

Floral complexity as indicator of plant vulnerability

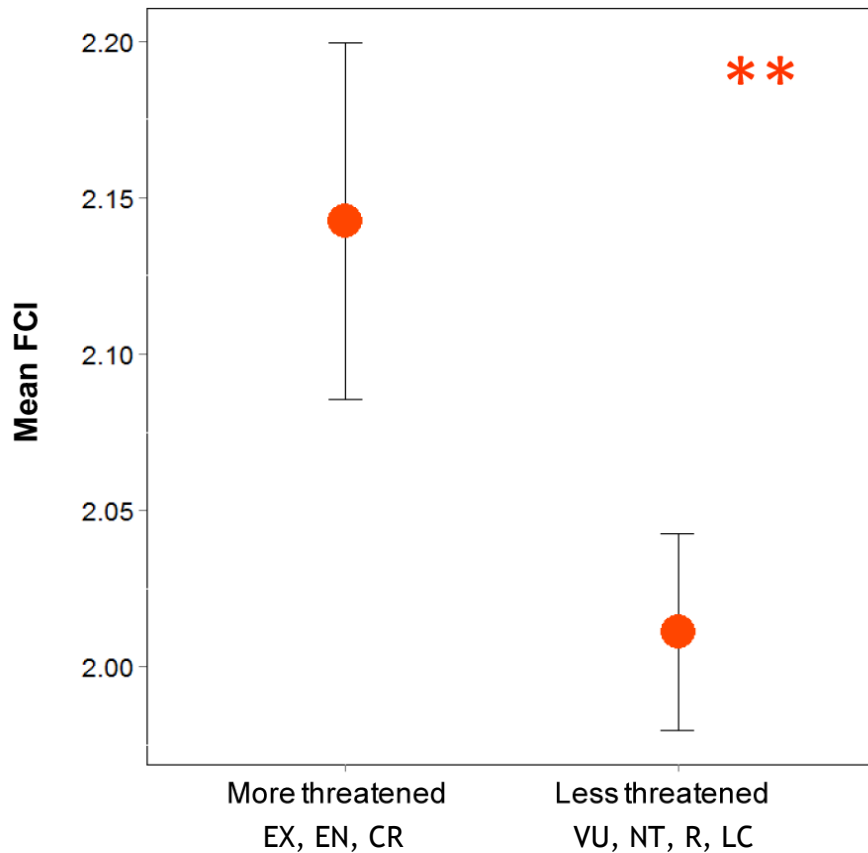
Lessons learned from the Mediterranean Red Data Books

Martha Charitonidou*, Anastasia Stefanaki, Amparo Lázaro, Joana Cursach, Maria Panitsa, Ioannis Bazos, Aphrodite Kantsa, Rosa Ranalli, Mauro Fois, Marta Galloni, Gianluigi Bacchetta, Sílvia Castro, João Loureiro, Katerina Goula, Luis Navarro, Magda Bou Dagher Kharrat, Rhea Kahale, Loukia Vassileiou, Giovanna Aronne, Živa Fišer, Theodora Petanidou

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Stefanaki et al. 2015 *PLOS ONE*



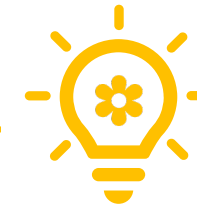
Floral Complexity Index - FCI:
shale, depth, συμμετρία, κατάτμηση,
λειτουργική ανθική μονάδα

RESEARCH ARTICLE

Lessons from Red Data Books: Plant Vulnerability Increases with Floral Complexity

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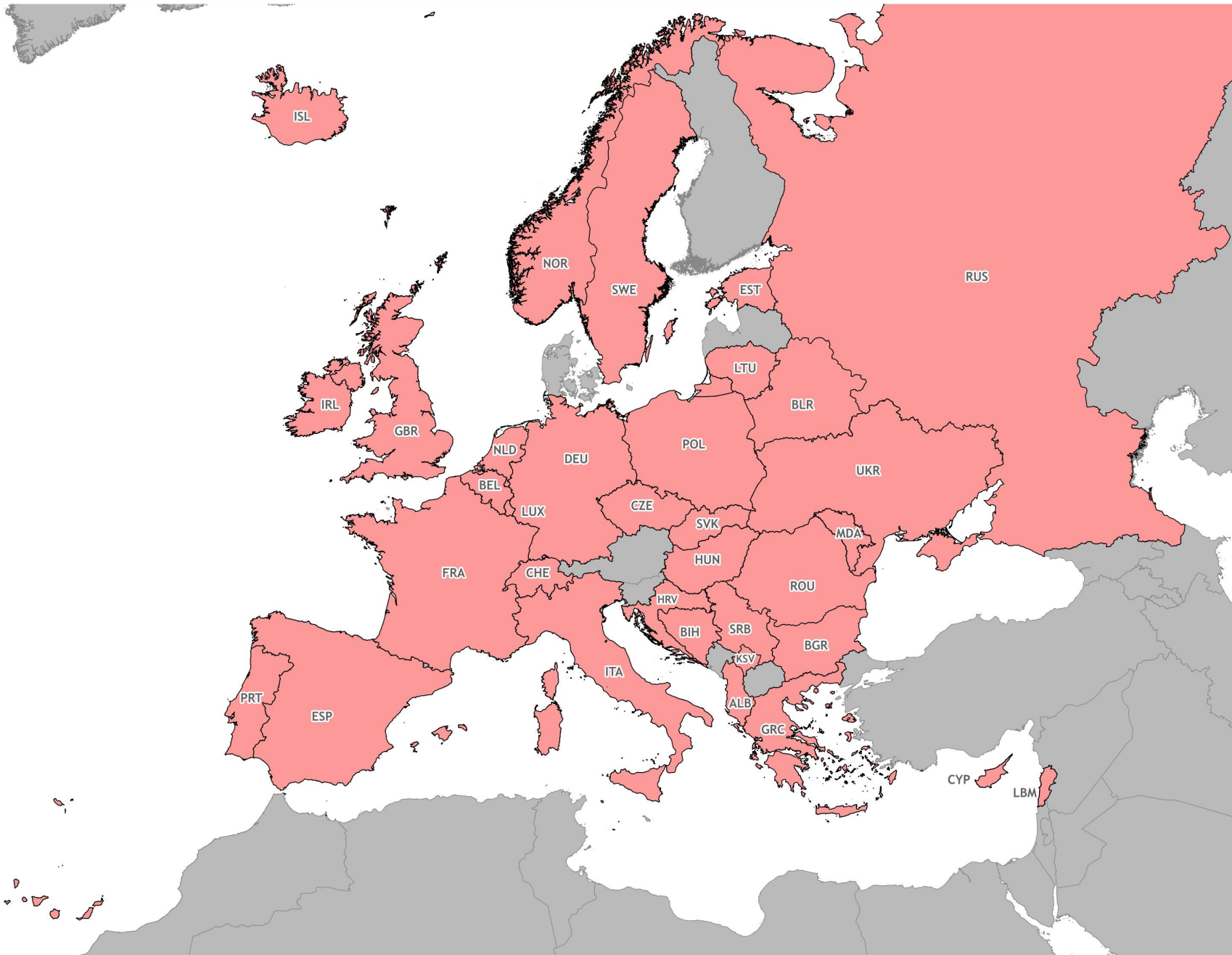
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Can we use floral complexity as an indicator of vulnerability of the entire European flora?

- **Scope:** To investigate if floral complexity can be an index of **plant vulnerability** for European flora
 - **Plant vulnerability** (*sensu* IUCN): mainly described on the basis of **extrinsic** (environmental) factors
 - Can it be associated with **intrinsic** (+ floral) characteristics?
- **Action:** Compile a **database** of **intrinsic & extrinsic** characteristics of European plant taxa (per country)

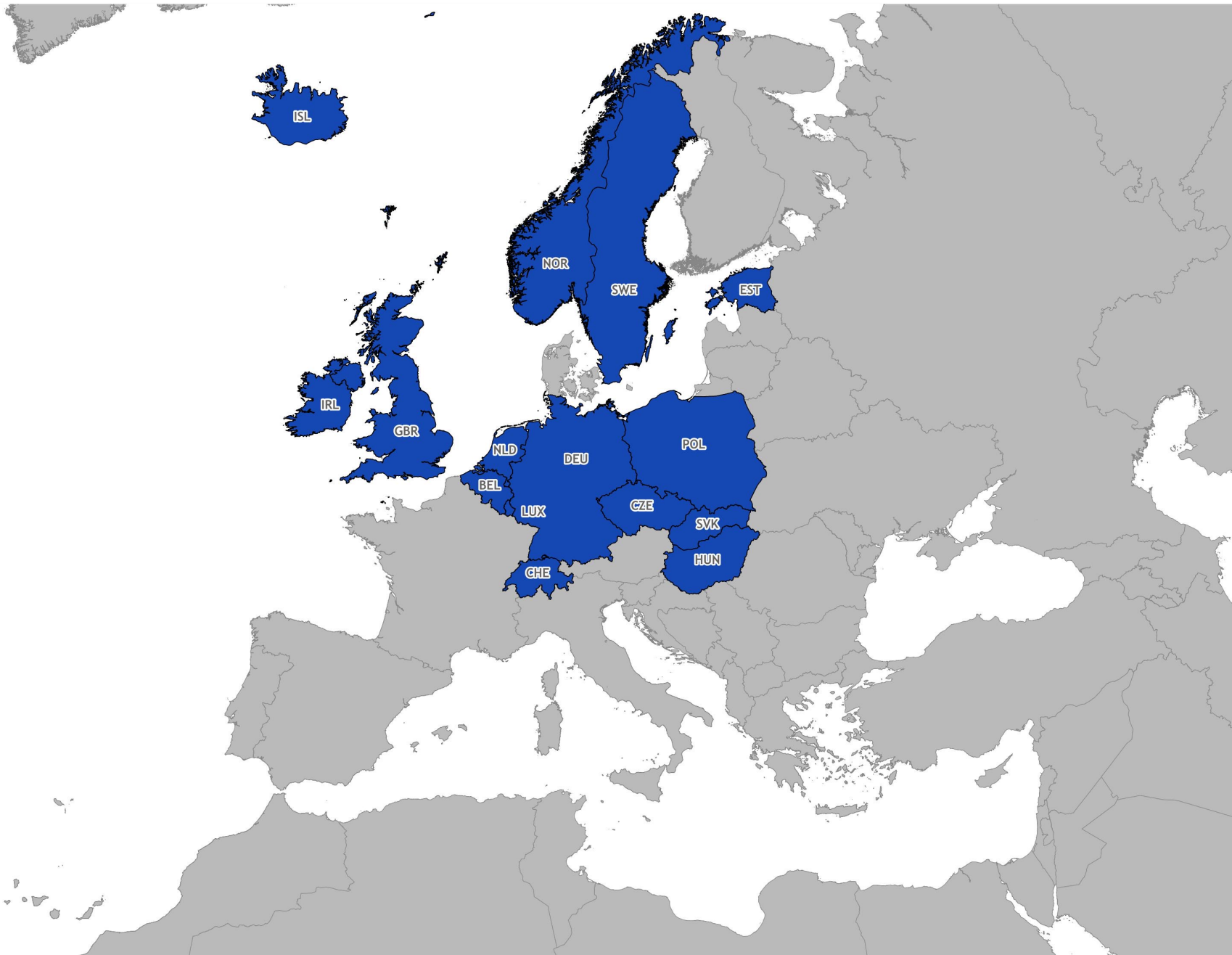




- 38 separate dataset
- 35 countries
- FCP database:
 - 26.135 initial records (2022)
 - 25.744 (nomenclature update *sensu* POWO)
- 10111 taxa
- Data quality: **extremely heterogenous**
 - Data grouping

