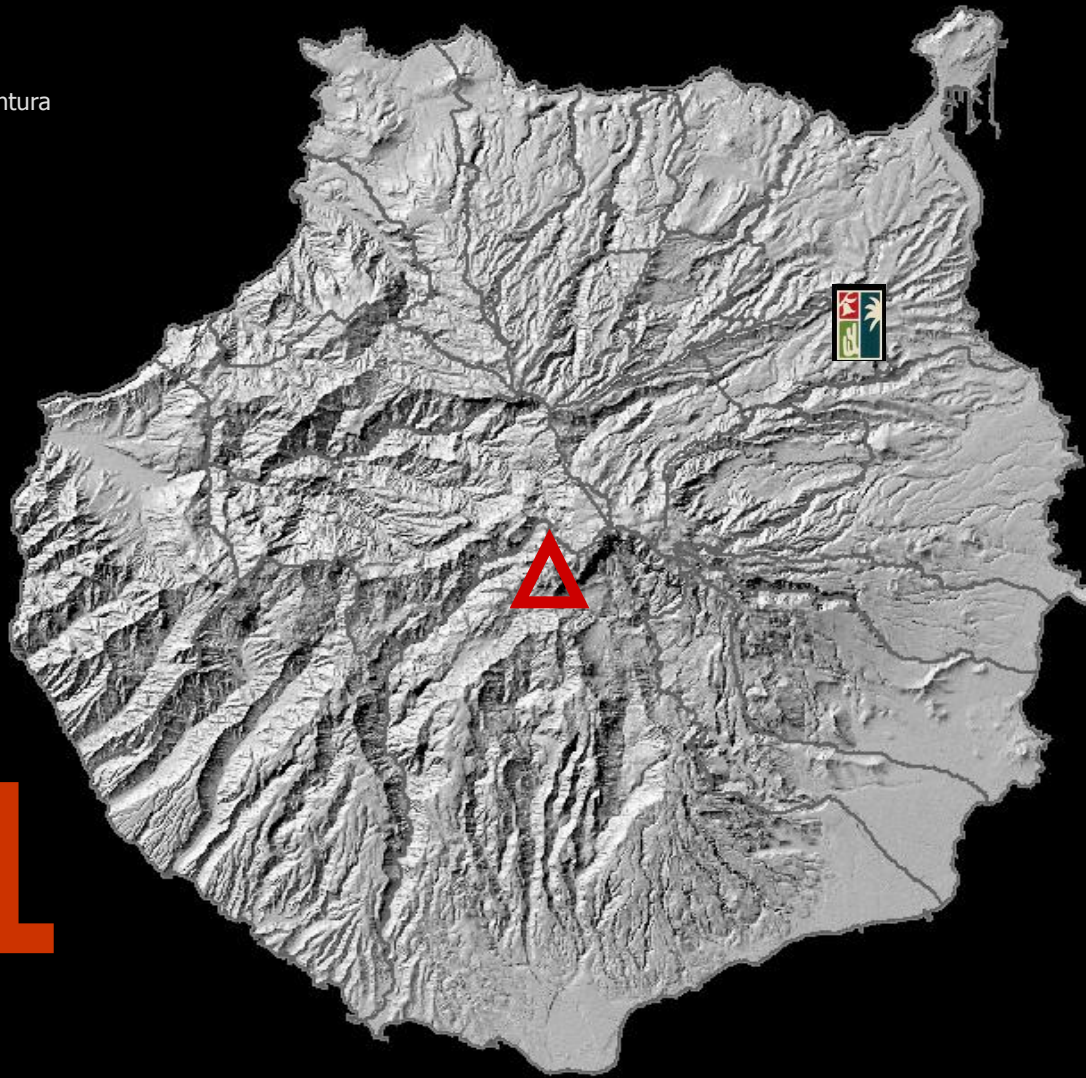
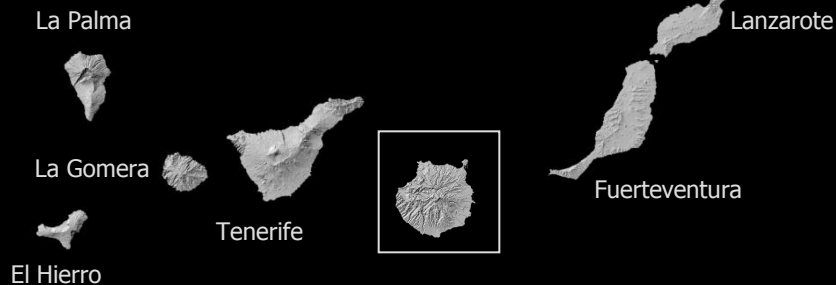


