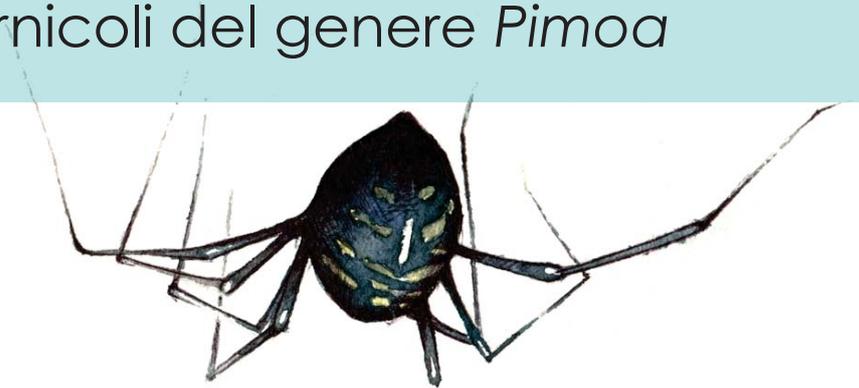




Filogeografia, ecologia e storia naturale dei ragni cavernicoli del genere *Pimoa*

Stefano Mammola

Marco Isaia
Elena Piano
Gustavo Hormiga
Miquel A. Arnedo



Meta menardi



Outline

- Introduzione
- Filogeografia
- Tassonomia
- Nicchia ecologica

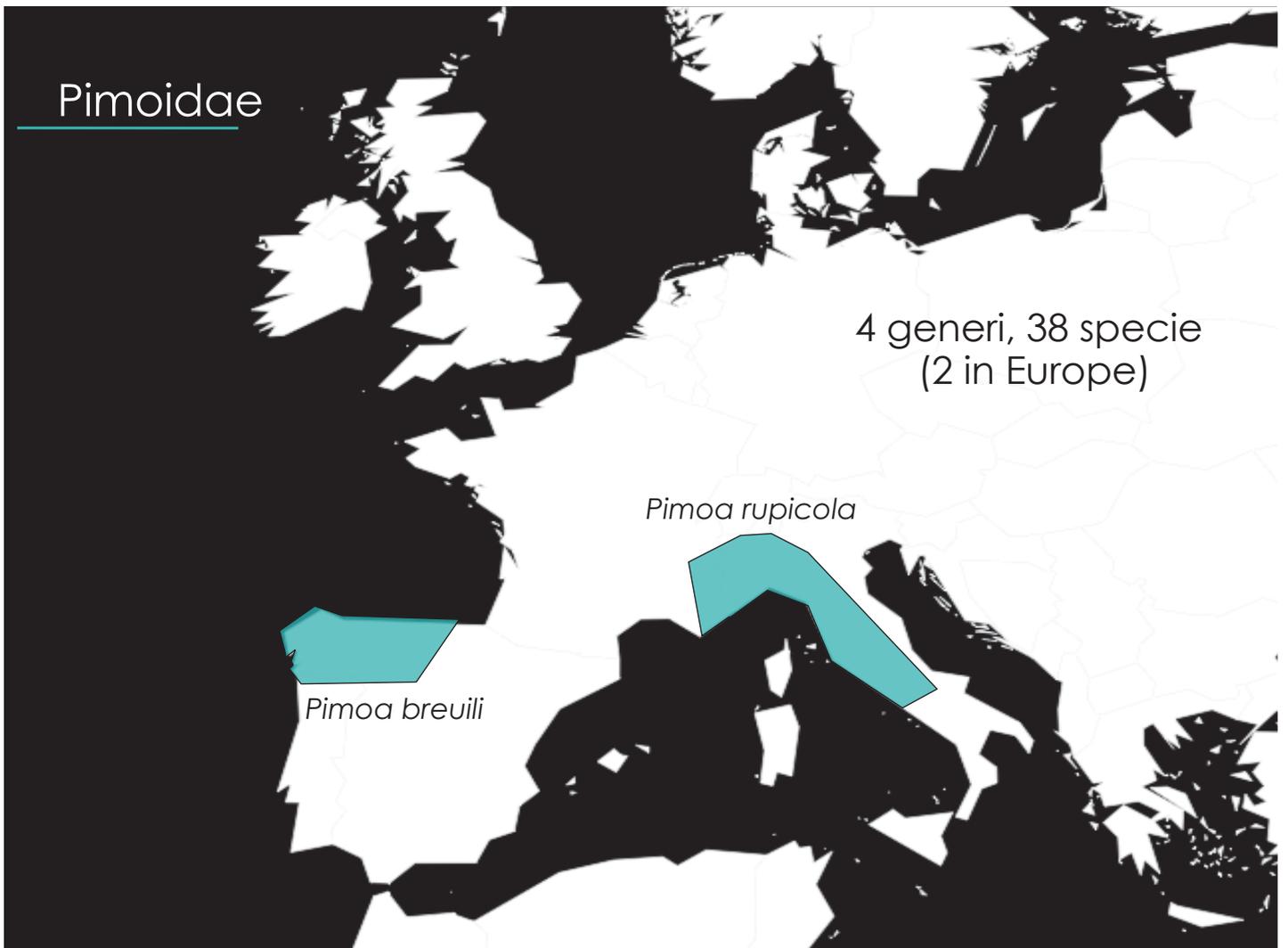


Pimoidae

4 generi, 38 specie
(2 in Europe)

Pimoa brevili

Pimoa rupicola



Pimoa rupicola (Pimoidae)