North & Central Europe

- 16714 records
- 4668 taxa



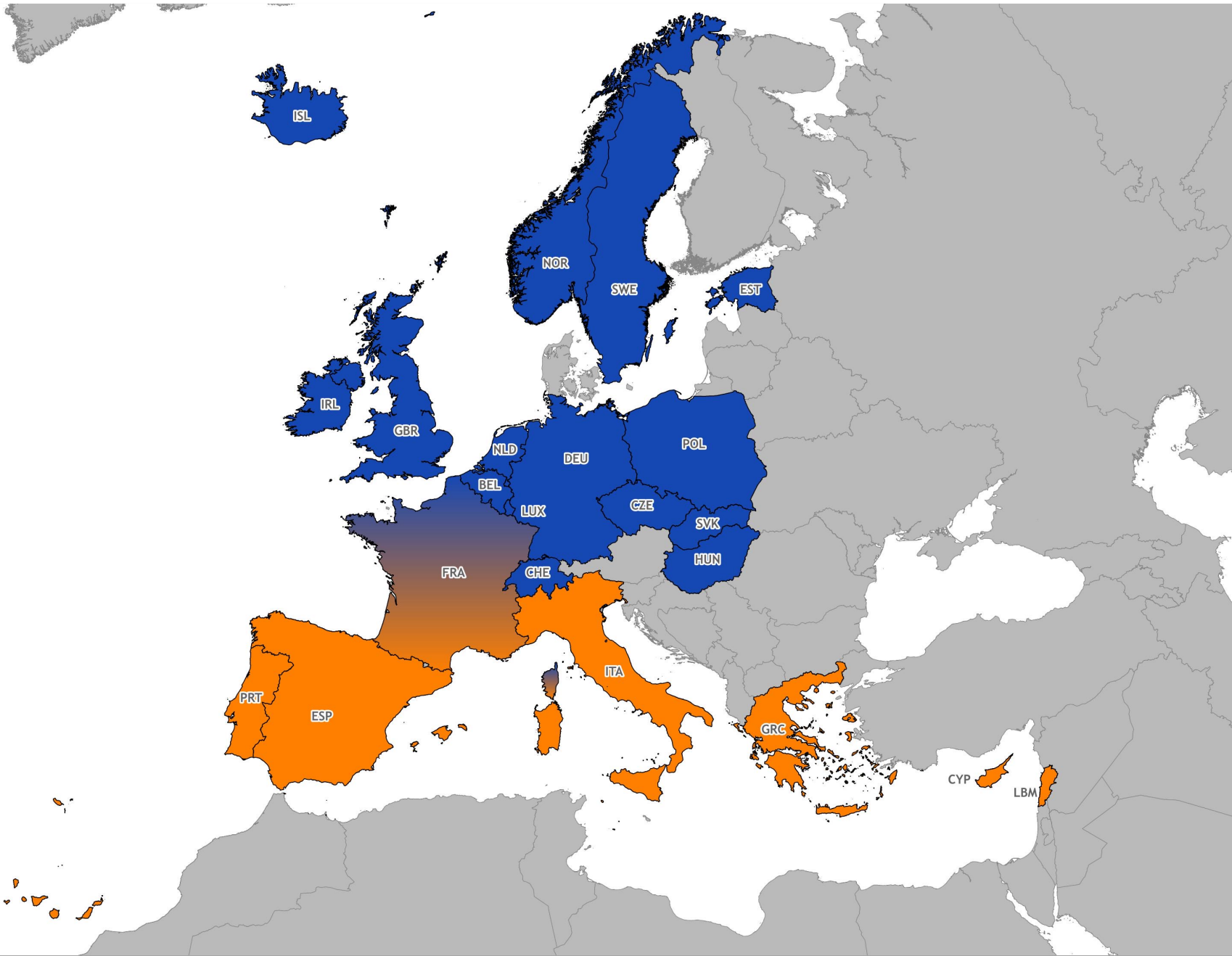
North & Central Europe

- 16714 records
- 4668 taxa

Mediterranean

- 5353 records
- 4843 taxa





North & Central Europe

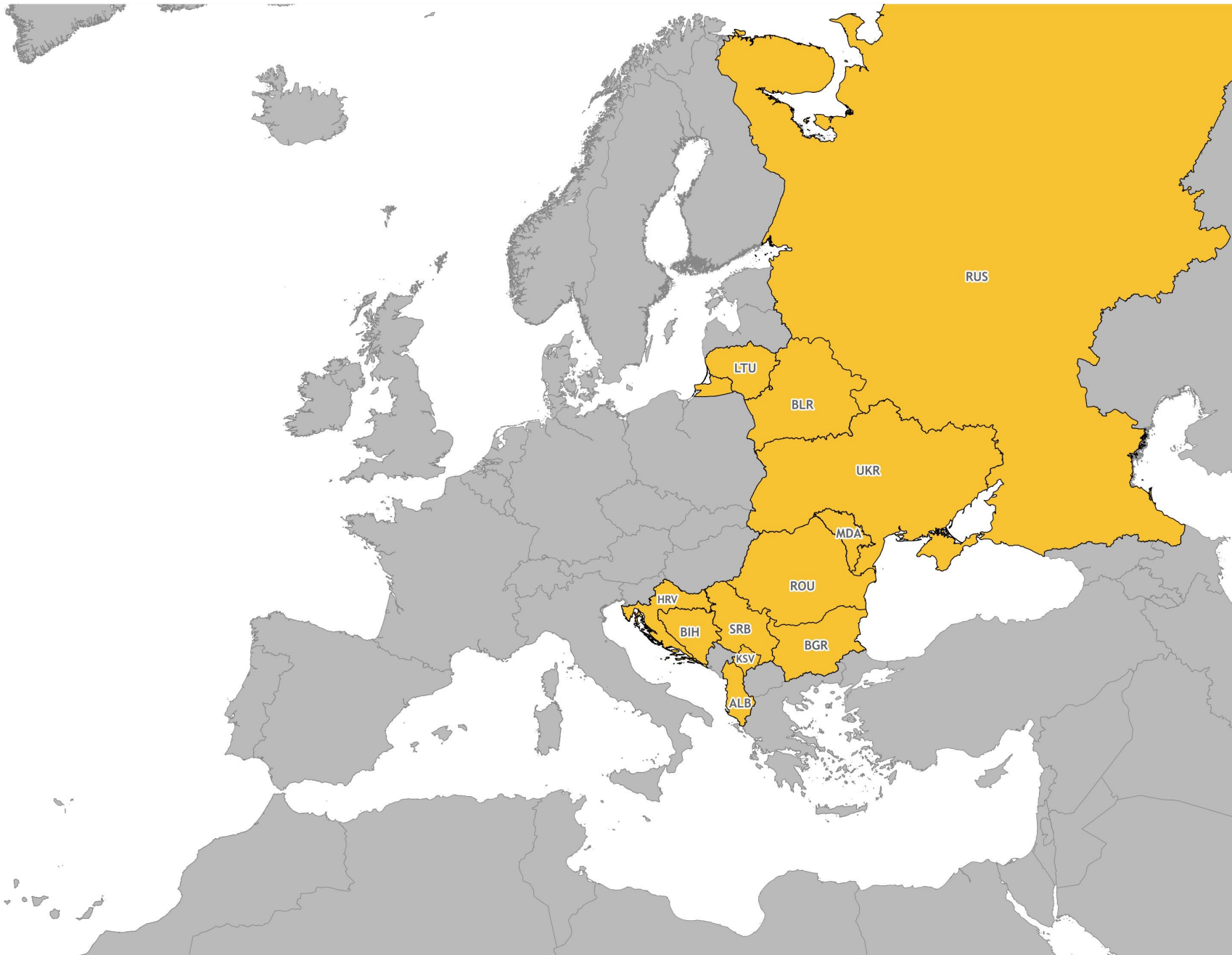
- 16714 records
- 4668 taxa

Μεσόγειος

- 5353 καταγραφές
- 4843 taxa

France

Member of both NC & Med



North & Central Europe

- 16714 records
- 4668 taxa

Mediterranean

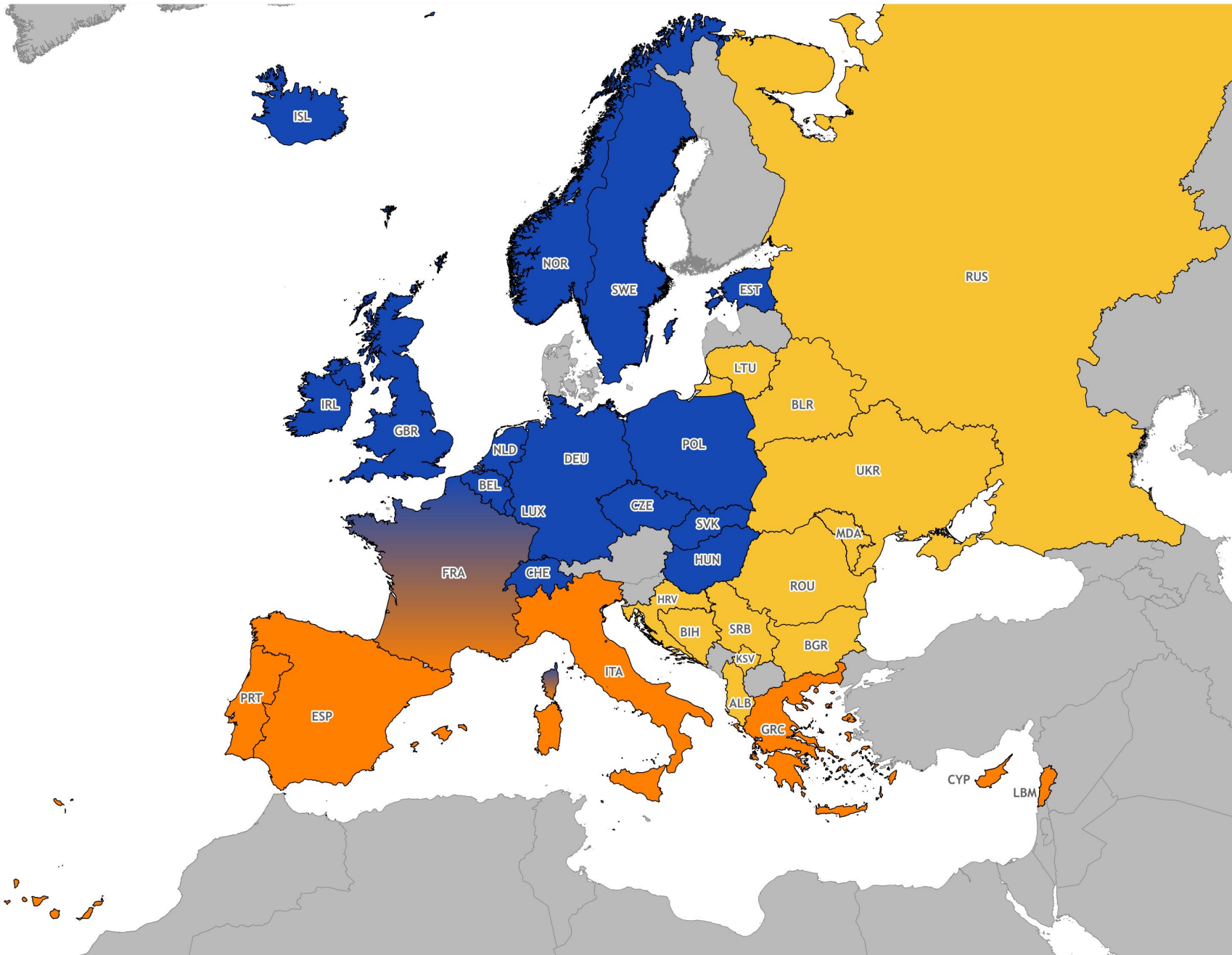
- 5353 records
- 4843 taxa

France

Member of both NC & Med

Balkans & Eastern Europe

- 3667 records
- 2457 taxa



North & Central Europe

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Mediterranean

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- Data validation using all available resources

➤ Med evaluation Team





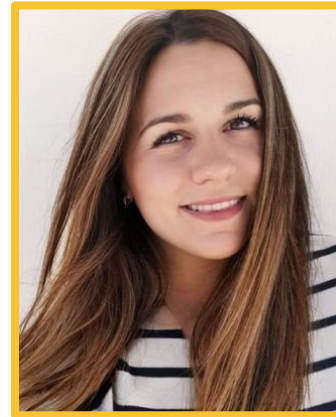
Med evaluation Team



**Theodora
Petanidou**



**Anastasia
Stefanaki**



**Martha
Charitonidou**