Photo credits: Felicia Oliva-Tejera



# 1

 *Lotus genistoides*





# Canarian endemic *Lotus* (sect. *Pedrosia*) (Oliva-Tejera et al. 2005)

# Gran Canaria

La Palma

Lanzarote

La Gomera

Fuerteventura

Tenerife

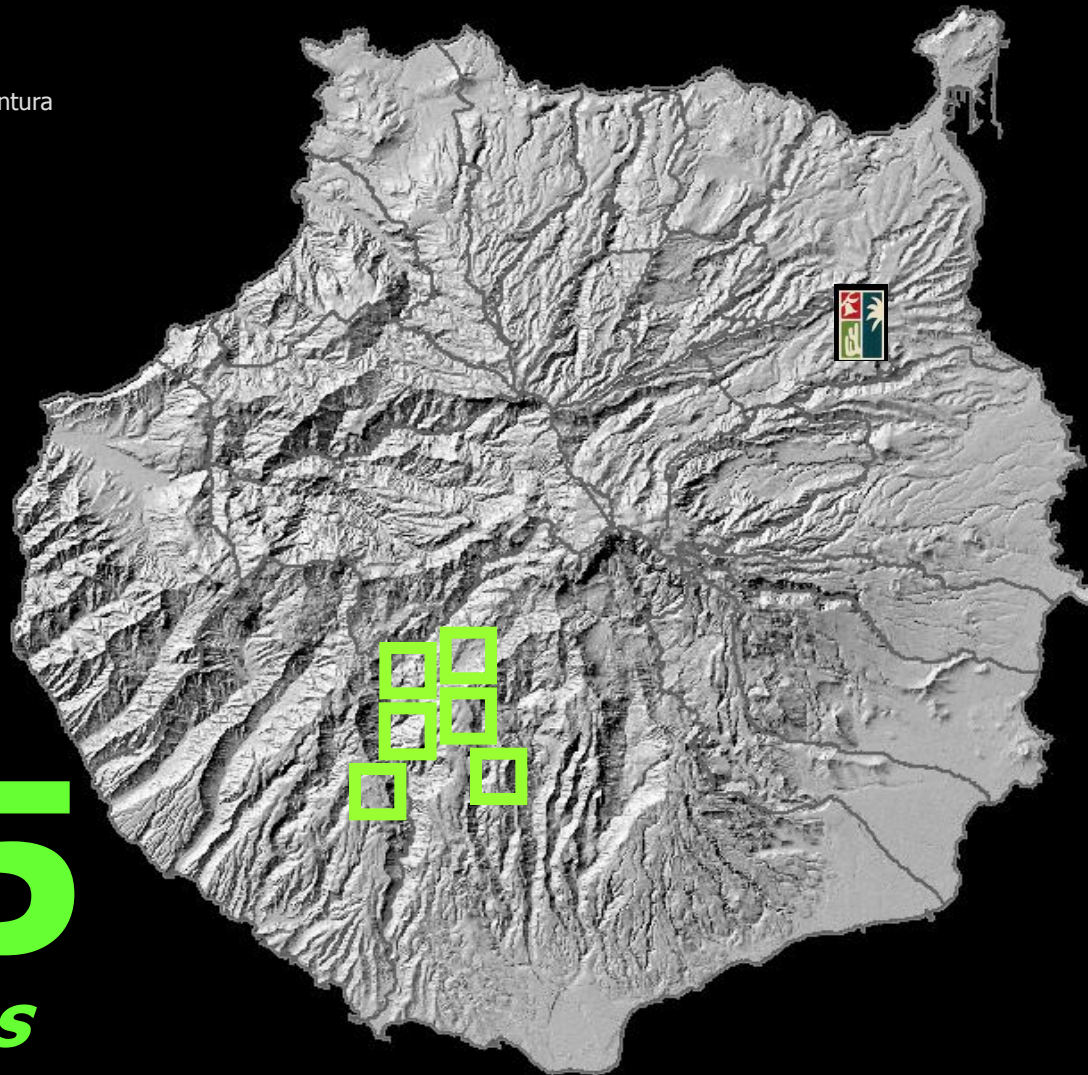
El Hierro

Photo credits: Felicia Oliva-Tejera



# 5

□ *Lotus holosericeus*







# Canarian endemic *Lotus* (sect. *Pedrosia*) (Oliva-Tejera et al. 2005)

La Palma

Lanzarote

La Gomera

Fuerteventura

Tenerife

El Hierro

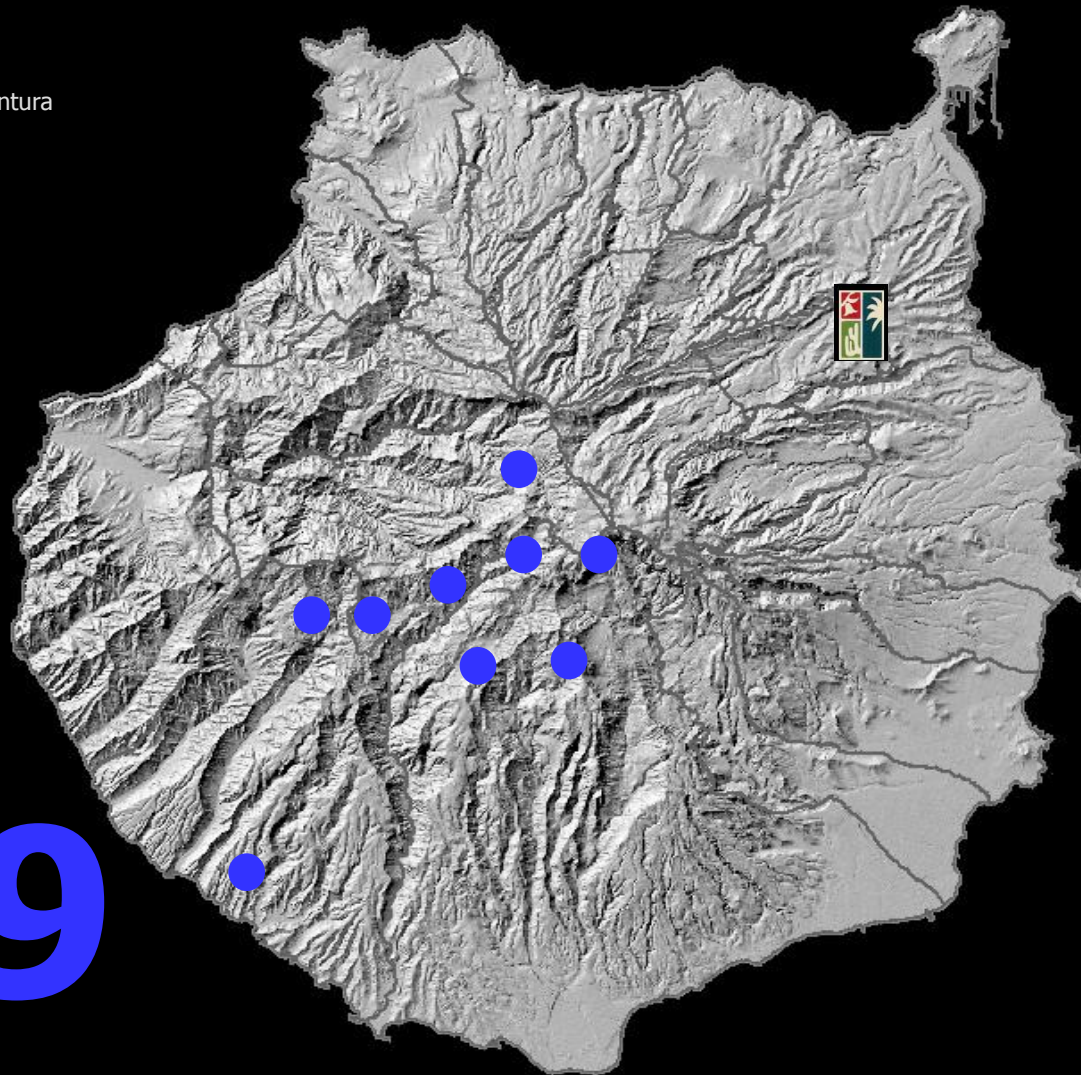
