Species distribution models:

from theory to practice

Global change ecology
AA 2019-20

Introduction

my dreams vs my reality

The course for dummies

Language

Teacher

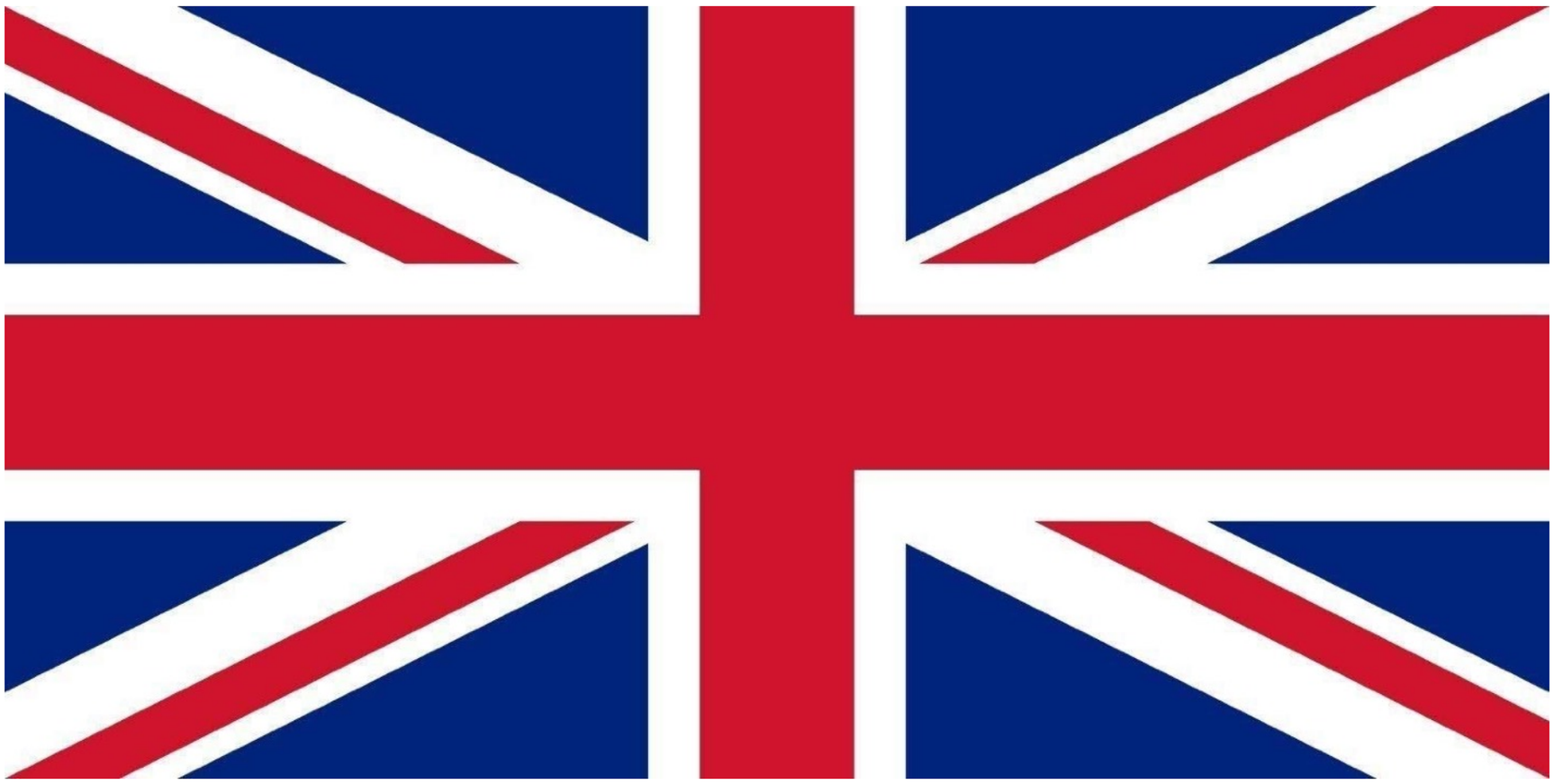
Topic

Schedule

Classes

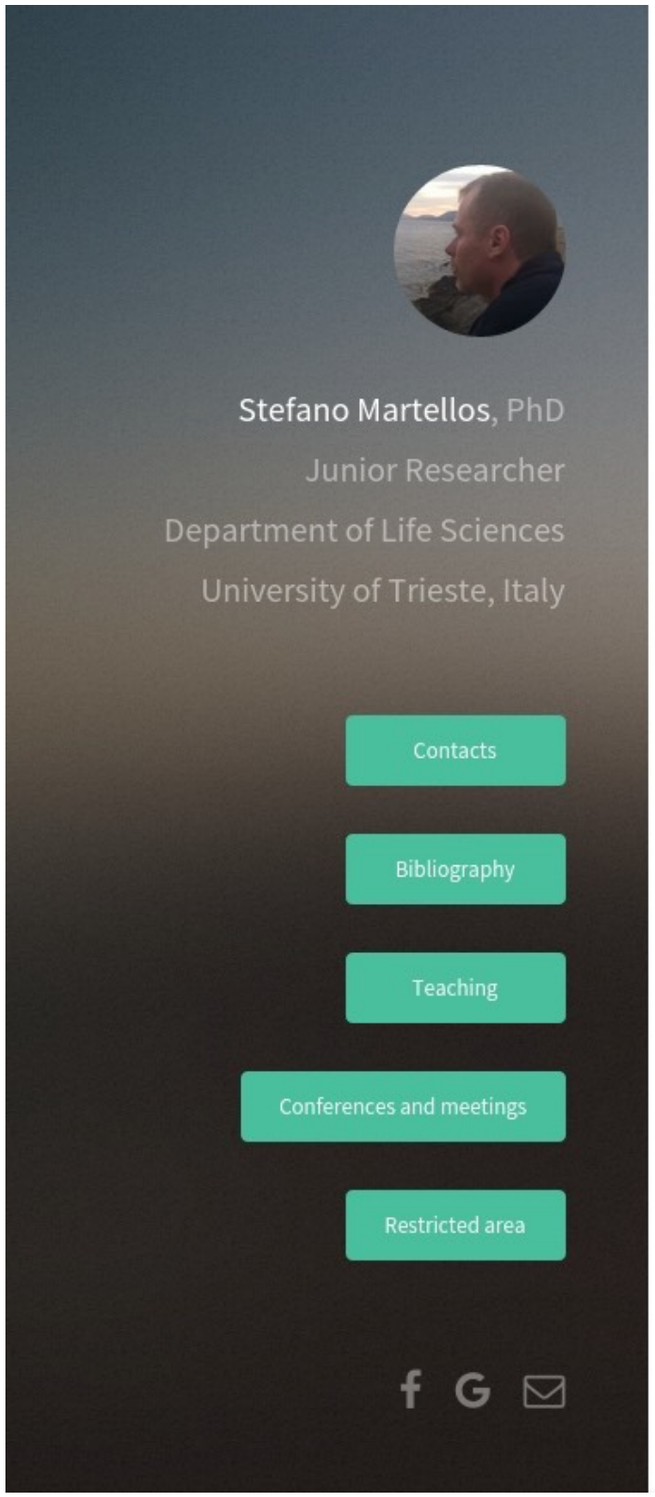
Materials

Test



Introduction: teacher

http://dryades.units.it/SM/

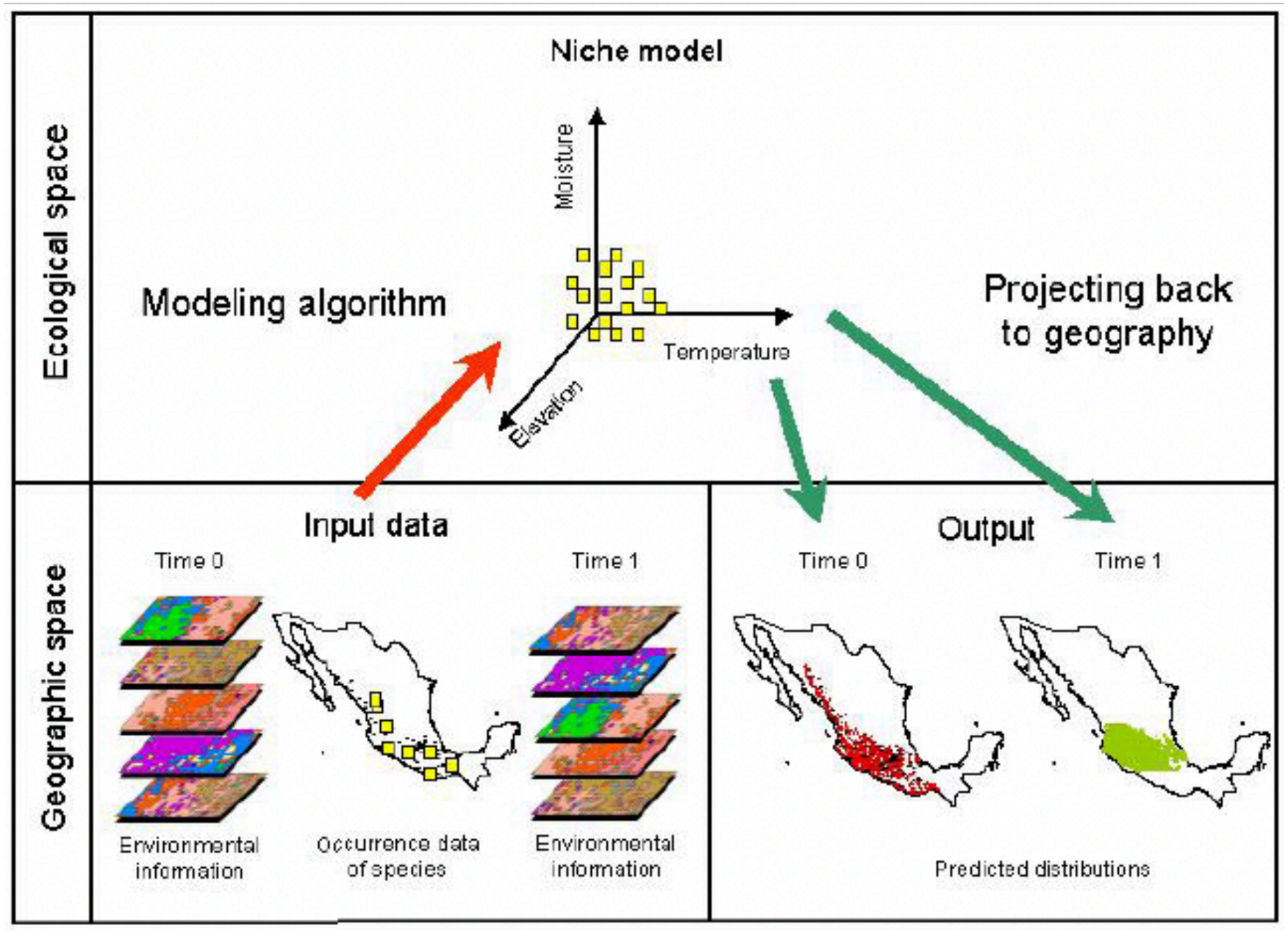


About me

I graduated in Biological Sciences in 1999, and defended my PhD thesys in 2005, at