Maria Panitsa



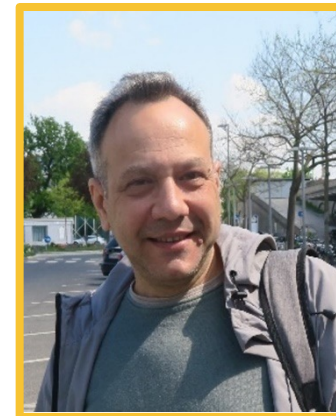
**Aphrodite
Kantsa**



**Amparo
Lázaro**



**Joana
Cursach**



Ioannis Bazos

Mediterranean

- 5353 records
- 4843 taxa

- Data validation using all available resources
- Med evaluation Team

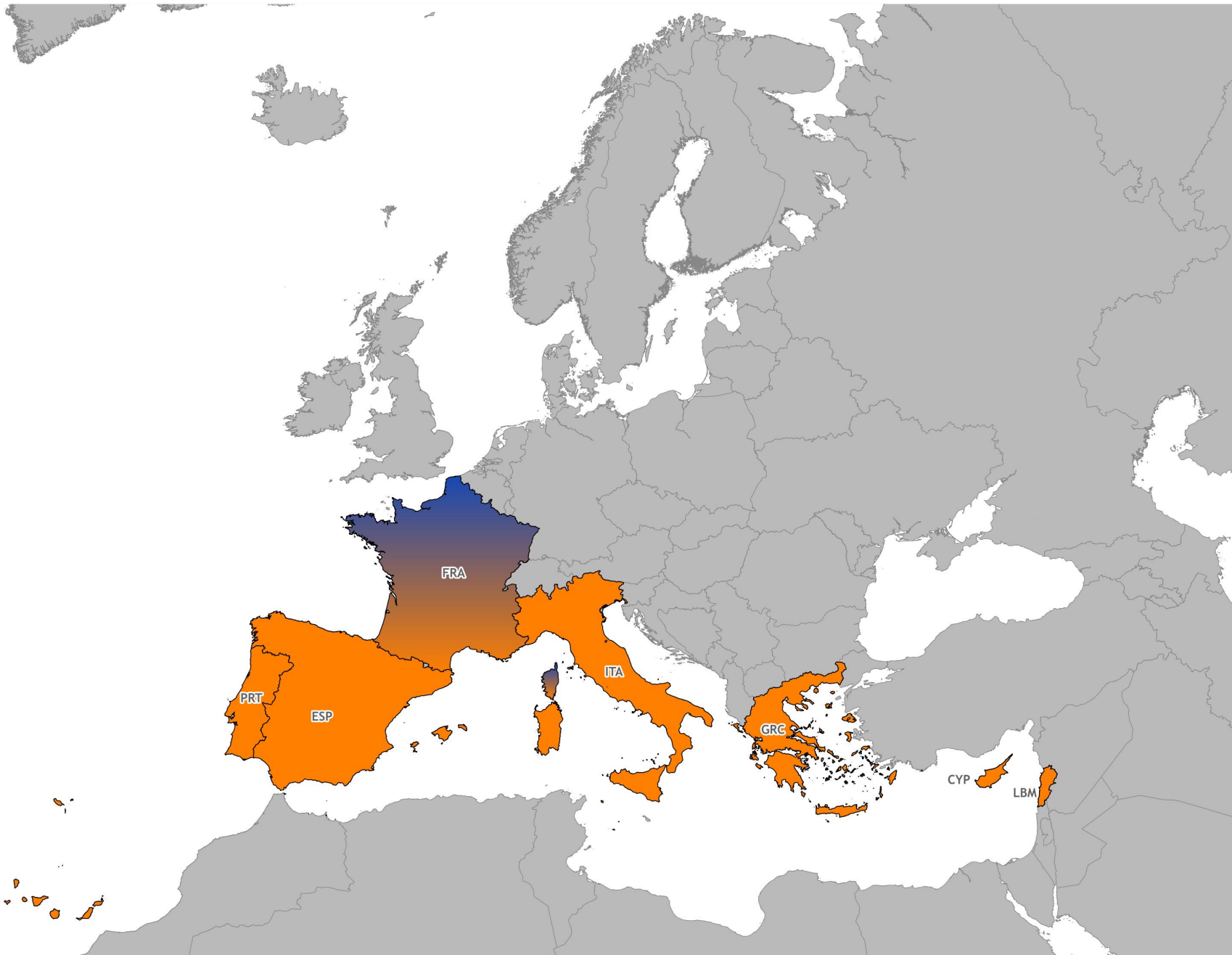
- 90% of total Med assessed

- Add France (south)
- Remove all taxa with LC status

- 7 countries

LBM, CYP, GRC, ITA, FRA, ESP, PRT

- 4156 taxa (4508 records)





Data Analysis

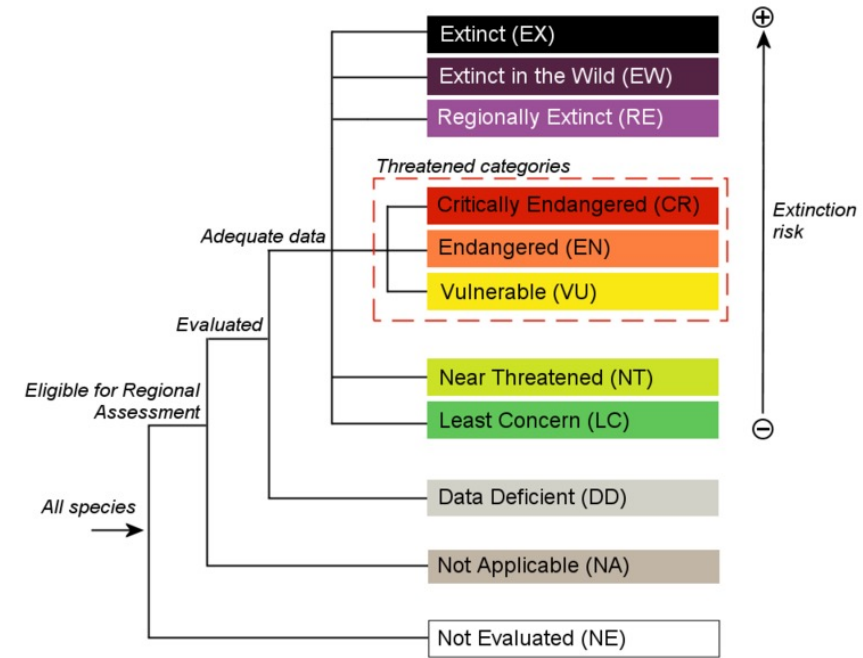
7 countries (LBM, CYP, GRC, ITA, FRA*, ESP, PRT)

→ selected taxa (removing LC ones)

15 variables: 10 intrinsic (incl. floral) + 5 extrinsic

Vulnerability {

- More threatened: EX, EW, RE, EN, CR
- Less threatened: VU, NT, R



3 spatial levels: entire Mediterranean, East Mediterranean, West Mediterranean

Binomial Generalized Linear Mixed Models:

which characteristics can better predict plant vulnerability?