# Gran Canaria

Photo credits: Felicia Oliva-Tejera



# 9

• *Lotus sp*





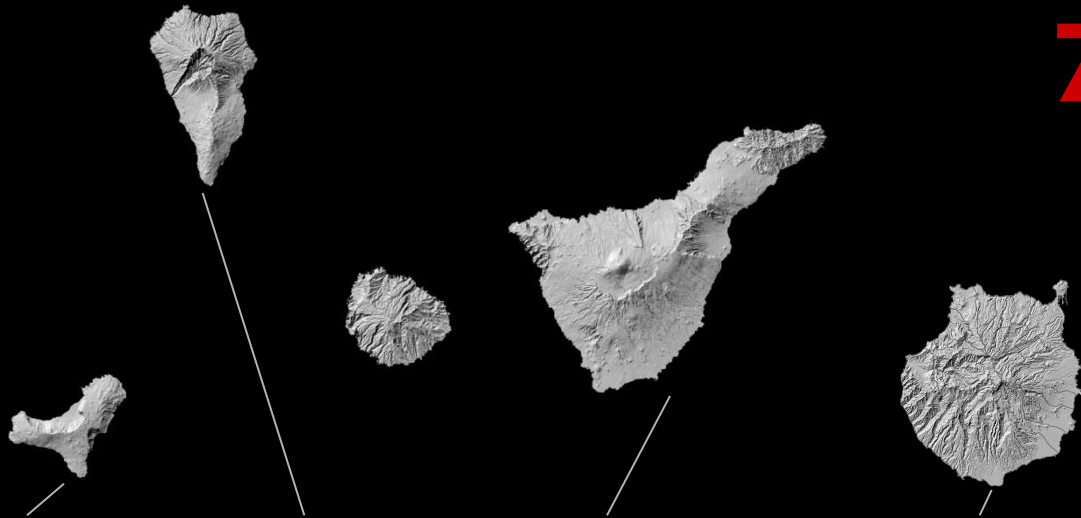


Sampling totals — **1,108** individuals

(Oliva-Tejera et al. 2005 and unpubl. data)

**29** populations

**7** taxa



**El Hierro**

**La Palma**

**Tenerife**

**Gran Canaria**



**49**

**99**

**54**

**906**

individuals

**1**

**2**

**2**

**24**

populations

**1**

**1**

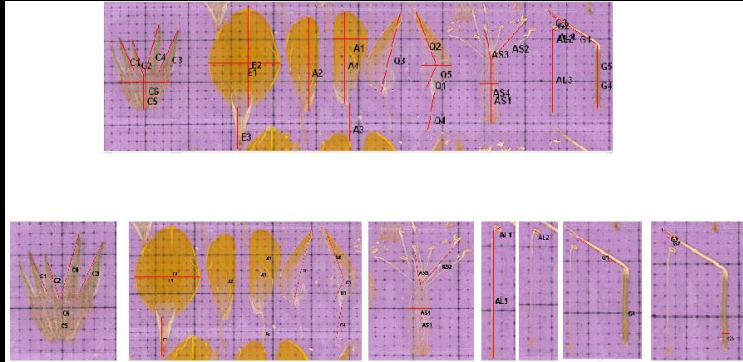
**1**

**6**

taxa

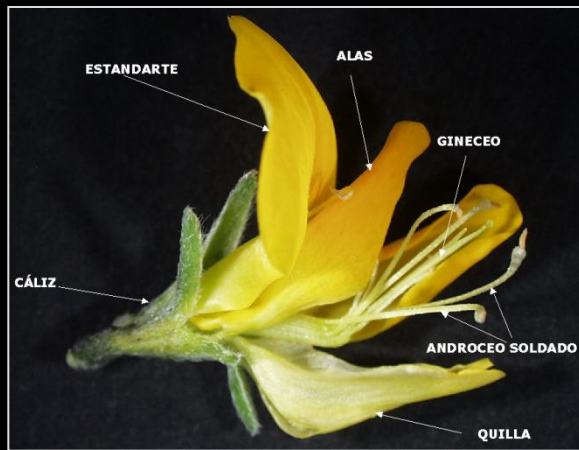
# Protocol (morphology)

(Oliva-Tejera et al. unpubl. data)