the University of Trieste (NE Italy). Since then I worked at the former Dept. of Biology (now Dept. of Life Sceicnes) of the University of Trieste, dealing mostly with lichens and biodiversity informatics.
I participated to several national and international projects, and coordinated the LIFE+ project CSMON-LIFE.

Curriculum vitae

Introduction: topic



Good question…..

Dream:

Frontal lessons

Groupwork

Q&A sessions

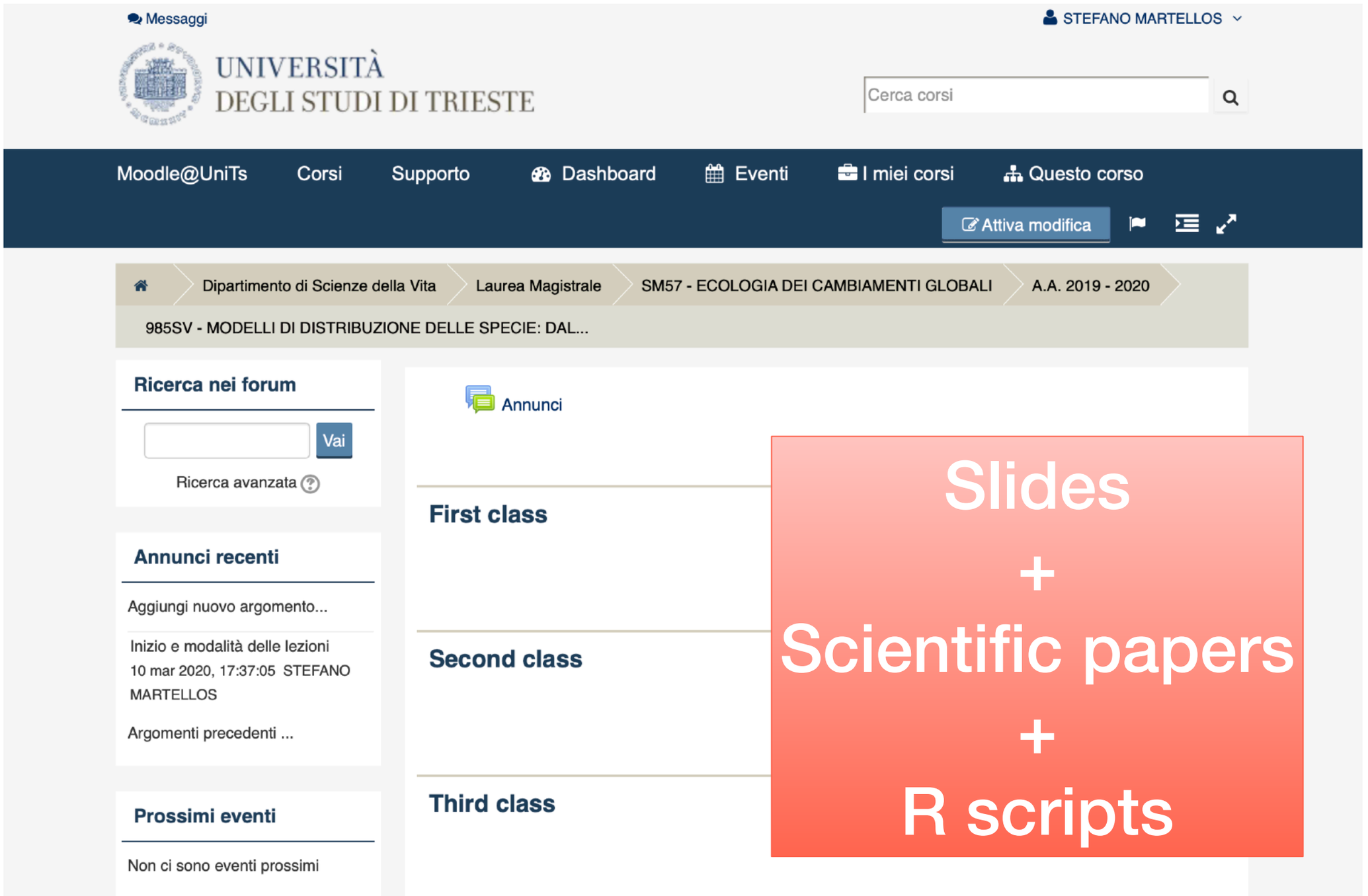
Reality:

Streaming

?