Habitat



Zona liminare/subliminare

Habitat

Miniere, bunker,
cantine

Habitat

Lettiera



Pietraie



MSS



Occasionalmente in ambienti più superficiali

[Bertaku, 1890; Jackson, 1926; Thaler, 1976; Hormiga, 1994; Isaia *et al.*, 2014, 2015]

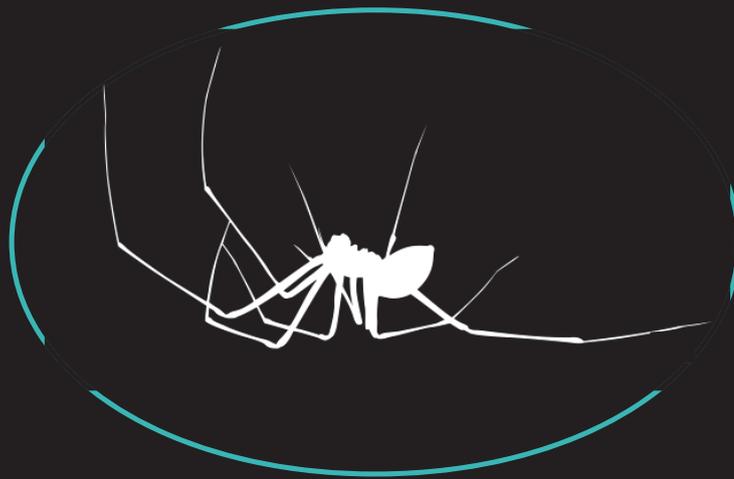
Outline

Introduzione

● Filogeografia

Tassonomia

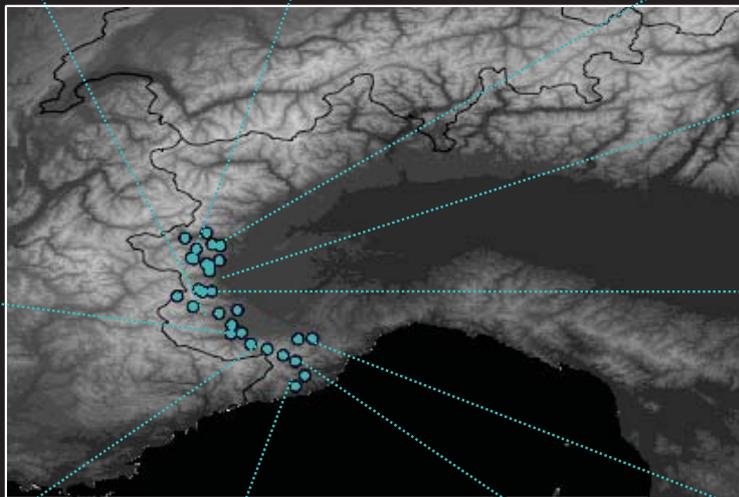
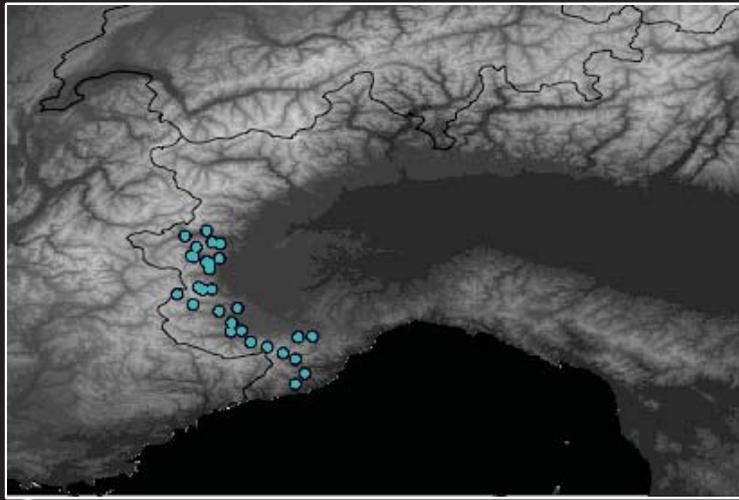
Nicchia ecologica