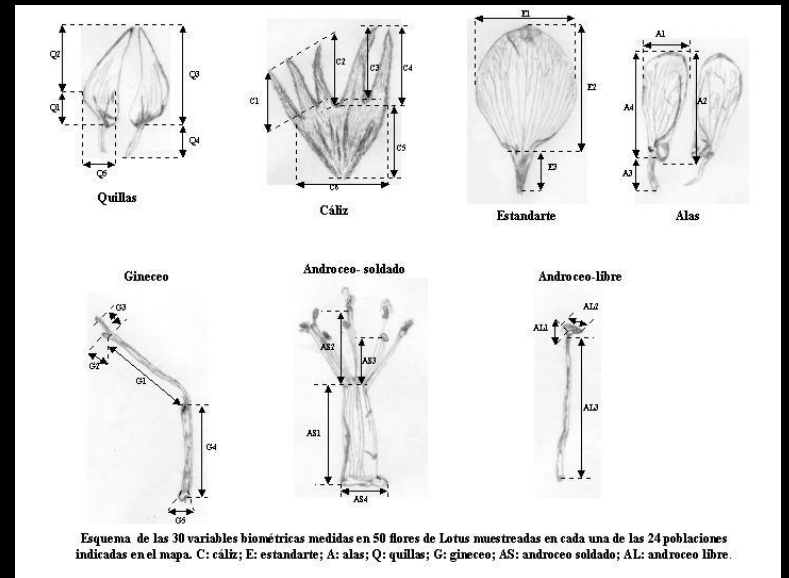


Dissection and mounting

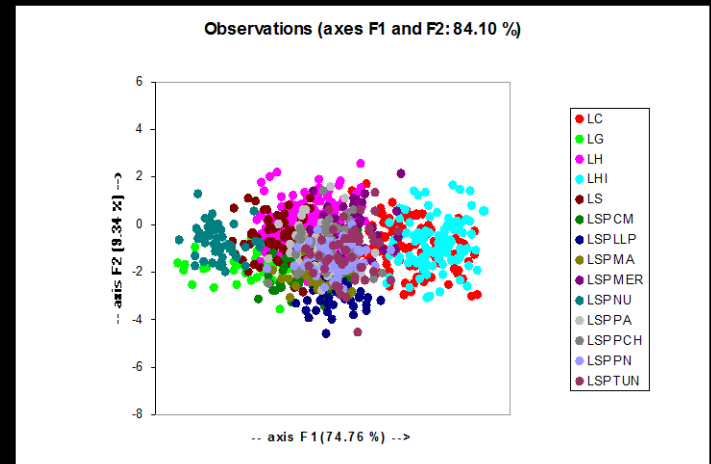
Photo credits: Felicia Oliva-Tejera



1,100 flowers



Computer-assisted measurement of 30 variables

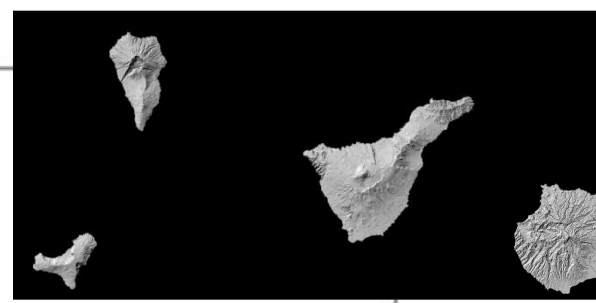
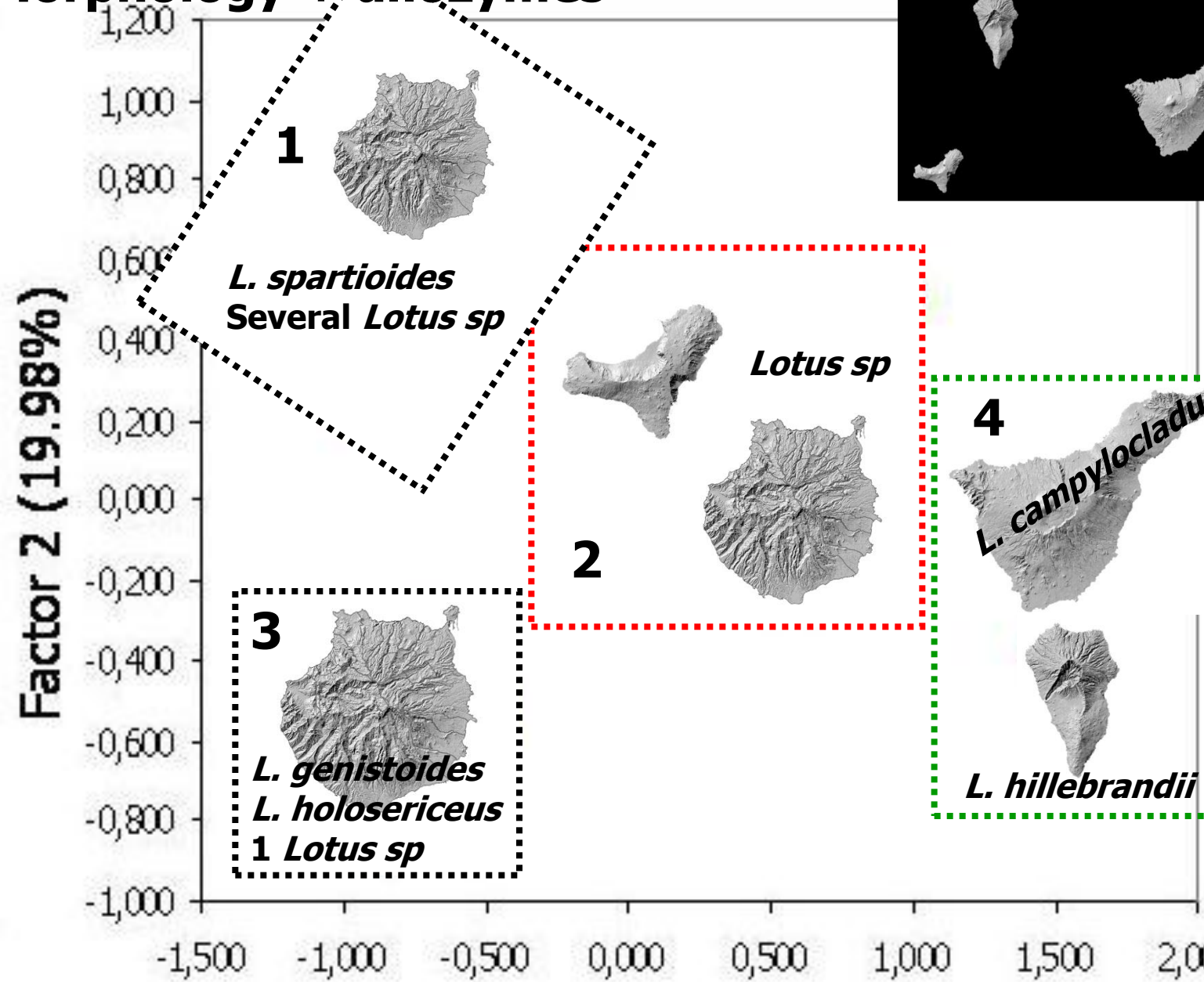