So what?

Introduction: materials



A discussion on the main theoretical topics of the course.

Your practical work will be evaluated during the practical classes (if we will be able to have any….)


Question
Time

Let’s start with an example….

Non sicuro — dryades.units.it

la Repubblica -... | Botanica Sistem... | Species distribu... | A very brief intr... | specie endemic... | Biodiversità in It... | Download | Portale della Flo... | Crocus biflorus...

Crocus biflorus Mill.

Endemica / Endemic

Abruzzo; **Basilicata**; **Calabria**; **Campania**; **Emilia-Romagna**; **Friuli Venezia Giulia**; **Lazio**; **Liguria**; **Lombardia**; **Marche**; **Molise**; **Piemonte**; **Puglia**; **Sicilia**; **Trentino-Alto Adige**; **Toscana**; **Umbria**; **Veneto**;

Iridaceae Juss.

Asparagales Link

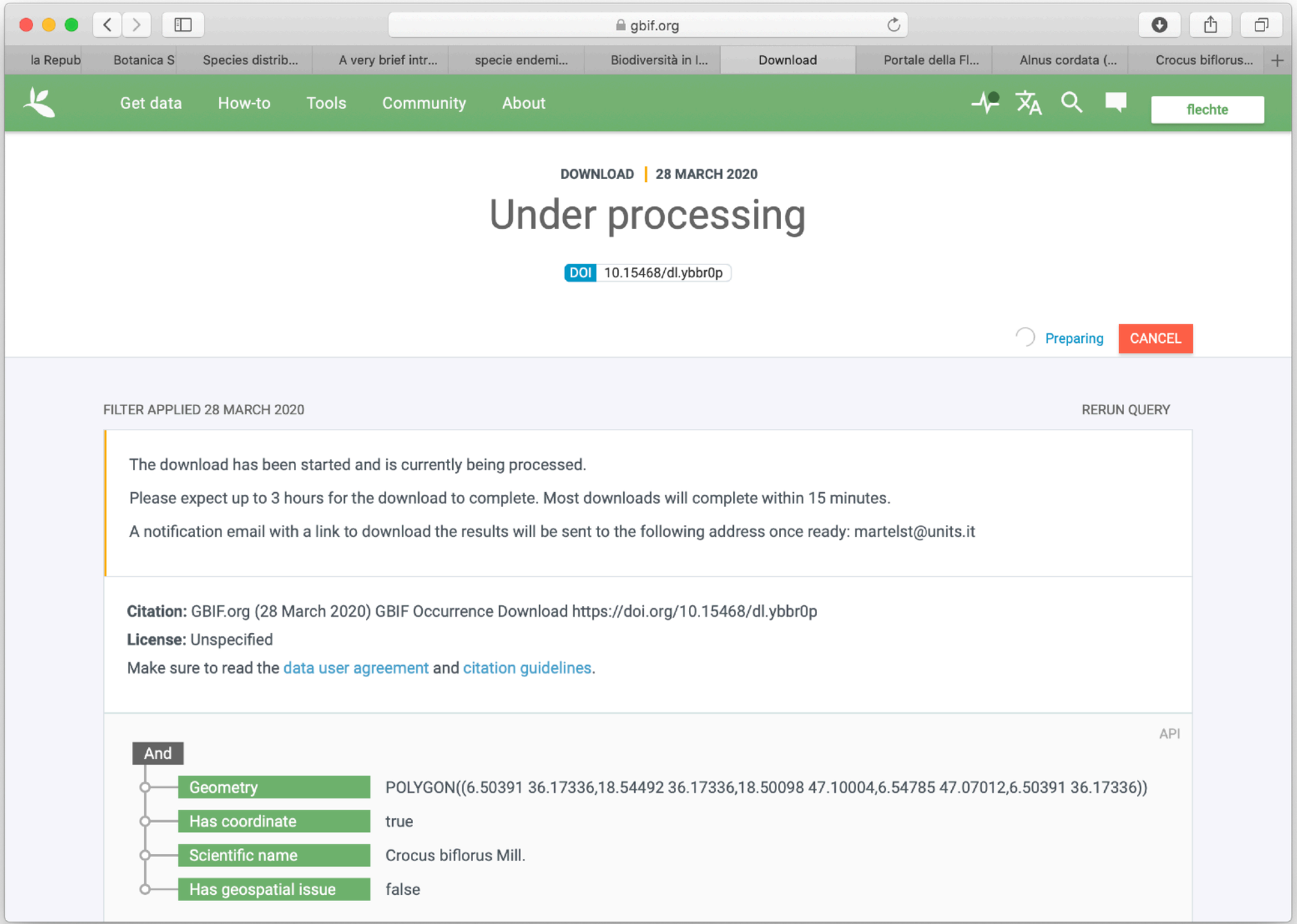
Lilianae Takht.

Magnoliidae Novák ex Takht.