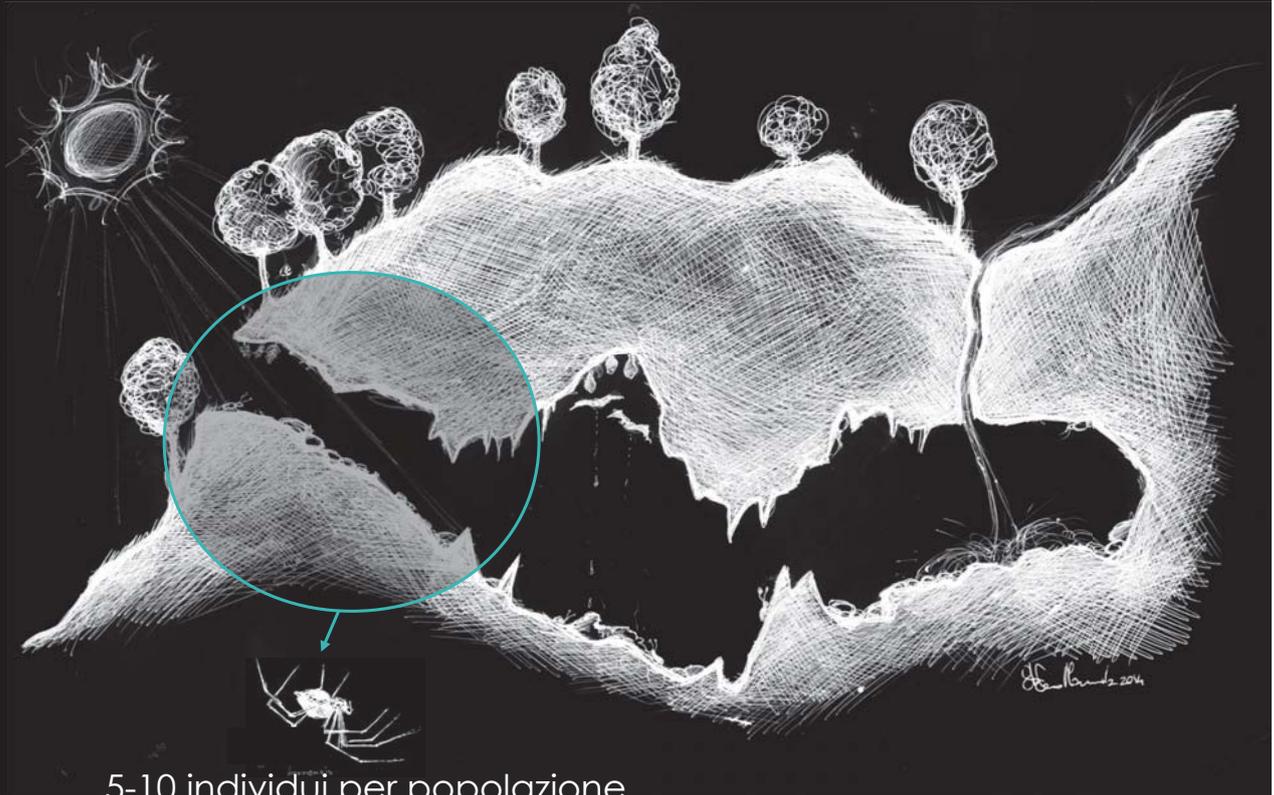
Quali eventi climatici passati hanno determinato l'odierna struttura di popolazione in questi ragni ?