PCA & Discriminant analysis



# PCA Morphology + allozymes

- ◆ LSTA
- LSBE
- LHPI
- × LHRO
- \* LHAR
- LHPP
- + LHCU
- LHTE
- LGCJ
- ◆ LCTAU
- LCREA
- ▲ LHICUM
- LHIFUE
- × LSPNU
- LSPCM
- LSPMA
- LSPPA
- LSPPN
- ◆ LSPPCH
- LSPTUN
- ▲ LSPLL
- × LSPMER



**Factor 1 (53.46%)**



# Canarian endemic *Lotus* (sect. *Pedrosia*)

(Oliva-Tejera et al. 2005)

&

(Oliva-Tejera et al. unpubl. data)

Population genetic differentiation in taxa of *Lotus* (Fabaceae: Loteae) endemic to the Gran Canarian pine forest

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- There are discrepancies between morphological and genetic data
- Allozymes offered much more discrimination than morphology
- Combining both kinds of data allows meaningful insight:

*L. genistoides* should be included within *L. holosericeus*

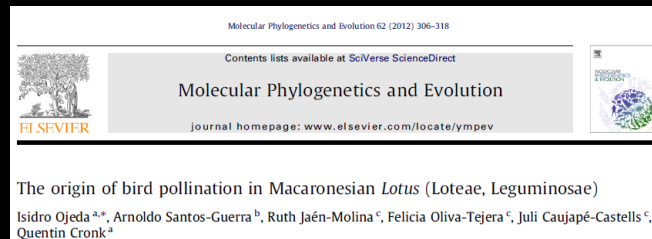
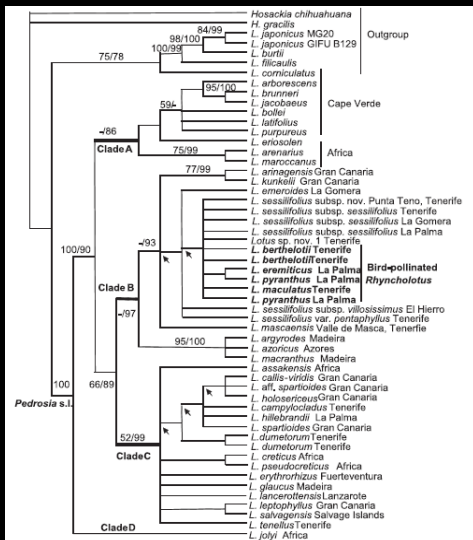
*L. campylocladus* (from Tenerife) and *L. hillebrandii* (from La Palma) are closely related

The **8 *Lotus* sp from Gran Canaria** are a heterogeneous group:

4 of them are closer to taxa from other islands than to Gran Canarian ones

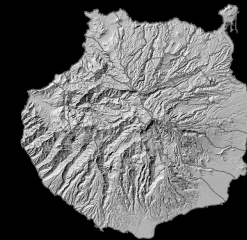
3 of them group with *Lotus spartioides* (Gran Canaria)

1 of them is closer to *Lotus holosericeus* (Gran Canaria)



(Ojeda et al. 2012)

- 4 nuclear regions
- 3 plastid regions



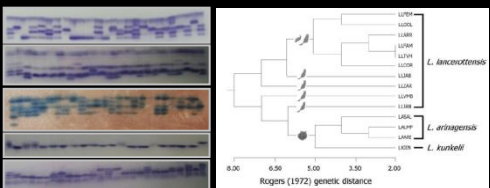
- Multiple origins confirmed
- Dynamic within-island migration
- Very likely followed by hybridization



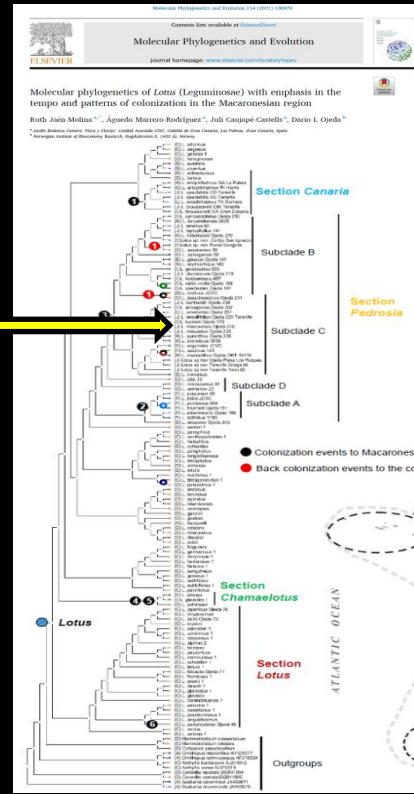
# The case of *Lotus kunkelii*: A holistic conservation plan

Photo credits: Felicia Oliva-Tejera and Jardín Botánico "Viera y Clavijo"

American Journal of Botany 93(8): 1116-1124, 2006.  
**PATTERNS OF GENETIC DIVERGENCE OF THREE CANARIAN ENDEMIC *LOTUS* (FABACEAE): IMPLICATIONS FOR THE CONSERVATION OF THE ENDANGERED *L. KUNKELII***  
 FELICIA OLIVA-TEJERA,<sup>2</sup> JULI CAUJAPÉ-CASTELLS,<sup>2,5</sup> JOSEFA NAVARRO-DÉNIZ,<sup>2</sup> ALFREDO REYES-BETANCORT,<sup>3</sup> STEPHAN SCHOLZ,<sup>4</sup> MARIO BACCARANI-ROBAS,<sup>2</sup> AND NERIEIDA CARRERA GARCÍA<sup>2</sup>



Oliva-Tejera et al. (2006)