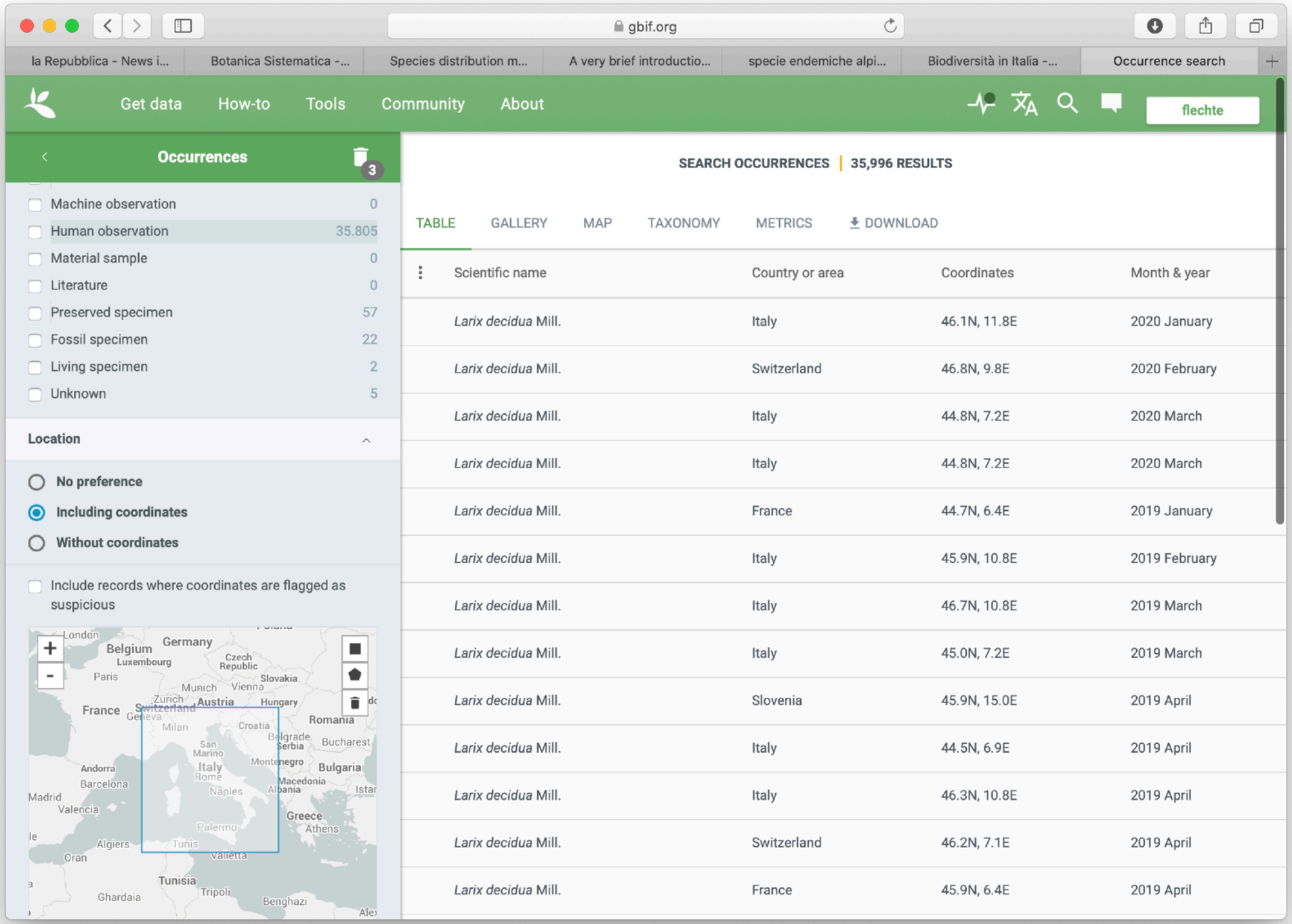
APG IV
Angiosperm
Phylogeny
Group IV system

Andrea Moro

Introduction



Introduction



Non sicuro — dryades.units.it

la Repubblica -... | Botanica Sistem... | Species distribu... | A very brief intr... | specie endemic... | Biodiversità in It... | Download | Portale della Flo... | Fraxinus ornus...

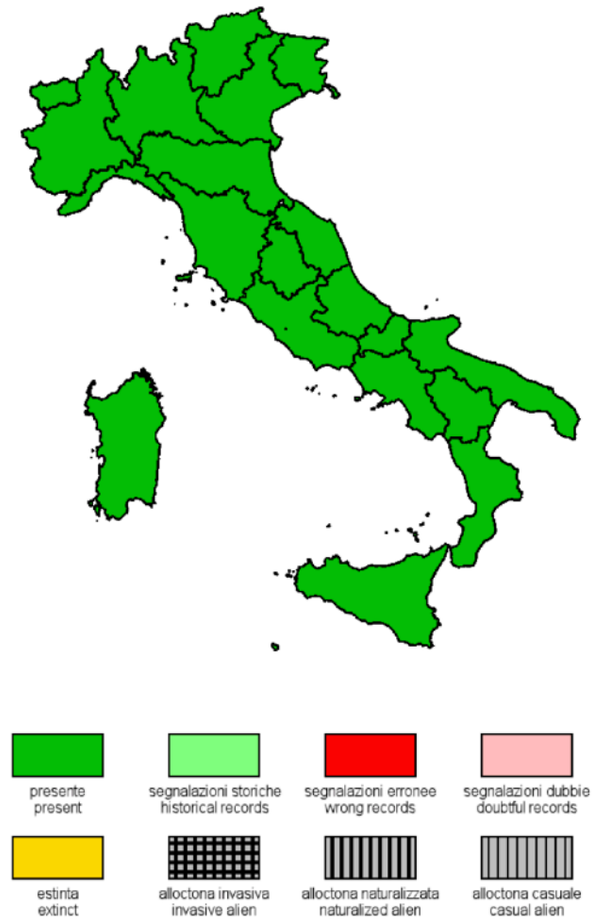
Fraxinus ornus L. subsp. ornus

Abruzzo; **Basilicata**; **Calabria**; **Campania**; **Emilia-Romagna**; **Friuli Venezia Giulia**; **Lazio**; **Liguria**; **Lombardia**; **Marche**; **Molise**; **Piemonte**; **Puglia**; **Sardegna**; **Sicilia**; **Trentino-Alto Adige**; **Toscana**; **Umbria**; **Valle d'Aosta**; **Veneto**;

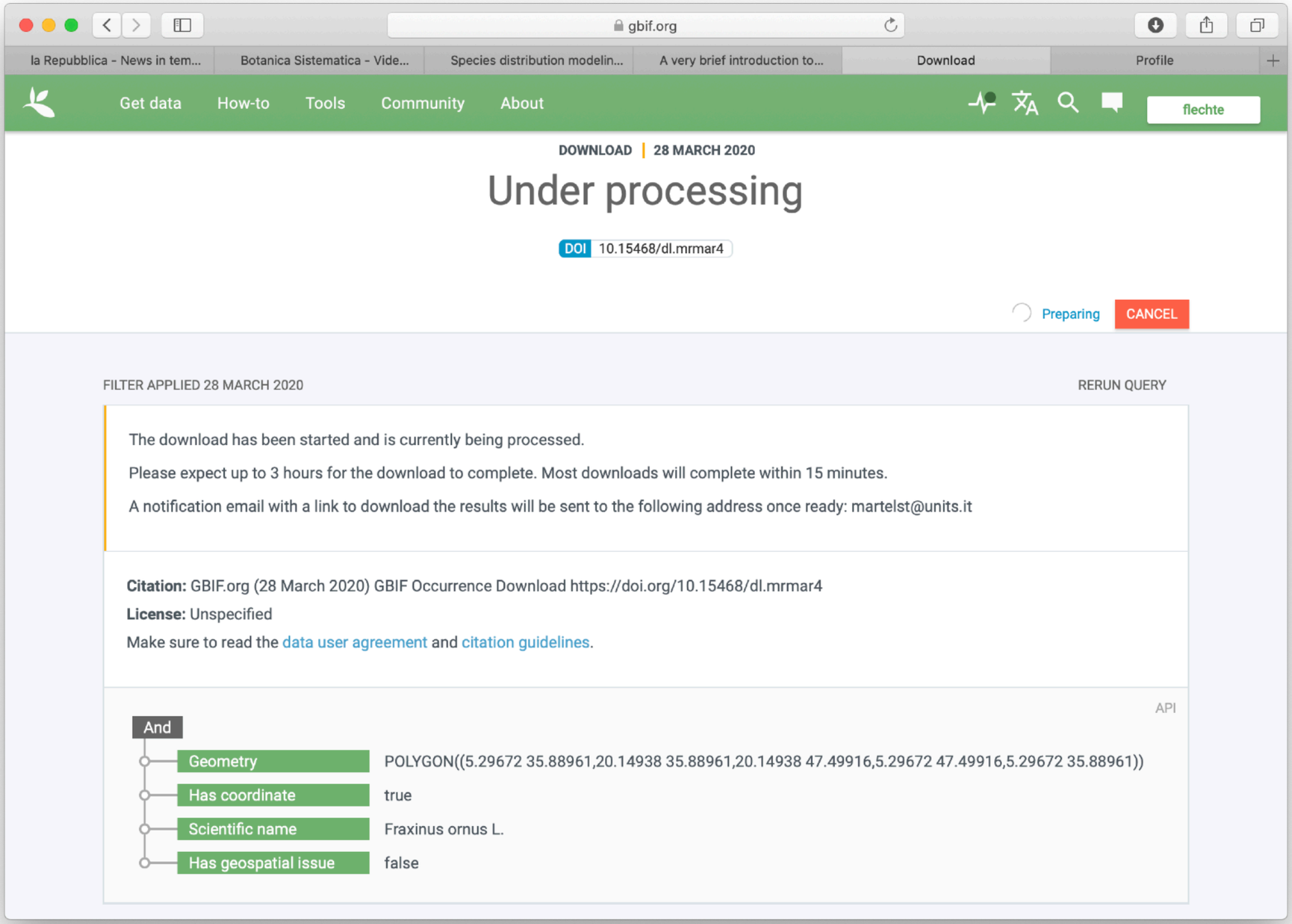
Oleaceae Hoffmanns. & Link
Lamiales Bromhead
Asteranae Takht.
Magnoliidae Novák ex Takht.