→ better fitted models selected based on a backwards stepwise process (Akaike criterion)

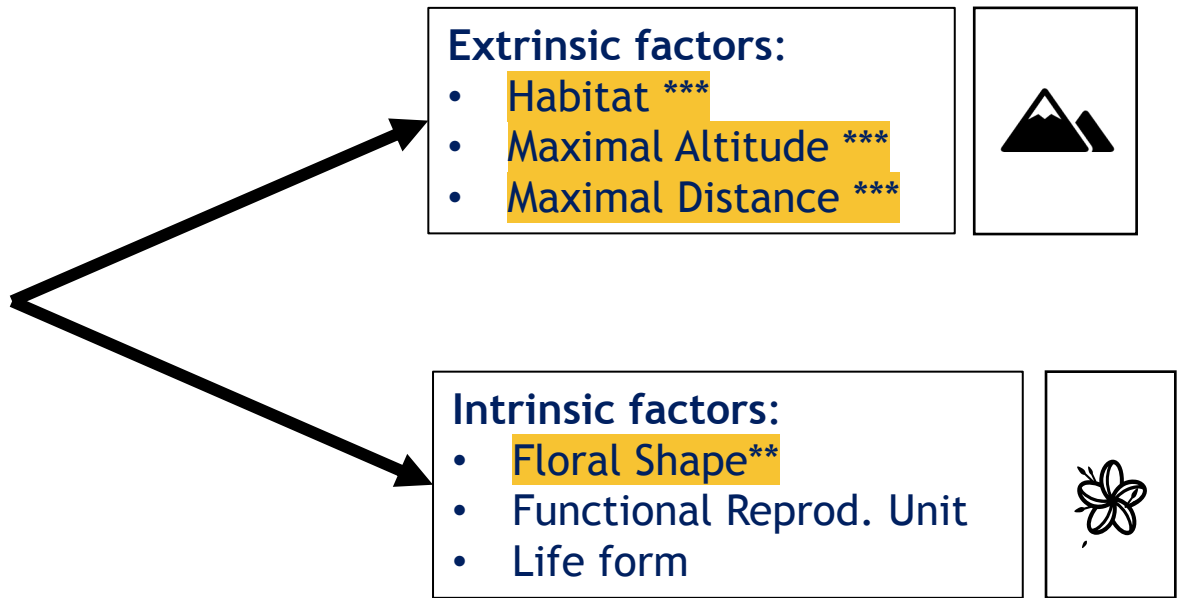


Results: entire Mediterranean

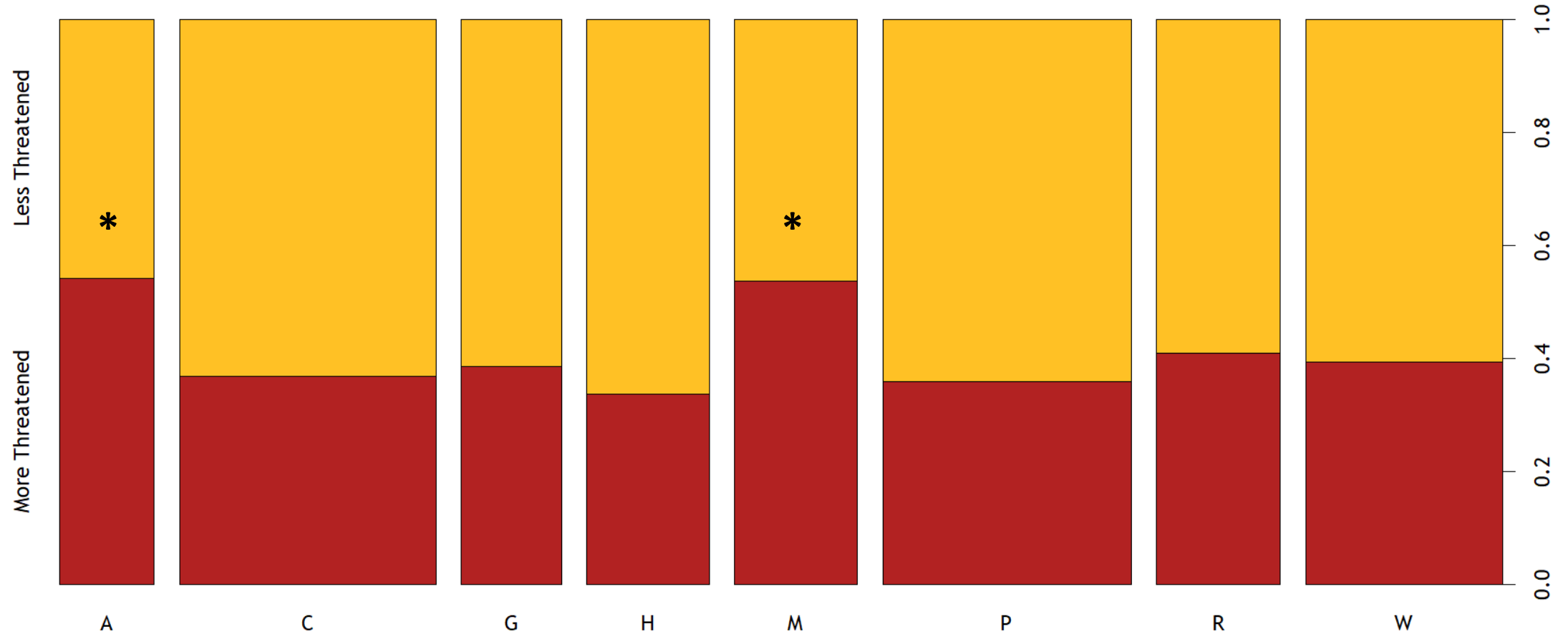


Higher vulnerability
is better predicted by:

(EX, EW, RE, EN, CR)