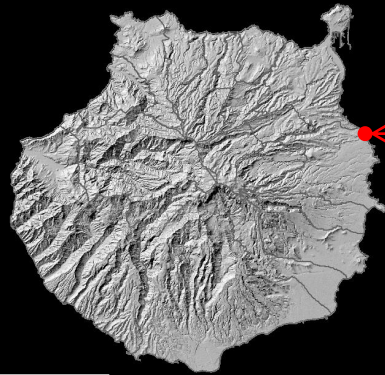


Jaén-Molina et al. 2021

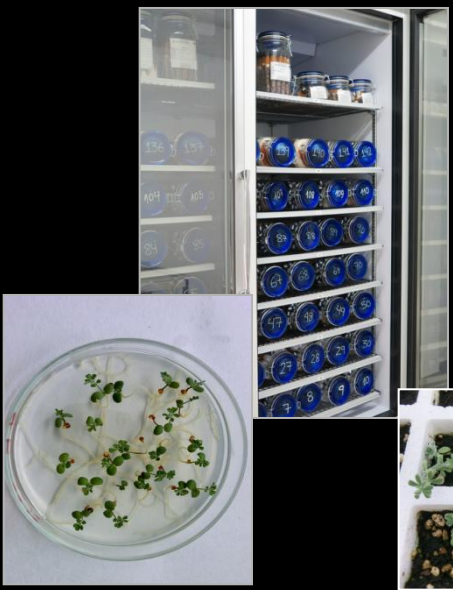
## Recovery Plan decree (2009)

PLAN DE RECUPERACIÓN YERBAMUDA DE JINÁMAR (*LOTUS KUNKELII*) D7/2009  
 Decreto 7/2009, de 27 de enero, por el que se aprueba el Plan de Recuperación de la especie vegetal Yerbamuda de Jinámar (*Lotus Kunkelii*) (B.O.C. 29, de 12.2.2009).

"Jinámar Site of Scientific interest"



**Critically threatened**



Díaz-Bertrana and Saturno 2016

# Is *Lotus kunkelii* a good species? (I)

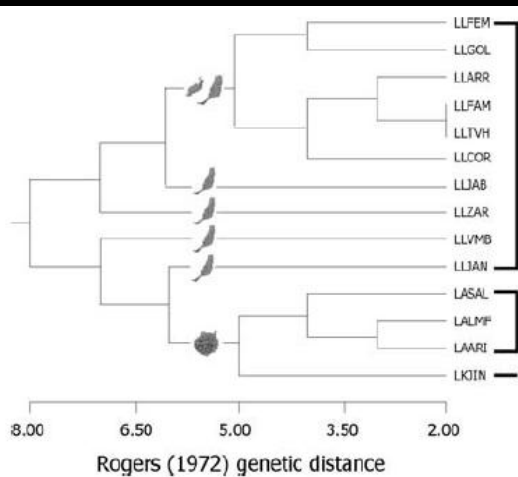
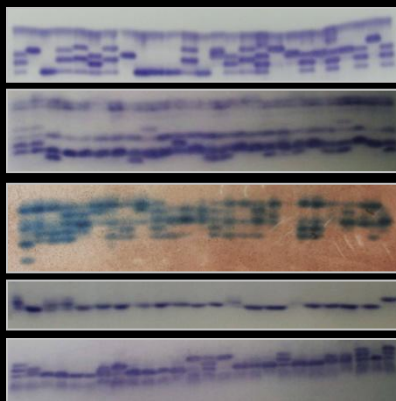
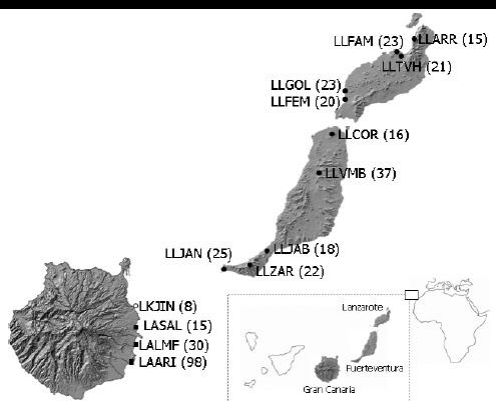


## 2006-YES, IT IS (allozymes)

American Journal of Botany 93(8): 1116-1124. 2006.

### PATTERNS OF GENETIC DIVERGENCE OF THREE CANARIAN ENDEMIC *LOTUS* (FABACEAE): IMPLICATIONS FOR THE CONSERVATION OF THE ENDANGERED *L. KUNKELII*<sup>1</sup>

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*L. lancerottensis*

*L. arinagensis*  
*L. kunkelii*

## 2009 Canarian Government's official bulletin (BOC)

PLAN DE RECUPERACIÓN YERBAMUDA DE JINÁMAR (*LOTUS JUNKELII*)

D7/2009

### Recovery plan decree

Decreto 7/2009, de 27 de enero, por el que se aprueba el Plan de Recuperación de la especie vegetal Yerbamuda de Jinámar (*Lotus Kunkelii*) (B.O.C. 29, de 12.2.2009).

#### 2.2. GENÉTICA.

El número cromosómico determinado para esta especie es  $2n=28$  [ORTEGA, J. 1976. Citogenética del género *Lotus* en Macaronesia. I. Números de cromosomas. Bot. Macaronésica, 1:17-24]. Además este taxón ha sido objeto de discusión en lo que a su estatus taxonómico se refiere debido, principalmente, a las similitudes morfológicas observadas entre sus parientes geográficamente más próximos como son *Lotus arinagensis* (Gran Canaria) y *Lotus lancerottensis* (Fuerteventura, y Lanzarote). De hecho cabe destacar que *L. kunkelii* fue des-

crita originalmente como una subespecie de *L. lancerottensis*. Con objeto de aclarar estas dudas taxonómicas desde el Gobierno de Canarias y con motivo del proyecto Interreg III-B Atlántico se encargó al Jardín Canario Viera y Clavijo el estudio genético de estas tres especies. Los resultados obtenidos revelan que *Lotus kunkelii* es una buena especie, y se encuentra bien diferenciada genéticamente de *L. arinagensis* y *L. lanzarotensis* [OLIVA-TEJERA, F. et al. 2006. Patterns of genetic divergence of three Canarian endemic *Lotus* (Faba-