APG IV
Angiosperm
Phylogeny
Group IV system

Andrea Moro
© Dipartimento di Scienze della Vita, Università degli Studi di Trieste
Distributed under CC-BY-SA 4.0 license.

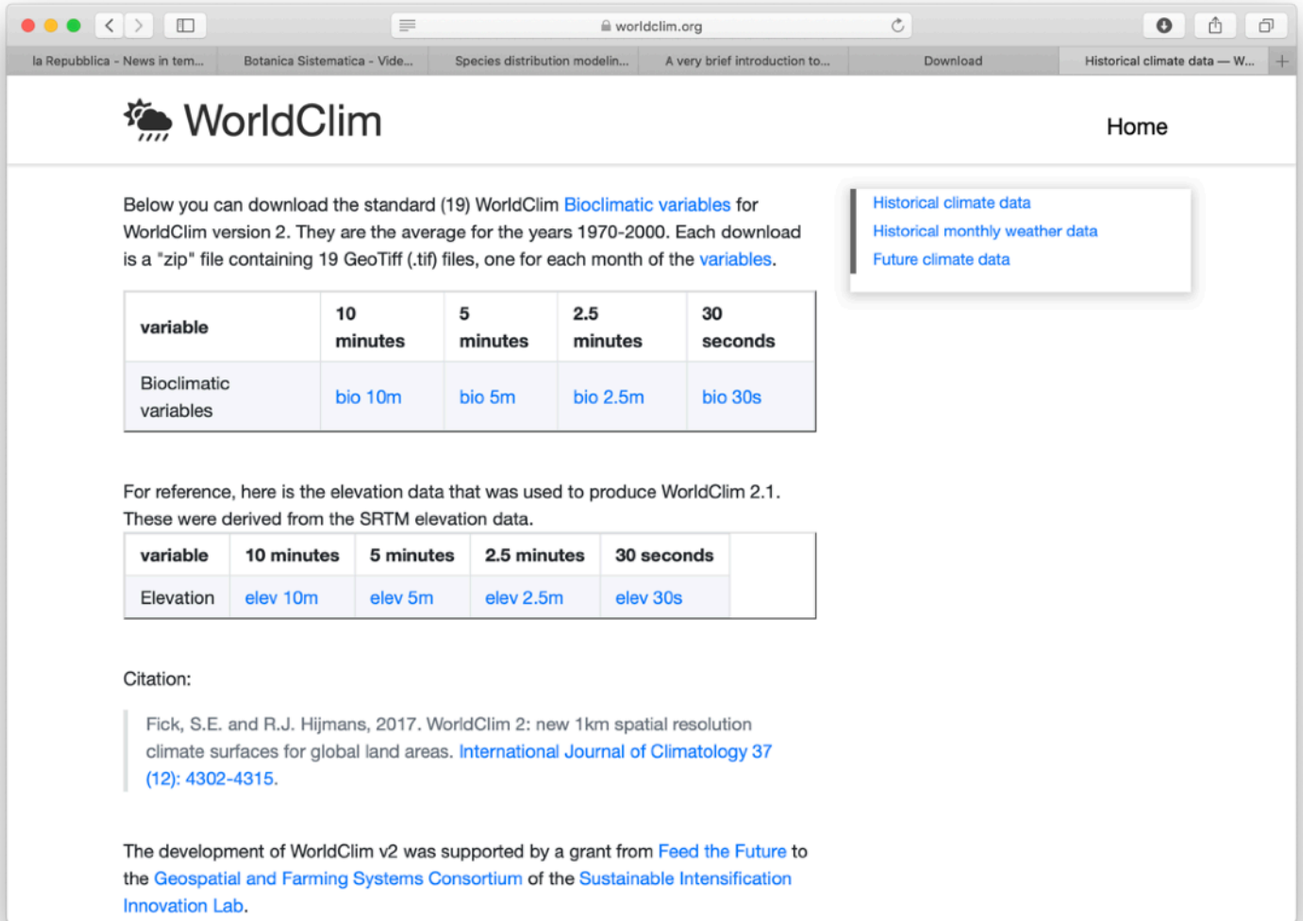


Introduction



Introduction

BIO1 = Annual Mean Temperature
BIO2 = Mean Diurnal Range (Mean of monthly (max temp - min temp))
BIO3 = Isothermality (BIO2/BIO7) (×100)
BIO4 = Temperature Seasonality (standard deviation ×100)
BIO5 = Max Temperature of Warmest Month
BIO6 = Min Temperature of Coldest Month
BIO7 = Temperature Annual Range (BIO5-BIO6)
BIO8 = Mean Temperature of Wettest Quarter
BIO9 = Mean Temperature of Driest Quarter
BIO10 = Mean Temperature of Warmest Quarter
BIO11 = Mean Temperature of Coldest Quarter
BIO12 = Annual Precipitation
BIO13 = Precipitation of Wettest Month
BIO14 = Precipitation of Driest Month
BIO15 = Precipitation Seasonality (Coefficient of Variation)
BIO16 = Precipitation of Wettest Quarter
BIO17 = Precipitation of Driest Quarter
BIO18 = Precipitation of Warmest Quarter
BIO19 = Precipitation of Coldest Quarter



Let’s switch to R Studio.

Does it seems simple?

However, this is indeed the simplest part of the job.
What is missing is the preparation of data.
And the interpretation part.

Plus, several questions do arise
since the very beginning….

Modelling what?

What are we modelling?

The actual distribution?

The realized, or fundamental niche?

Or habitat suitability?

First of all, however, we must answer to the following questions:

Why a given population is present in, or absent from, a given area?

Which are the drivers that shape the distribution of individuals of a species in the geographical space?

Modelling what?