Habitat ***



A = Freshwater habitats

C = Cliffs, rocks, walls, ravines, boulders

G = Temperate & sub-Mediterranean grasslands

H = High-mountain vegetation

M = Coastal (marine) habitats

P = Xeric Mediterranean phrygana & grasslands

R = Agricultural & Ruderal habitats

W = Woodlands & scrub

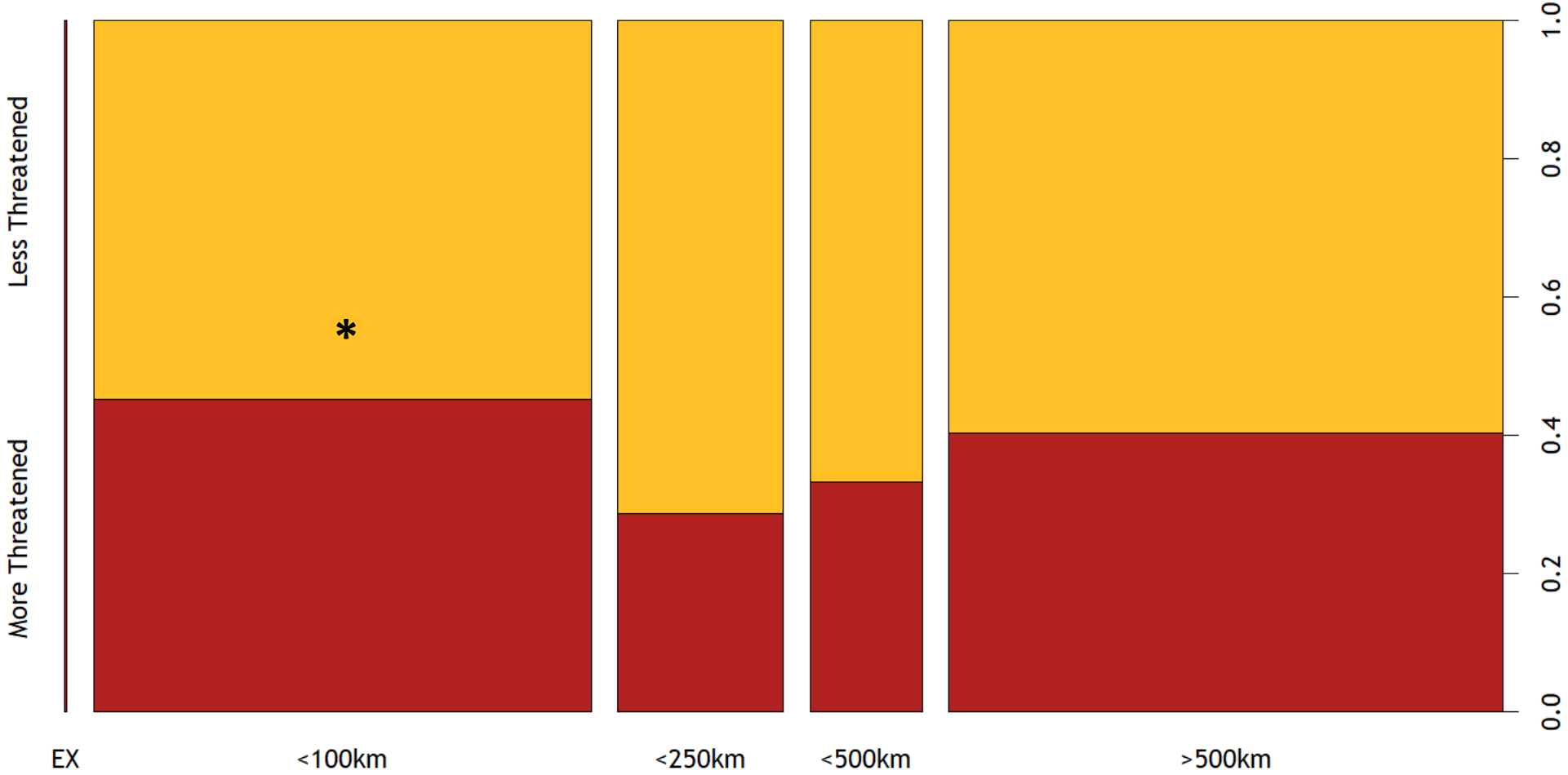


Species of Freshwater & Coastal Habitats are more threatened

**Mediterranean:
Extrinsic factors**



Maximal Distance ***



Range Restricted species (<100km) are more threatened

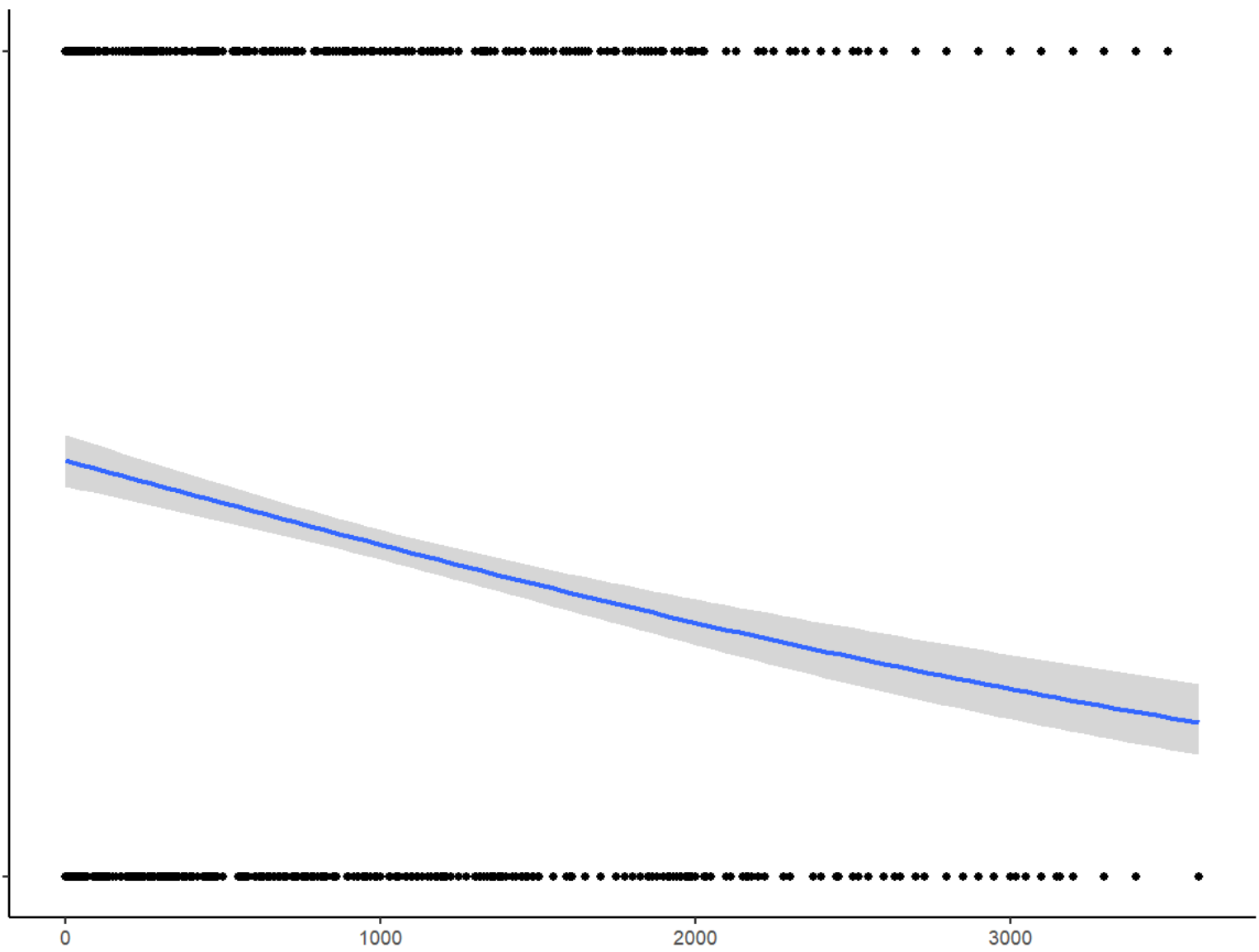
Mediterranean:
Extrinsic factors



More Threatened

Max. Altitude ***

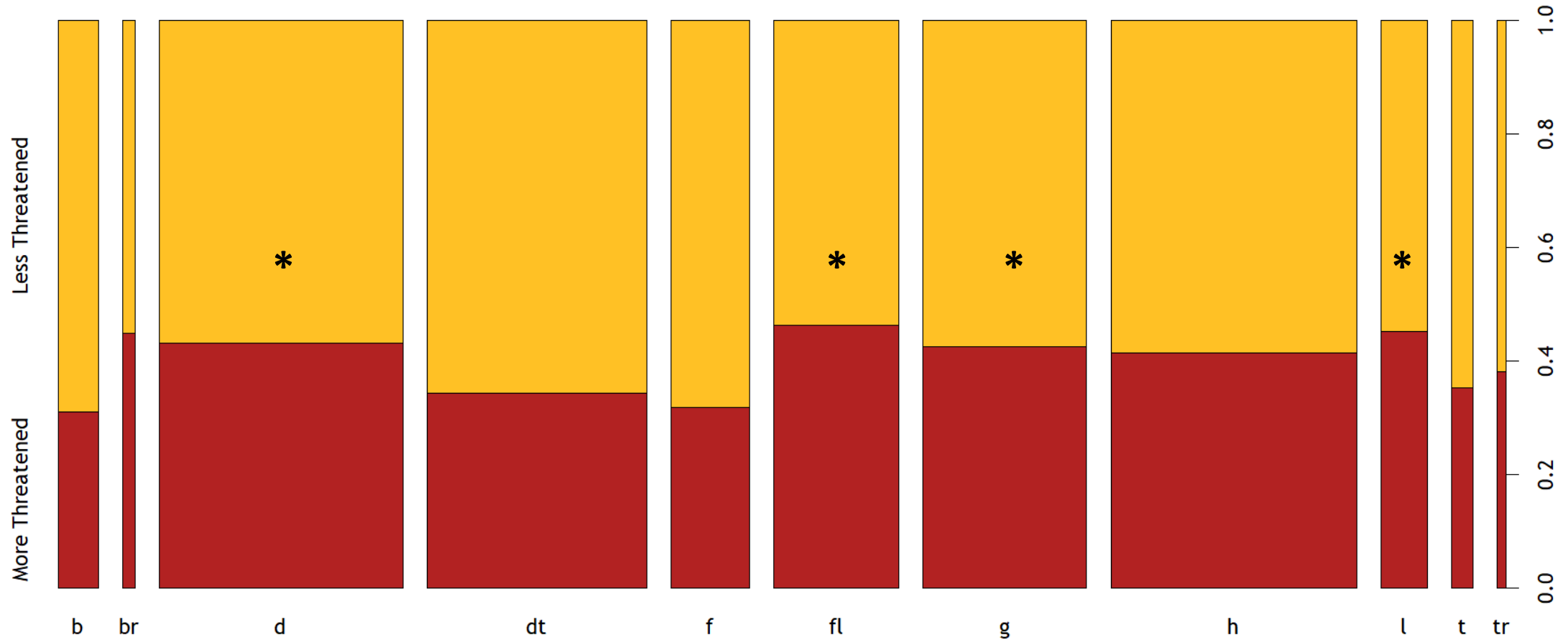
Less Threatened



Species with lower max. altitude are more threatened

Mediterranean:
Extrinsic factors





b = bell-shaped

br = brush-shaped

d = disk-shaped

t = tube-shaped

dt = disk-tube shaped

f = funnel-shaped

fl = flag-shaped

g = gullet-shaped

h = head-shaped

l = lip-shaped

tr = trap flowers



**Species with more complex floral shapes
are more threatened**



Results: W. Mediterranean



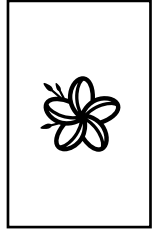
Higher vulnerability
is better predicted by:

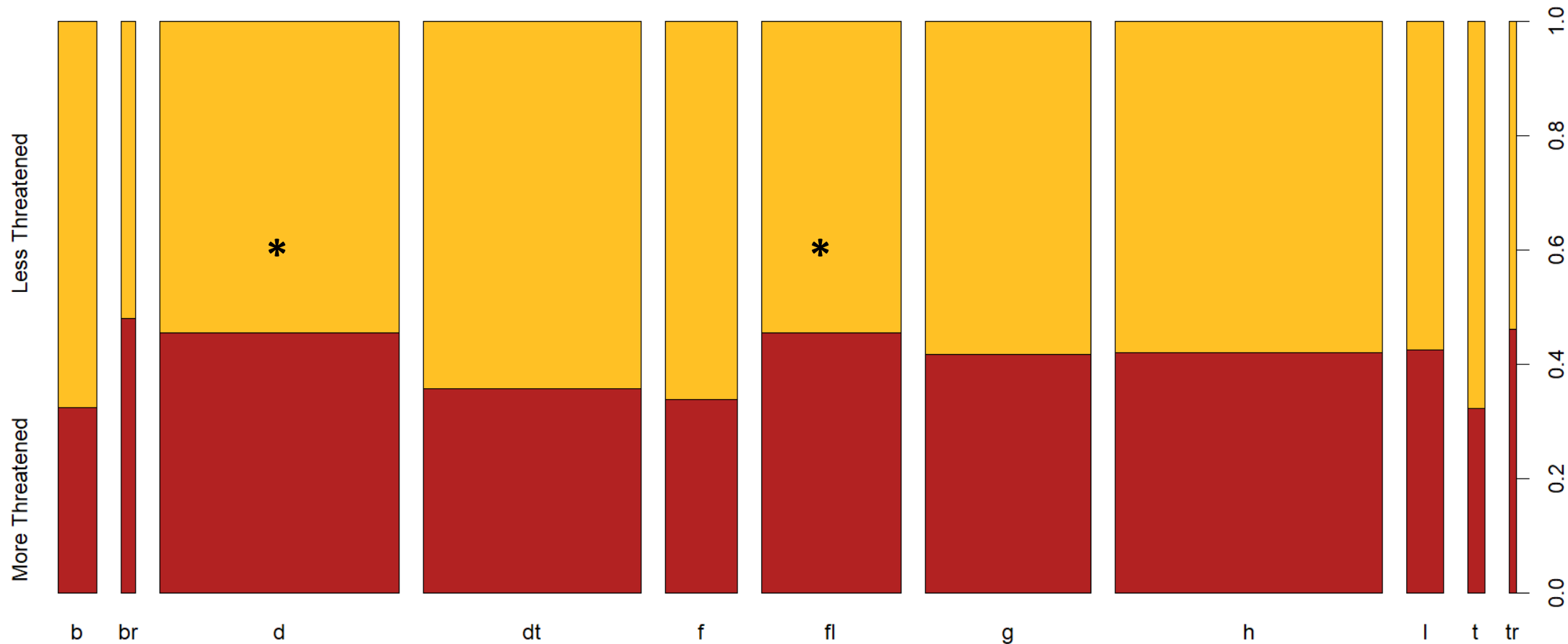
(EX, EW, RE, EN, CR)

- Extrinsic factors:**
- Habitat ***
 - Maximal Altitude ***
 - Maximal Distance ***