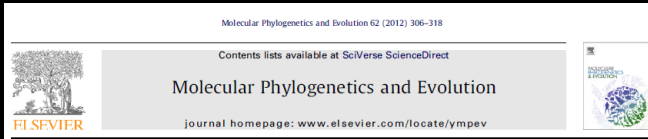


# Is *Lotus kunkelii* a good species? (II)

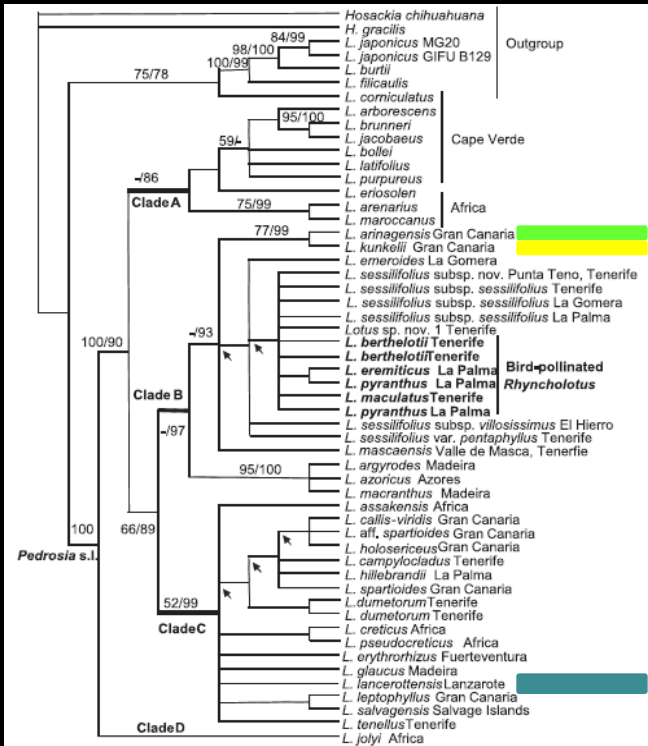


2021-YES, OF COURSE!

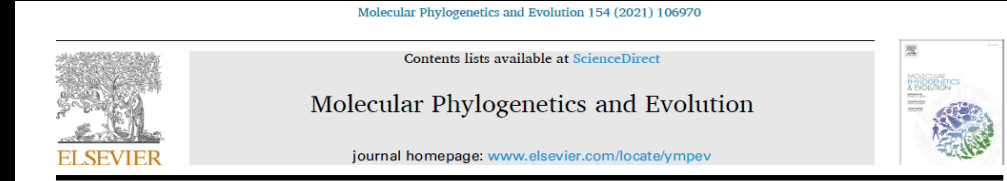
2011-YES, INDEED



The origin of bird pollination in Macaronesian *Lotus* (Loteae, Leguminosae)  
 Isidro Ojeda<sup>a,\*</sup>, Arnoldo Santos-Guerra<sup>b</sup>, Ruth Jaén-Molina<sup>c</sup>, Felicia Oliva-Tejera<sup>c</sup>, Juli Caujapé-Castells<sup>c</sup>, Quentin Cronk<sup>a</sup>



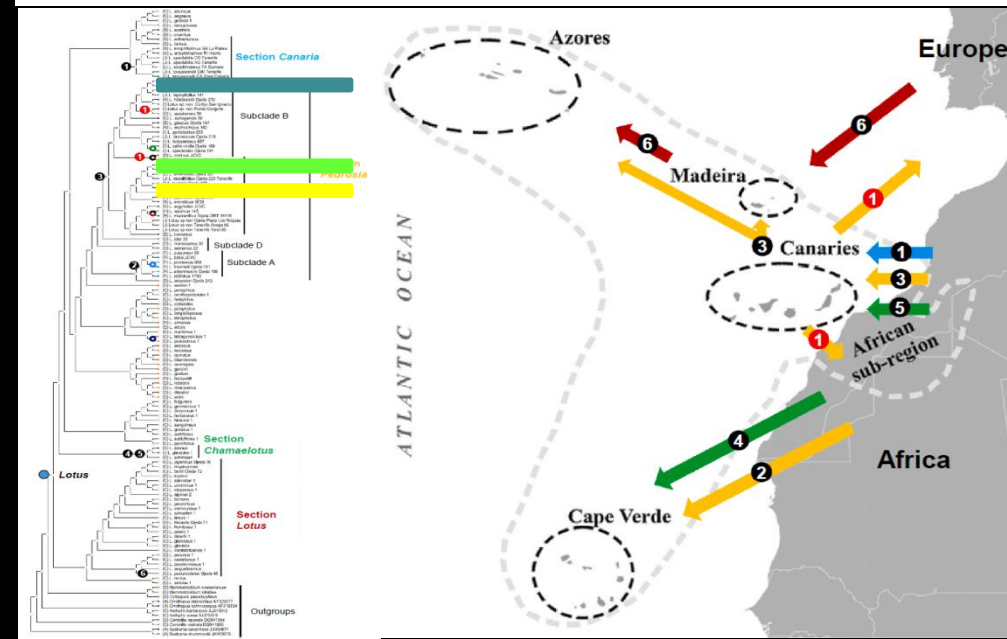
Confirms diagnosis of allozymes



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

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<sup>a</sup> Jardín Botánico Canario "Viera y Clavijo" - Unidad Asociada CSIC, Cabildo de Gran Canaria, Las Palmas, Gran Canaria, Spain  
<sup>b</sup> Norwegian Institute of Bioeconomy Research, Høgskoleveien 8, 1433 Ås, Norway



Confirms separation from *L. lancerottensis* BUT *L. kunkelii* closest to *L. mascaensis* from Tenerife

It is a quite young endemic (late Pleistocene)

# Recovery plan decree

Decreto 7/2009, de 27 de enero, por el que se aprueba el Plan de Recuperación de la especie vegetal Yerbamuda de Jinámar (*Lotus Junkelii*) (B.O.C. 29, de 12.2.2009).