Campionamento

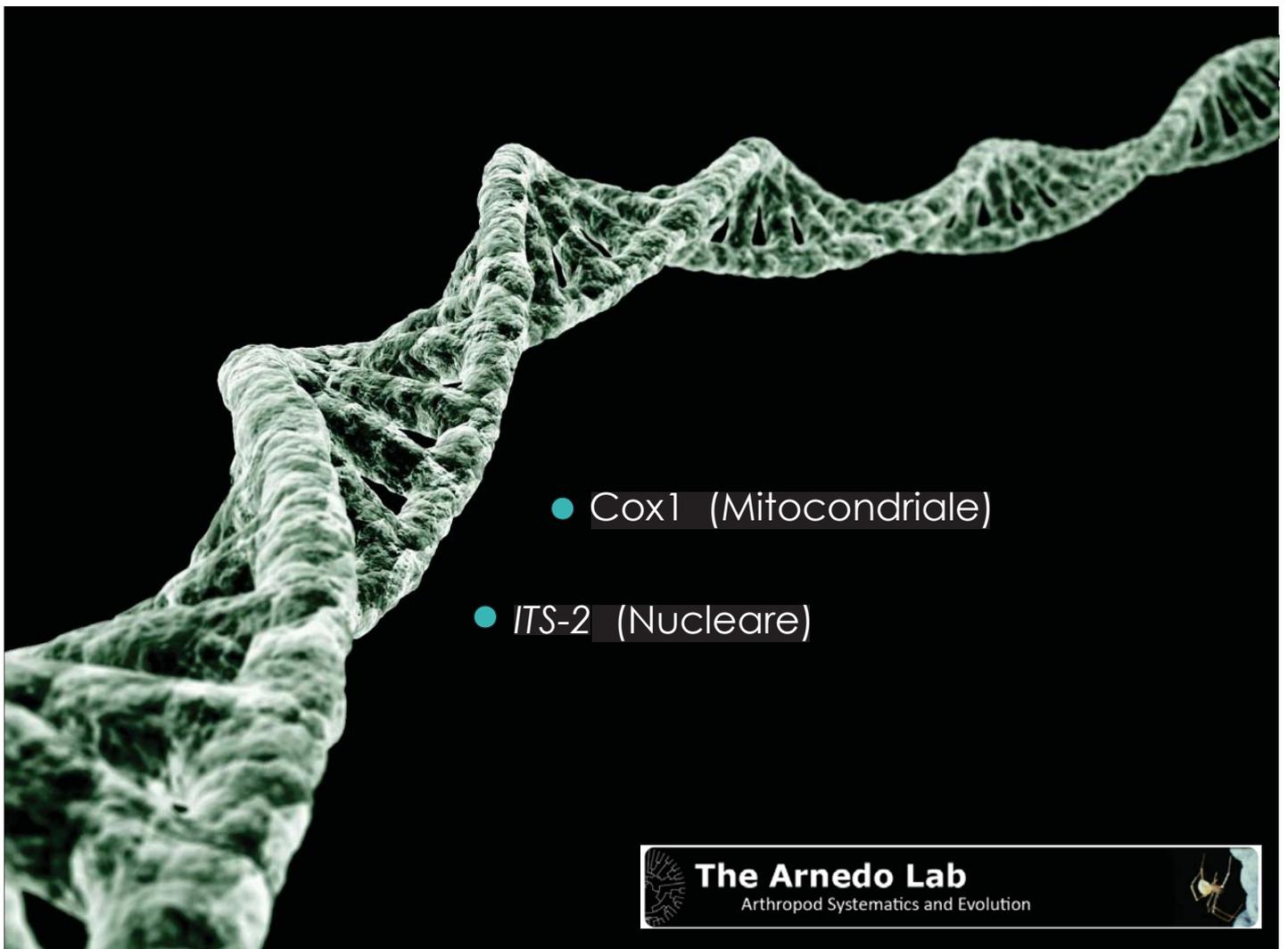
28 popolazioni



Campionamento



5-10 individui per popolazione



● Cox1 (Mitocondriale)

● ITS-2 (Nucleare)