- Intrinsic factors:**
- Floral shape **
 - Floral depth *
 - Life form *





b = bell-shaped

br = brush-shaped

d = disc-shaped

t = tube-shaped

dt = disk-tube shaped

f = funnel-shaped

fl = flag-shaped

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h = head-shaped

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tr = trap flowers

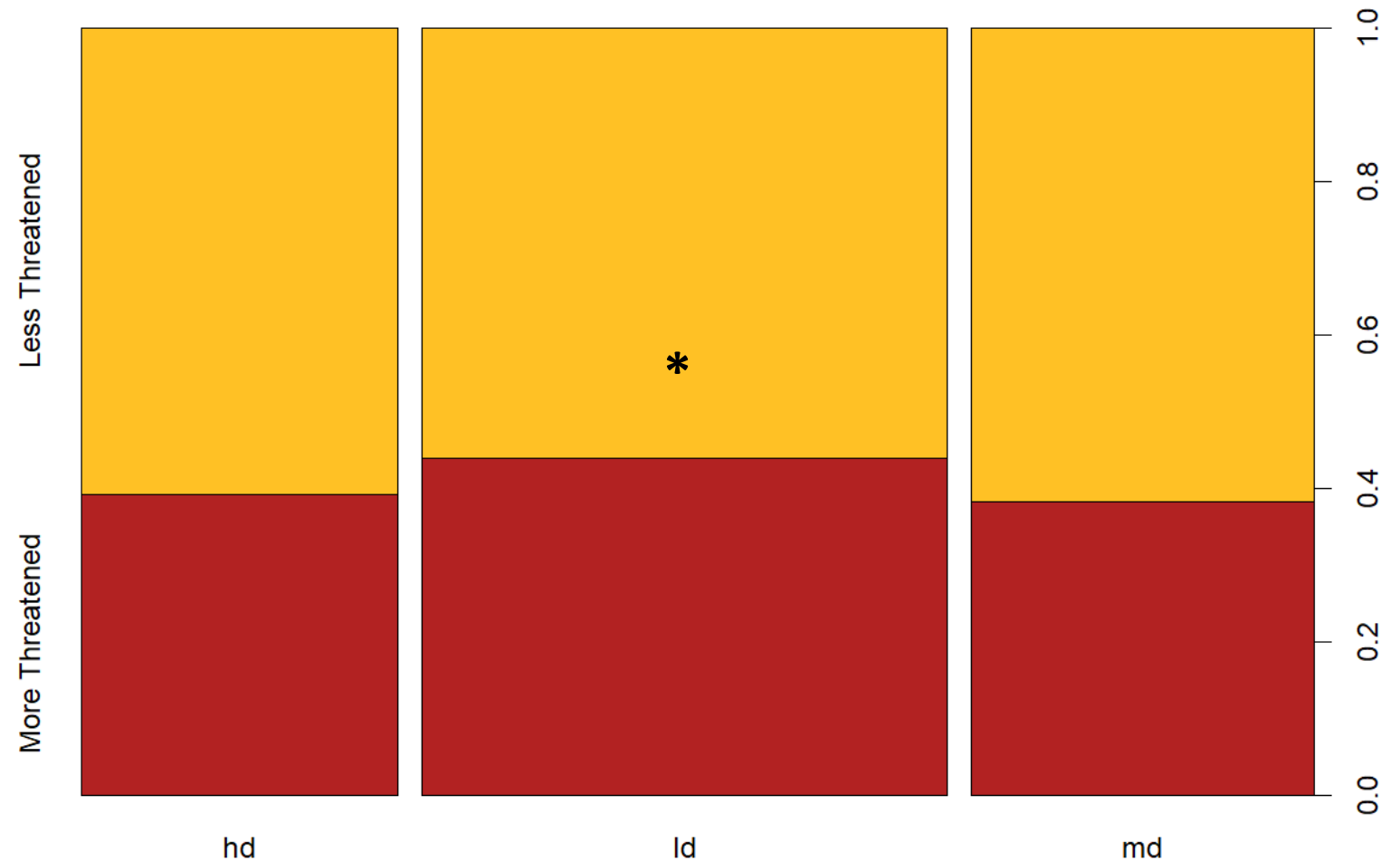


Complex floral shapes (flag) VS simple ones (disc)

Floral Depth *



Corallorhiza trifida - CR (Spain)
(photo: M. Bobocea)



Species with lower floral depth are more threatened

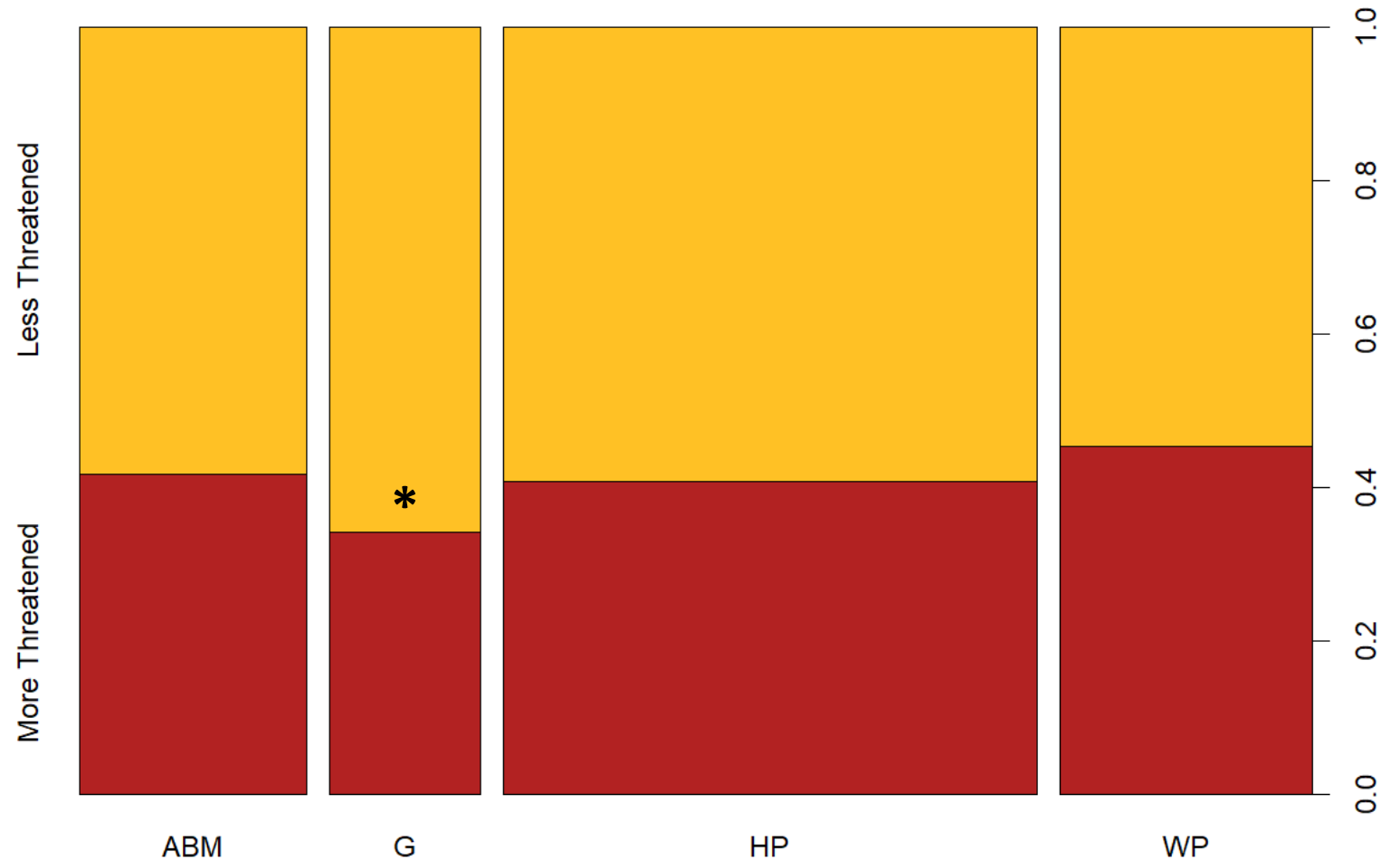
ld = low-depth flowers
md = medium-depth flowers
hd = high-depth flowers



Life Form *



Gennaria diphylla - NT (Italy)
(photo: Orchids of Britain and Europe)



Geophytes are significantly less threatened

ABM = Annuals, biennials and monocarpic perennials

G = Geophytes

HP = Herbaceous perennials

WP = Woody perennials



W. Mediterranean:
Intrinsic Factors



Results: E. Mediterranean



Higher vulnerability is better predicted by:
(EX, EW, RE, EN, CR)

Extrinsic factors:

- Maximal Distance **
- Habitat *
- Maximal Altitude *
- Endemicity *



Intrinsic factors:

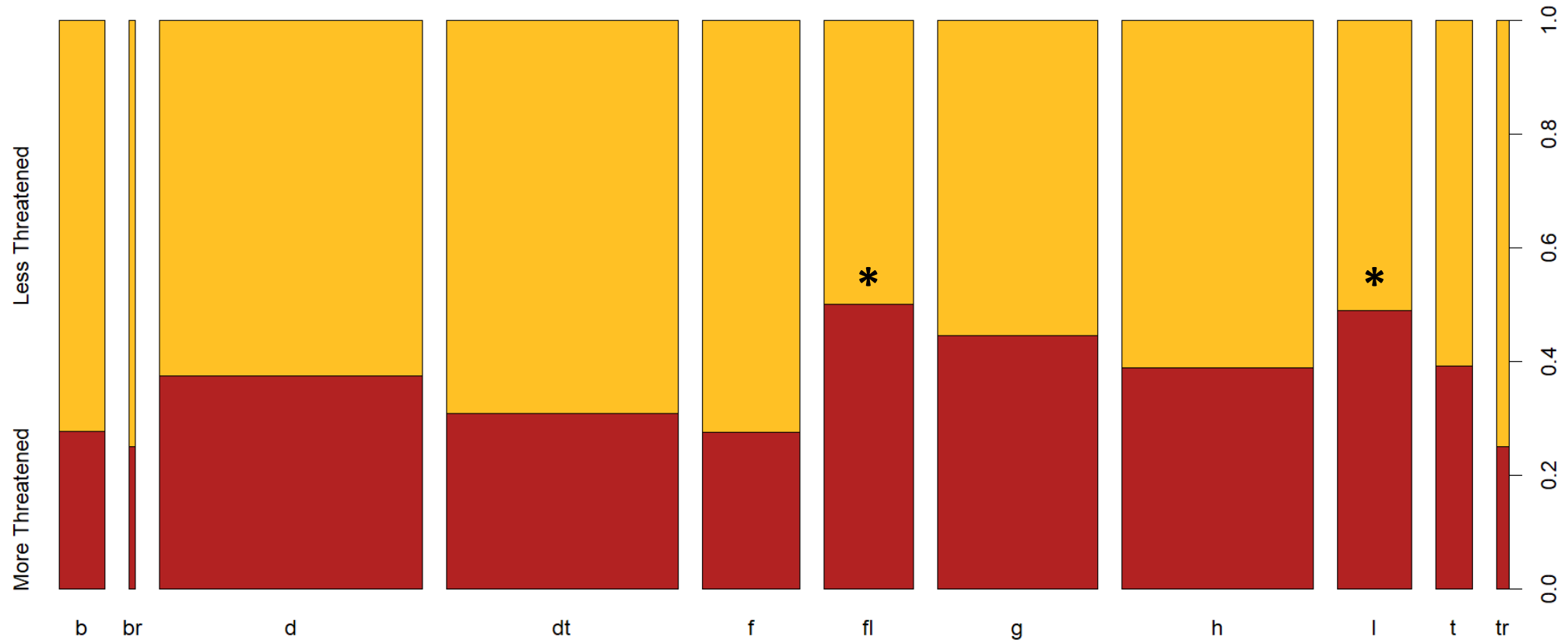
- Floral shape (grouped) **
- Floral symmetry *
- Floral colour *
- Functional Reprod. Unit *