**Objective 1. To increase the current number of individuals of *L. kunkelii*, in order to establish a population of at least 5000 reproductive individuals distributed in three nuclei, as well as to have the instruments for its *ex situ* conservation**

Action 1. To collect seed and/or vegetative samples in the only known population of *Lotus kunkelii*.

Action 2. To send at least 2.000 seeds of *L. kunkelii* to two Seed Banks for its short- mid-term conservation



May 26<sup>th</sup>, 2016

Photo credits: Jardín Botánico "Viera y Clavijo"



April 9<sup>th</sup> 2021  
Project NEXTGENDEM (MAC2/4.6d/236)





# Recovery plan decree

Decreto 7/2009, de 27 de enero, por el que se aprueba el Plan de Recuperación de la especie vegetal Yerbamuda de Jinámar (*Lotus Junkelii*) (B.O.C. 29, de 12.2.2009).

**Objective 1. To increase the current number of individuals of *L. kunkelii*, in order to establish a population of at least 5000 reproductive individuals distributed in three nuclei, as well as to have the instruments for its *ex situ* conservation**

Action 3. To create seedling stocks that allow us to obtain seeds when the reproductive turnover of the population is on the wane

Action 4. To carry out the needed actions to increase germination and rooting rates of the vegetative material, as well as the acclimation of the plants in cultivation, before their reintroduction.

Action 5. To cultivate the seed and vegetative material collected, with a view to obtain living stocks to be used in reinforcements and reintroductions.

Photo credits: Jardín Botánico "Viera y Clavijo"



Seed Bank, JBCVCSIC



Tafira conservation greenhouse  
Cabildo de Gran Canaria

# Recovery plan decree

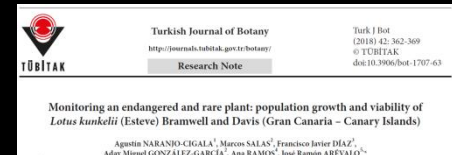
Decreto 7/2009, de 27 de enero, por el que se aprueba el Plan de Recuperación de la especie vegetal Yerbamuda de Jinámar (*Lotus Junkelii*) (B.O.C. 29, de 12.2.2009).

**Objective 1. To increase the current number of individuals of *L. kunkelii*, in order to establish a population of at least 5000 reproductive individuals distributed in three nuclei, as well as to have the instruments for its *ex situ* conservation**

Action 6. To carry out reinforcements and reintroductions in the only known natural population at the "Jinámar Site of Scientific interest".

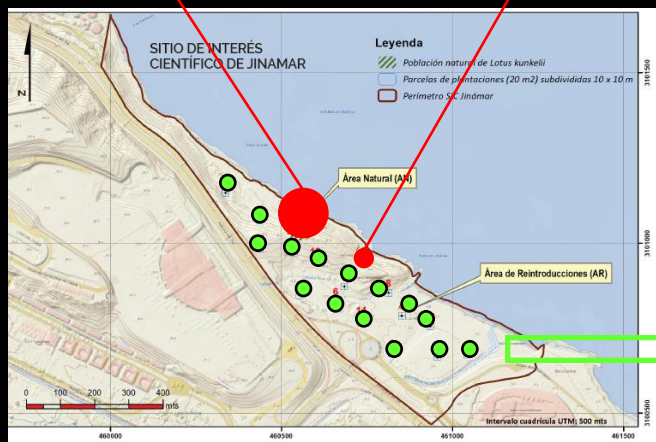
Actions 7 to 11 related to monitoring, informing, identifying the plants and training the rangers to differentiate it from *L. glaucus*

## Wild distribution (just 2 patches)



Naranjo-Cigala et al. (2018)

Díaz-Peña and Naranjo-Cigala



Díaz-Bertrana and Saturno (2016)



Díaz-Peña and Naranjo-Cigala



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**Objetivo 2. To promote the accomplishment of the “regime of uses” and the program of actions scheduled in the Conservation Rules of the “Jinamar Scientific Interest Site”, and to undertake a dissemination program about *Lotus kunkelii***

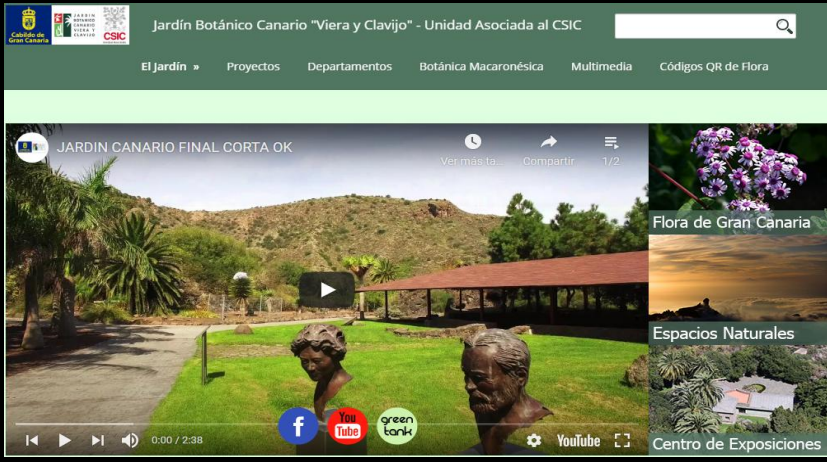


<https://www.youtube.com/watch?v=fMfu-7vZvWg>

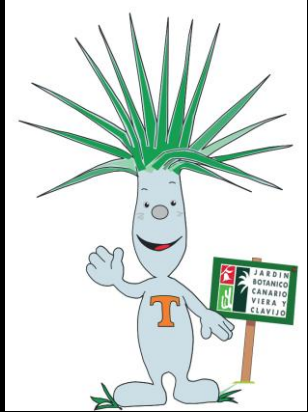
Project “The musical Herbarium” with “El Cancionero Isleño”



WEBSITE: <http://www.jardincanario.org/>



<https://www.facebook.com/JardinBotanicoCanarioVierayClavijo/>



# THANKS!