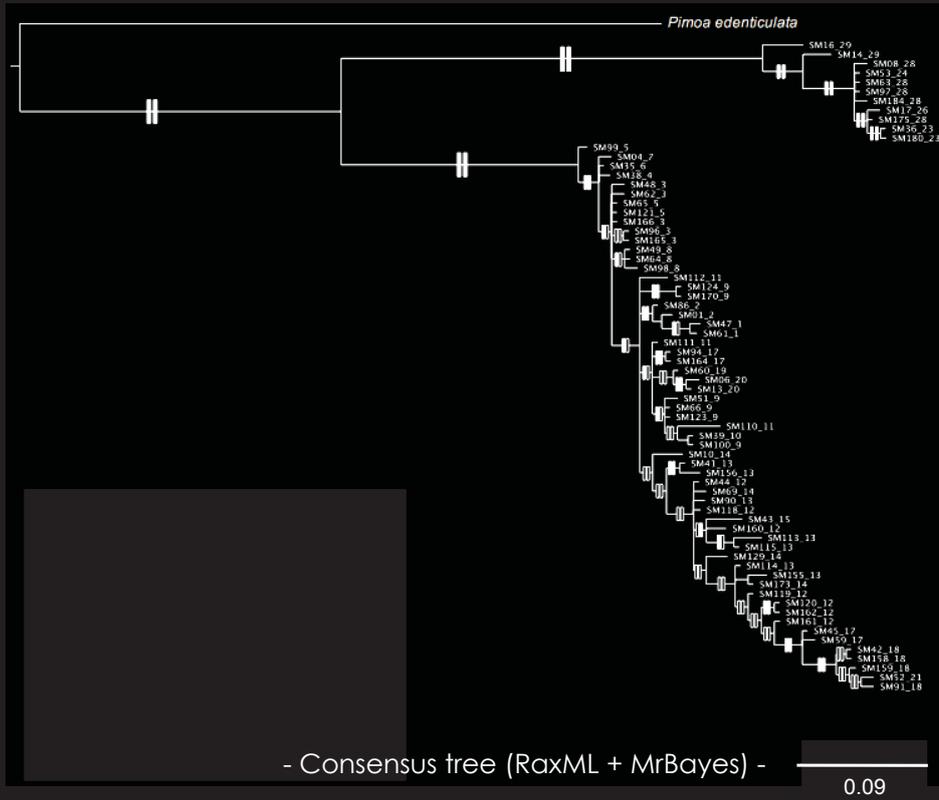


The Arnedo Lab

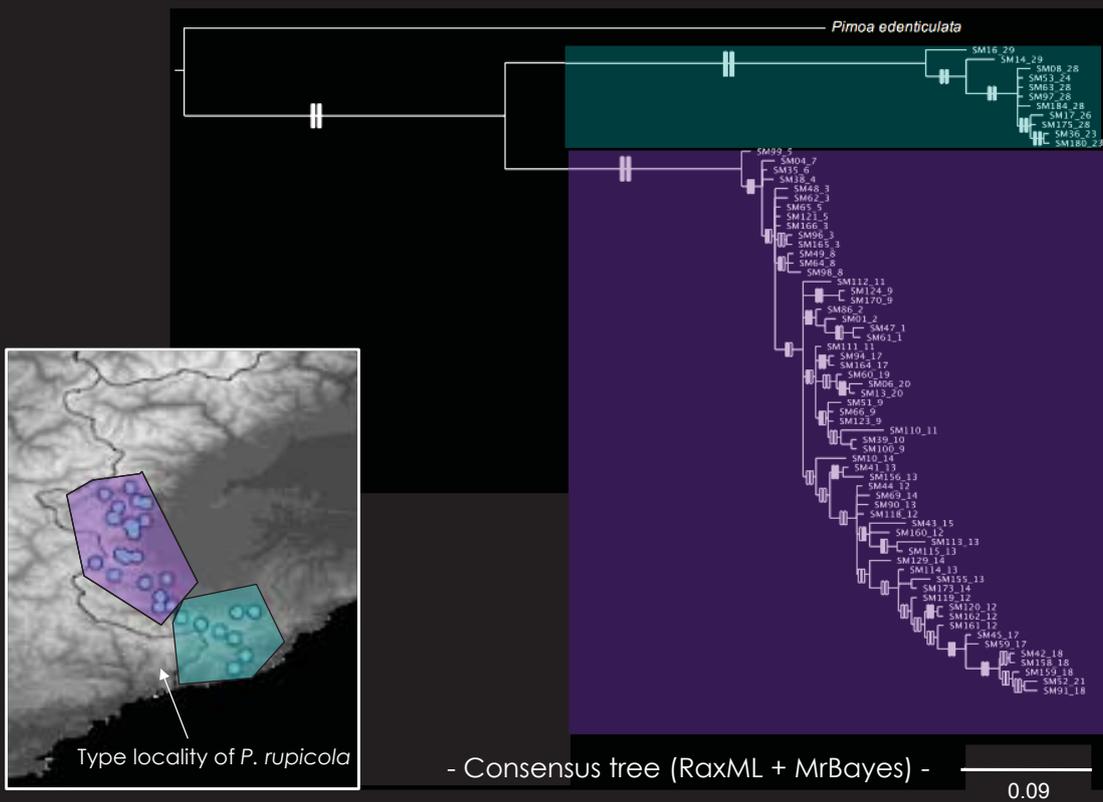