E. Mediterranean: Intrinsic factors

Floral shape *



b = bell-shaped
br = brush-shaped
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Complex floral shapes (flag/lip) linked with higher vulnerability



E. Mediterranean: Intrinsic factors



Iris bismarckiana
CR (Lebanon)



Dactylorhiza pythagorae
CR (Greece)

VS

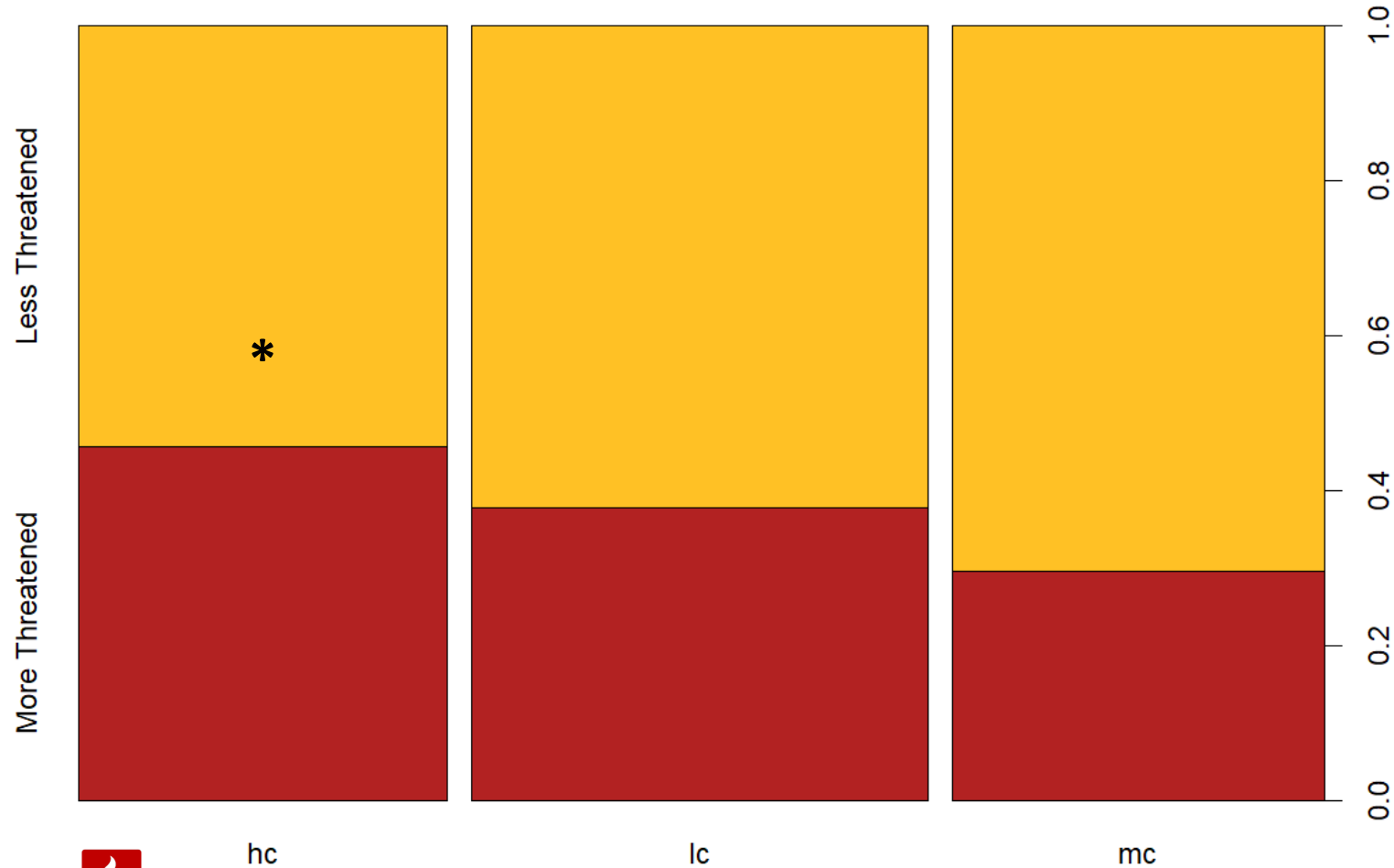


Soldanella rhodopaea
NT (Greece)



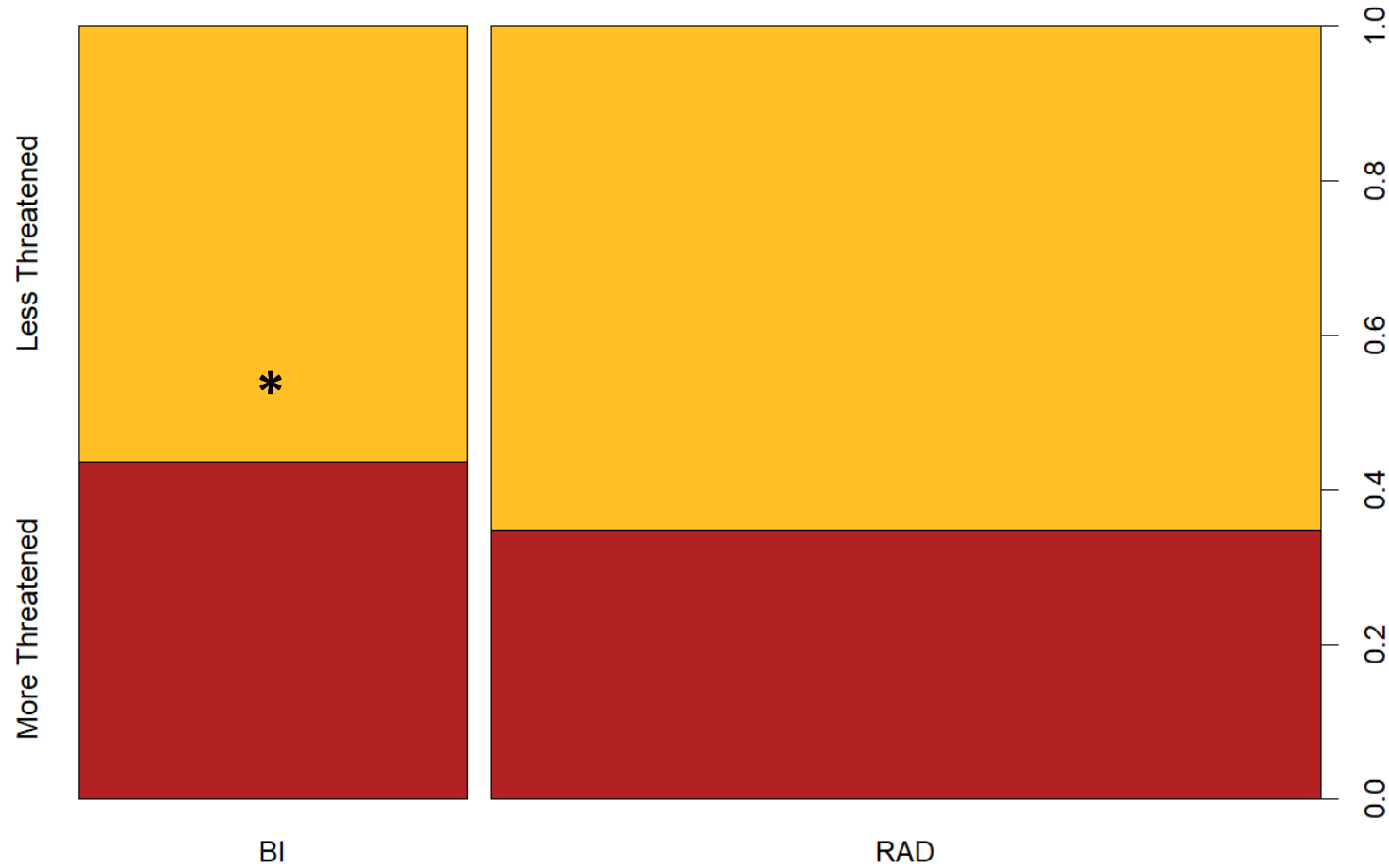
Fritillaria rhodia
R (Greece)

Floral shape (grouped) **



Complex floral shapes (flag/lip) linked with higher vulnerability

Floral symmetry *



Bilateral symmetry of flowers linked with higher vulnerability

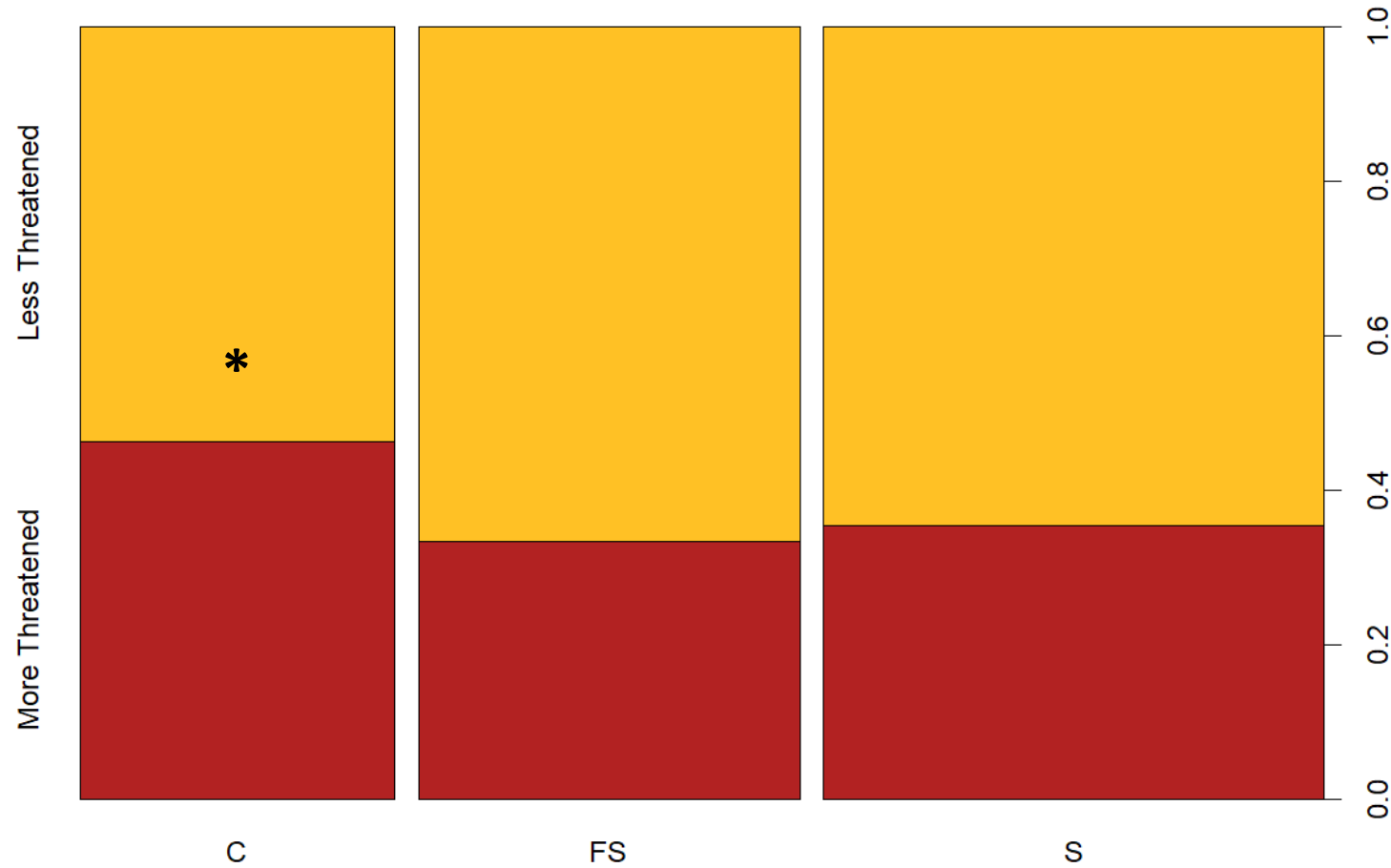
E. Mediterranean: Intrinsic factors



Pseudorchis albida
CR (Greece)