Species' distribution is mostly influenced by 4 groups of factors:

- abiotic conditions, which impose physiologic limits to the presence of a given taxon in a given area.
- biotic conditions, i.e. all the interactions of a taxon with the other organisms in the area.
- dispersal, i.e. the capability of a taxon to actually reach different areas in which abiotic conditions are suitable for its survival.
- evolution i.e. the capacity of a taxon to change in time. This factor, anyway, has little influence in short time lapses.

These factors interact to define the actual distribution of a taxon. Such interaction has different strength at different scale.

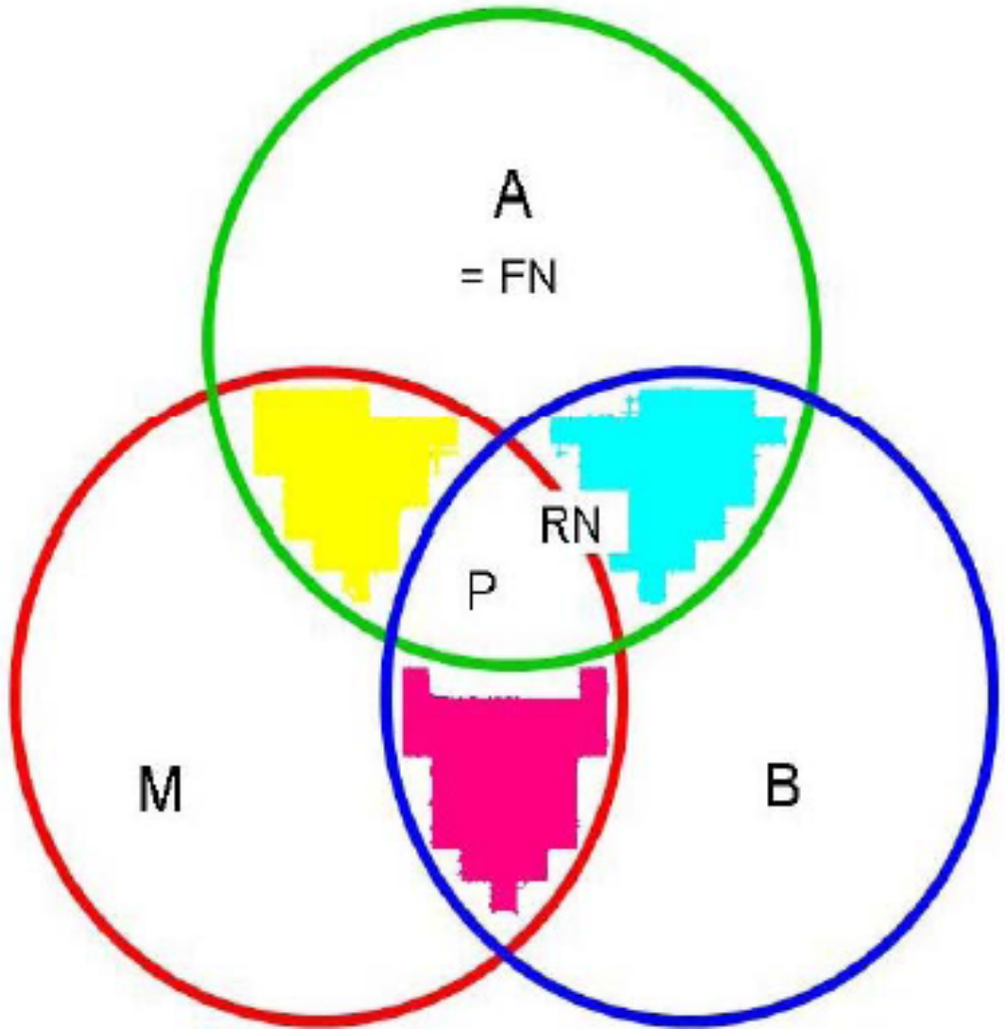
A taxon is present in a given area when:

1. physical and chemical factors permit a positive, density-independent fitness.

2. the overall interactions with all other livings produce a positive biotic, density-dependent fitness.

3. the area is accessible to the taxon. This factor can change along time, hence modifying the distribution of organisms.

Modelling what?



A = abiotic niche

B = biotic niche

M = accessible area

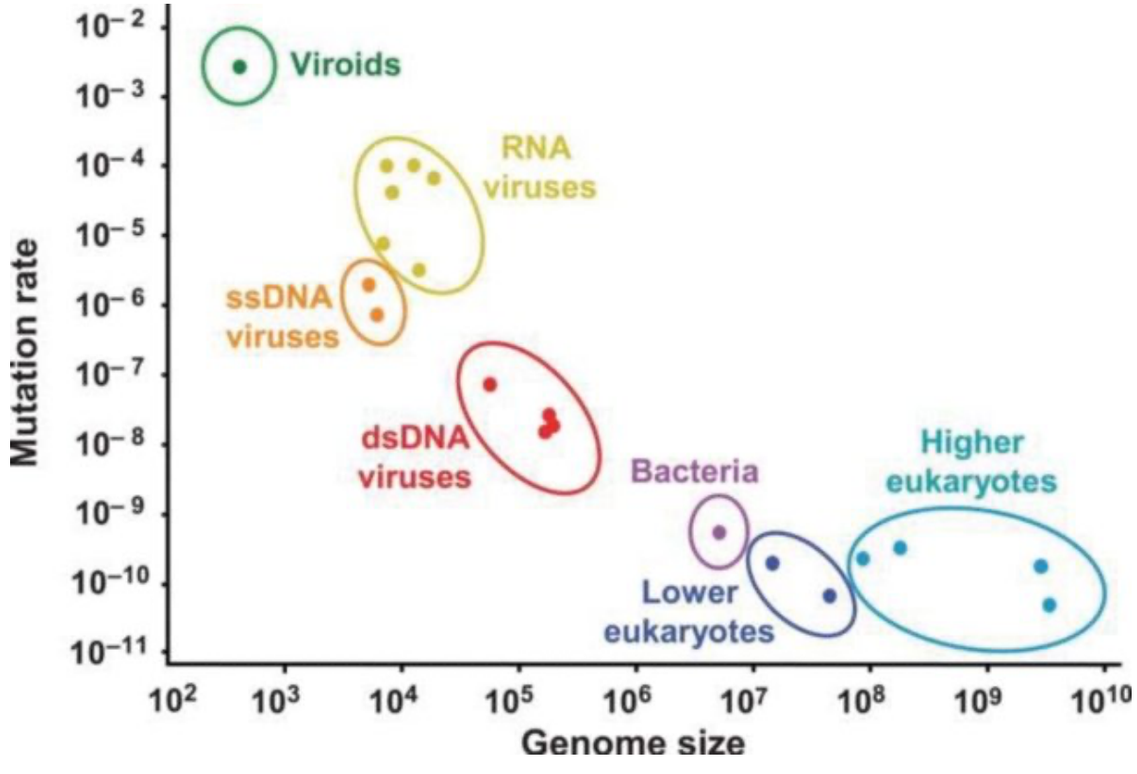
FN = fundamental niche

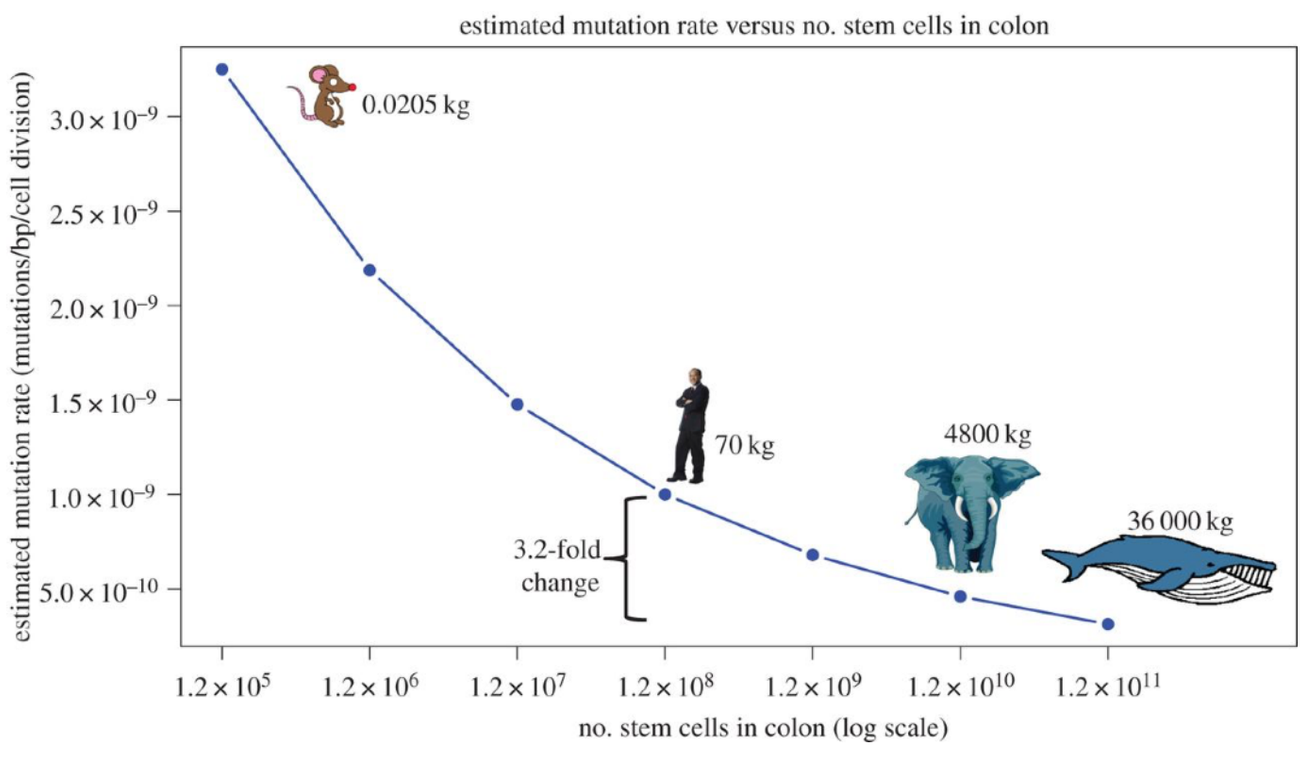
RN = realised niche

P = actual distribution

Evolution

We must bear in mind that this factor normally works on long times, thus is normally not affecting the present distribution of a species.
However…
While this is true, the time required for evolution does vary in different organisms. Certainly, in plants and animals it is normally not relevant. But when smaller organisms, with high mutation rates, and high number of generations per year, are taken into account, evolution could become relevant at a short temporal scale.





Dispersal

The capacity of dispersal of a species can account for its presence in a given area, and for its absence from other areas, in which climatic conditions could potentially allow its colonization.

The accessible area for a given species, at a given time, is the whole area within the colonizable reach of existing populations, i.e. where migration is not impeded by natural or human-made barriers to dispersal.

For the future conditions, it encompasses those areas that can be naturally colonized in the future, e.g. if species change their distribution in response to climate change or following invasions.

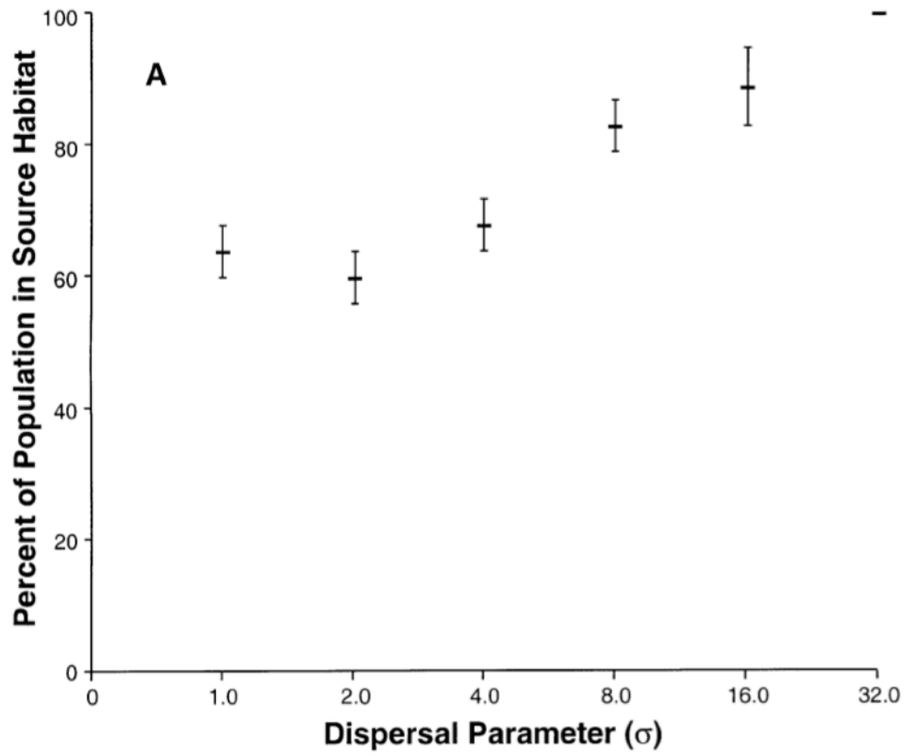
Evolution can affect dispersal, since mutations can improve or reduce dispersal ability of a taxon, or of one or more of its populations.

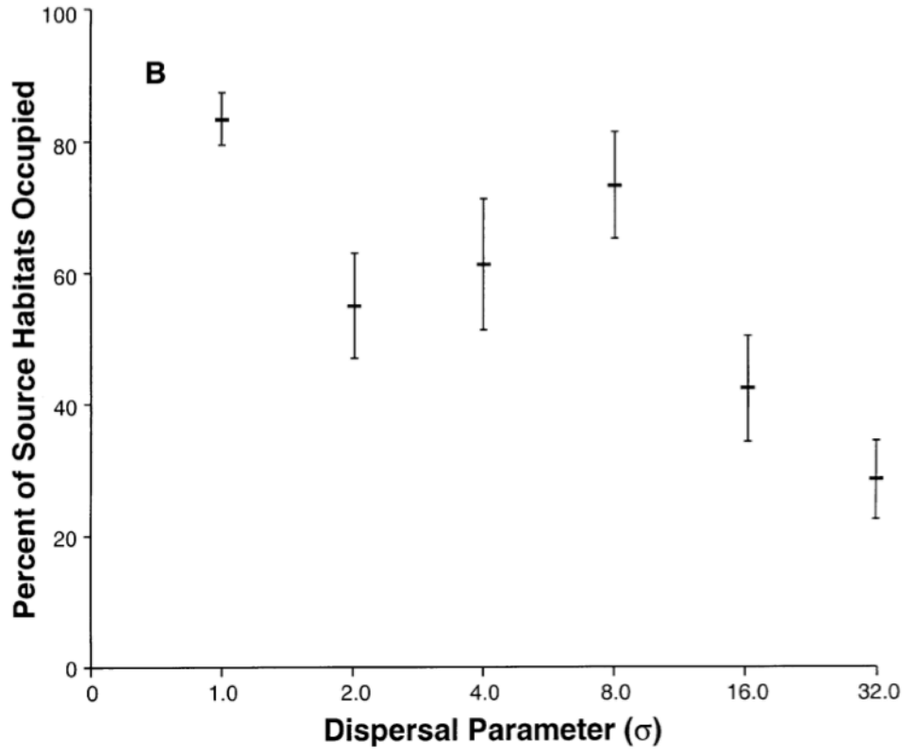
Dispersal

When dispersal rate is high (dispersal parameter < 2), often the portion of population which occurs in source habitat is lower than when dispersal is low (A). In the latter case, the amount of organisms occurring in sink populations is close to zero.