Functional Reproductive Unit *

E. Mediterranean: Intrinsic factors



Orchis punctulata
CR (Greece)



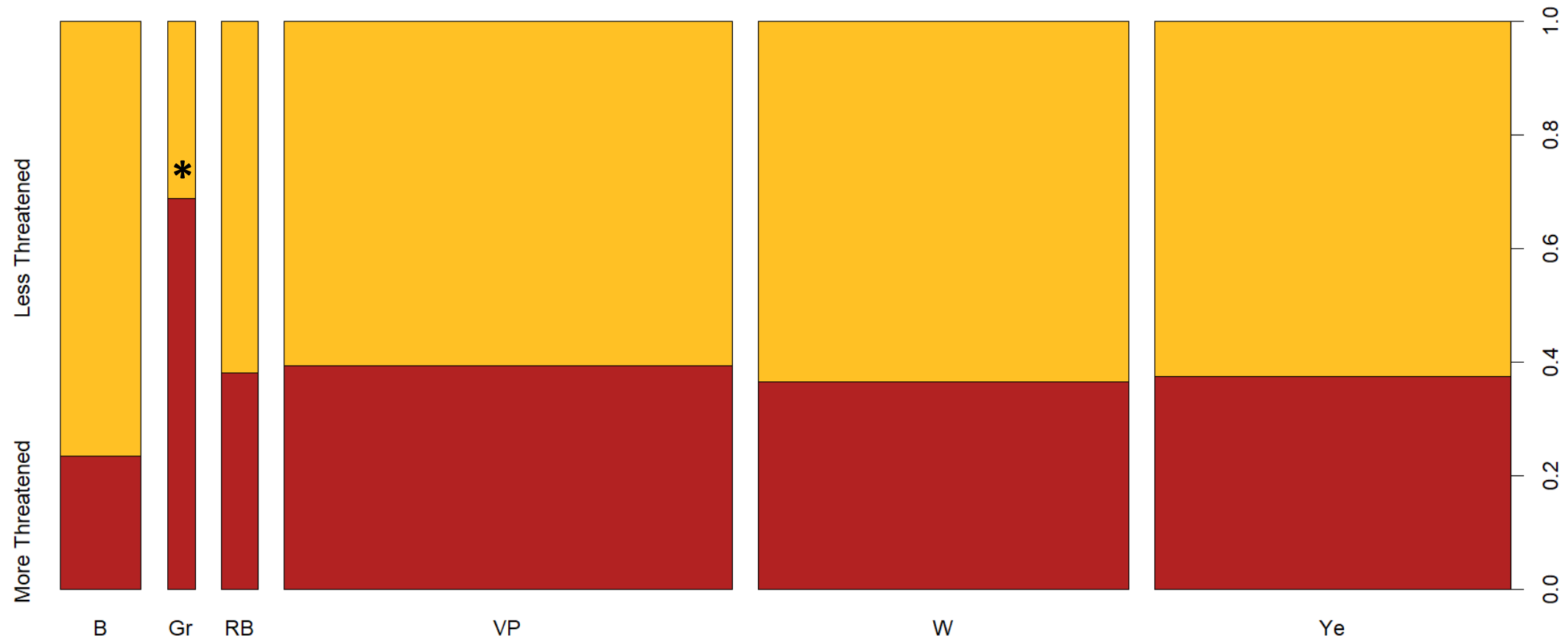
Cylindrical FRUs linked with higher vulnerability

C = cylindrical (spike, racemes, panicles)

FS = flat/spherical (heads, umbels, corymbs)

S = single (incl. also inflorescences with up to 5 concurrently functional flowers)

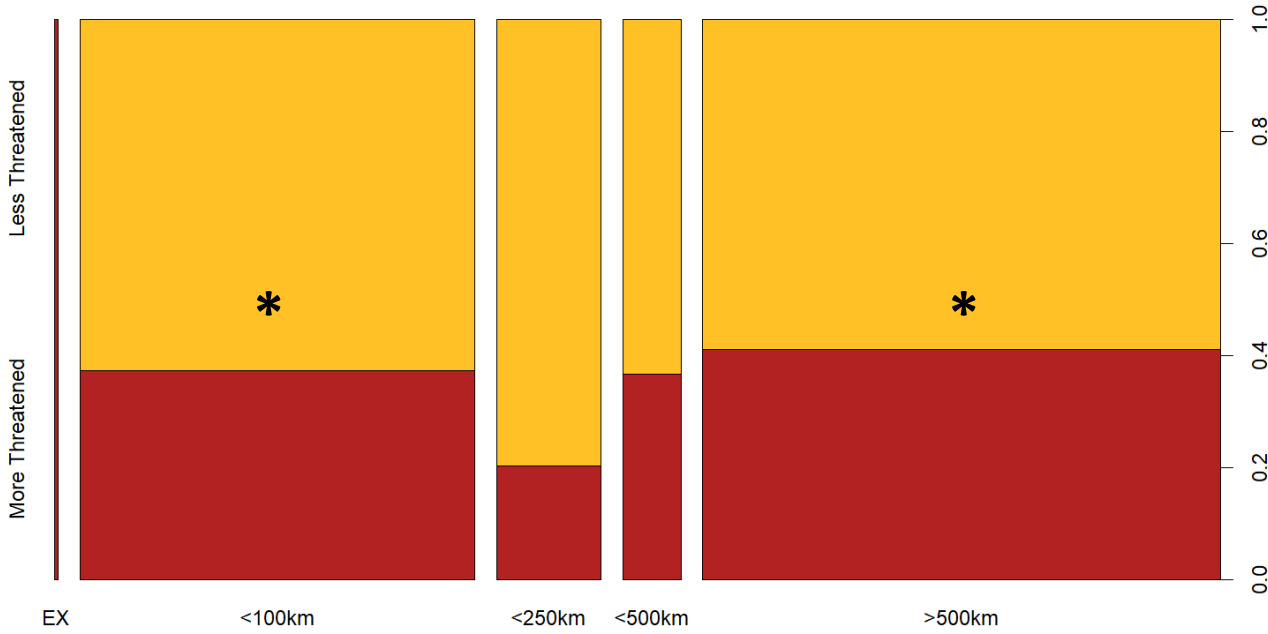
Floral colour *



Green-coloured flowers are more threatened



E. Mediterranean: The 'paradox' of extrinsic factors



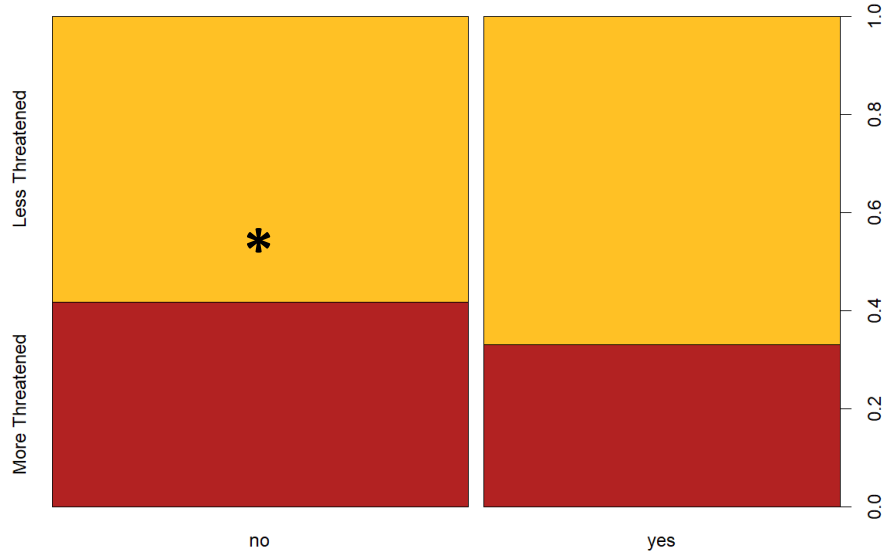
Range restricted VS widespread



Non-endemics VS endemics

E. Mediterranean: a botanical crossroad

- includes widespread species at their **distributional margins** (southern/western/eastern borders)
- includes various **widespread local endemics** (e.g. *Sideritis* species, Greece)






Results in brief

Entire
Mediterranean

West
Mediterranean

East
Mediterranean

	<p style="text-align: center;">Habitat</p> <p style="text-align: center;">Maximal Altitude</p> <p style="text-align: center;">Maximal Distance between populations</p> <p style="text-align: right;">Endemicity *</p>		
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	Floral shape	Floral shape Floral depth Life form	Floral shape Floral symmetry Floral colour FRU
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Key results in detail

- 1. Marine & Freshwater habitats** host more threatened species
(high significance in all spatial levels)
- 2. Species of lower altitudes** are more vulnerable towards extinction
(high significance in all spatial levels)
- 3. Range-restricted & widespread** species are more threatened
(high significance in all spatial levels)
- 4. Floral (intrinsic) characteristics** are significant predictors of plant vulnerability
 - **Floral shape** (all spatial levels): more complex shapes = more threatened species
 - **Depth (WMed) + symmetry, colour, FRU (EMed)**



What comes next?



- Build the Floral Complexity Index:
 - Two levels: (a) weights given by **experts' opinion**
(b) weights based on **model significance**
- Include the FCI in the analysis
- Complete the scientific paper!

We're almost there...