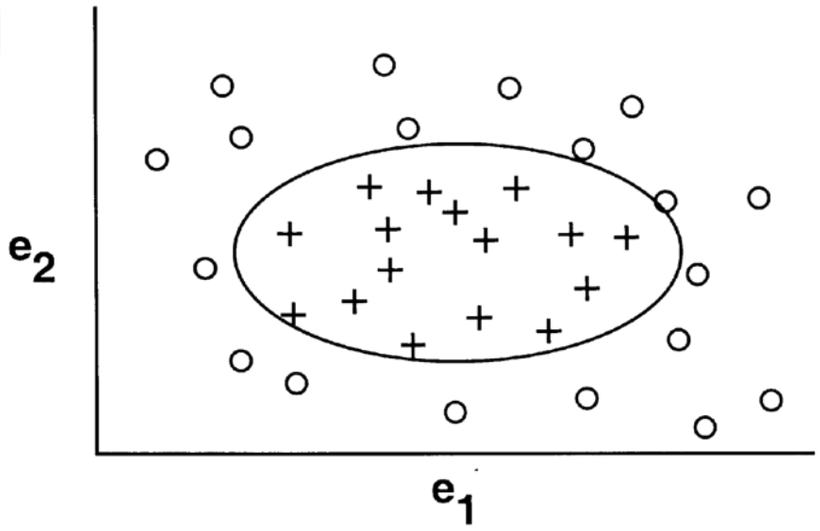
This increase in the percentage of the population in source habitat occurs despite a decrease in the fraction of source patches occupied (B).

These two trends taken together depicted a situation described by the source-sink dynamics theory, with a high fraction of the population occurring outside the bounds of the niche when dispersal is high and a large fraction of empty suitable sites when dispersal is low.

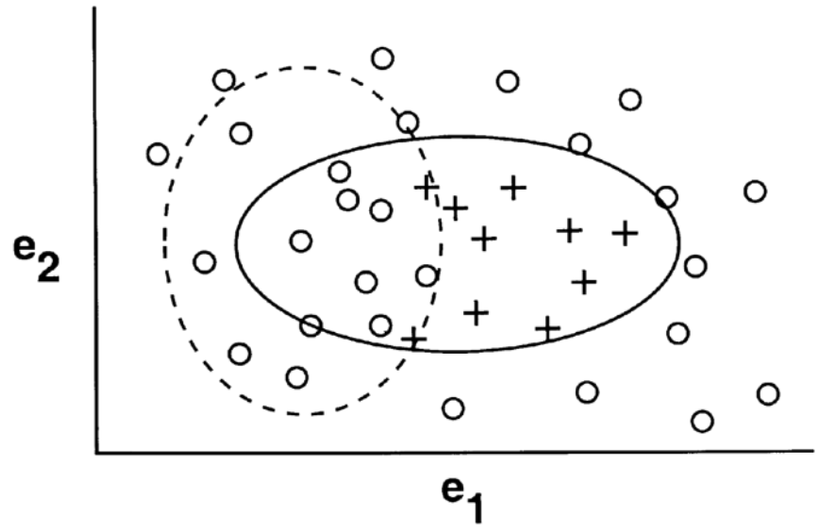




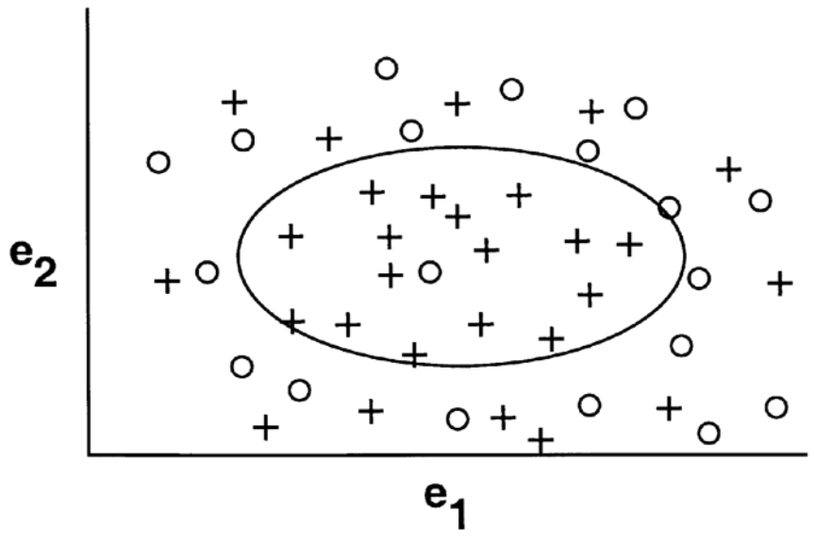
Dispersal



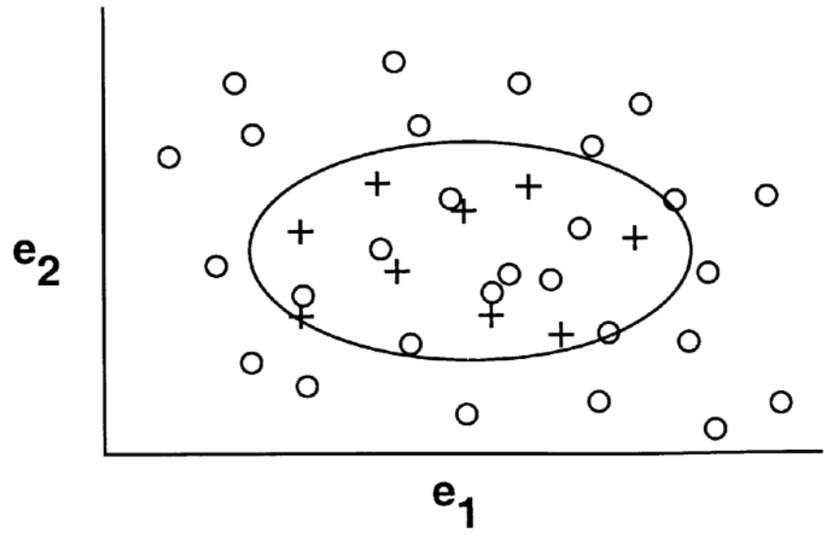
A. Grinellian Niche



B. Hutchinsonian Realized Niche



C. Source-Sink Dynamics



D. Dispersal Limitation