Arthropod Systematics and Evolution



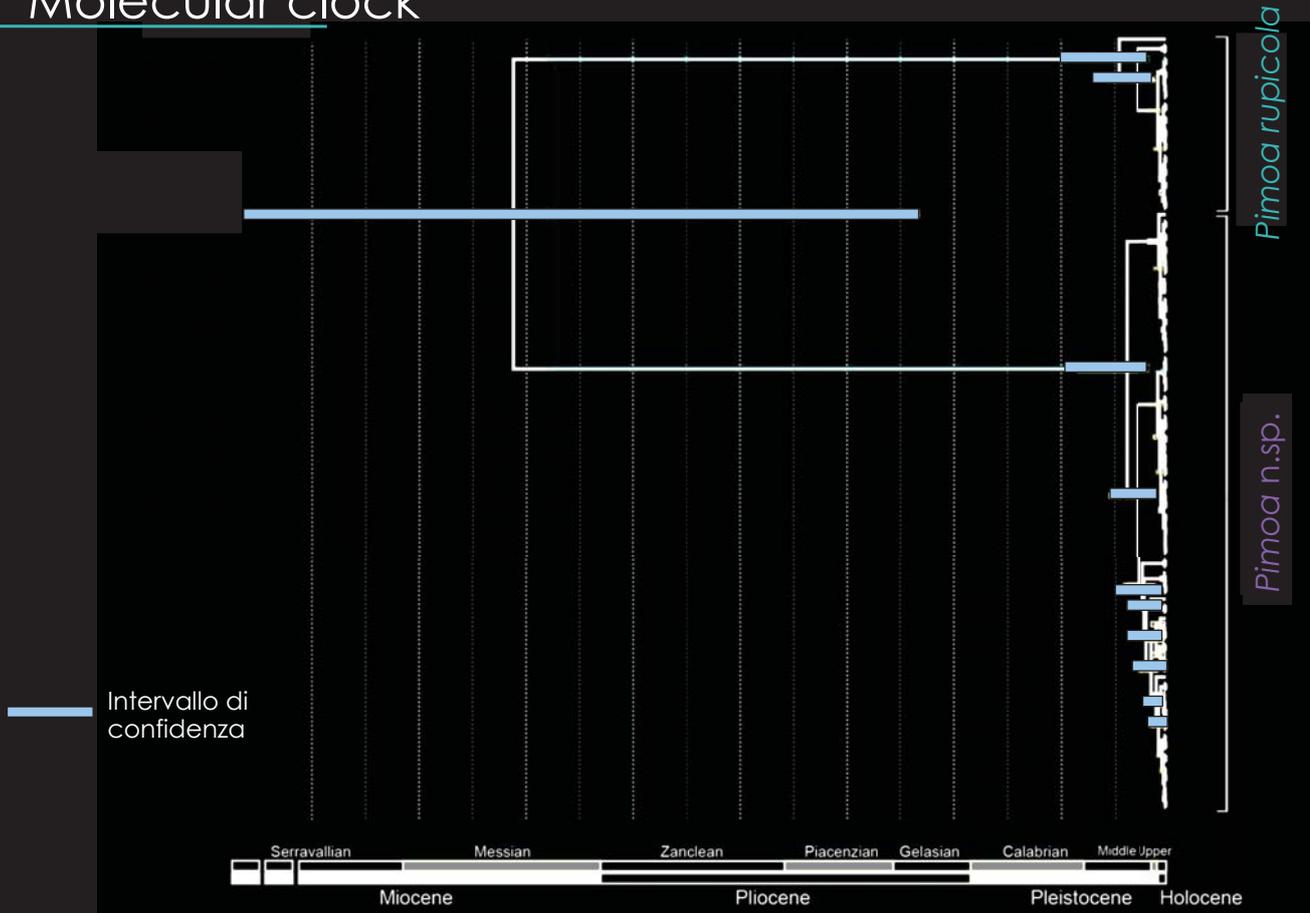
Filogenesi



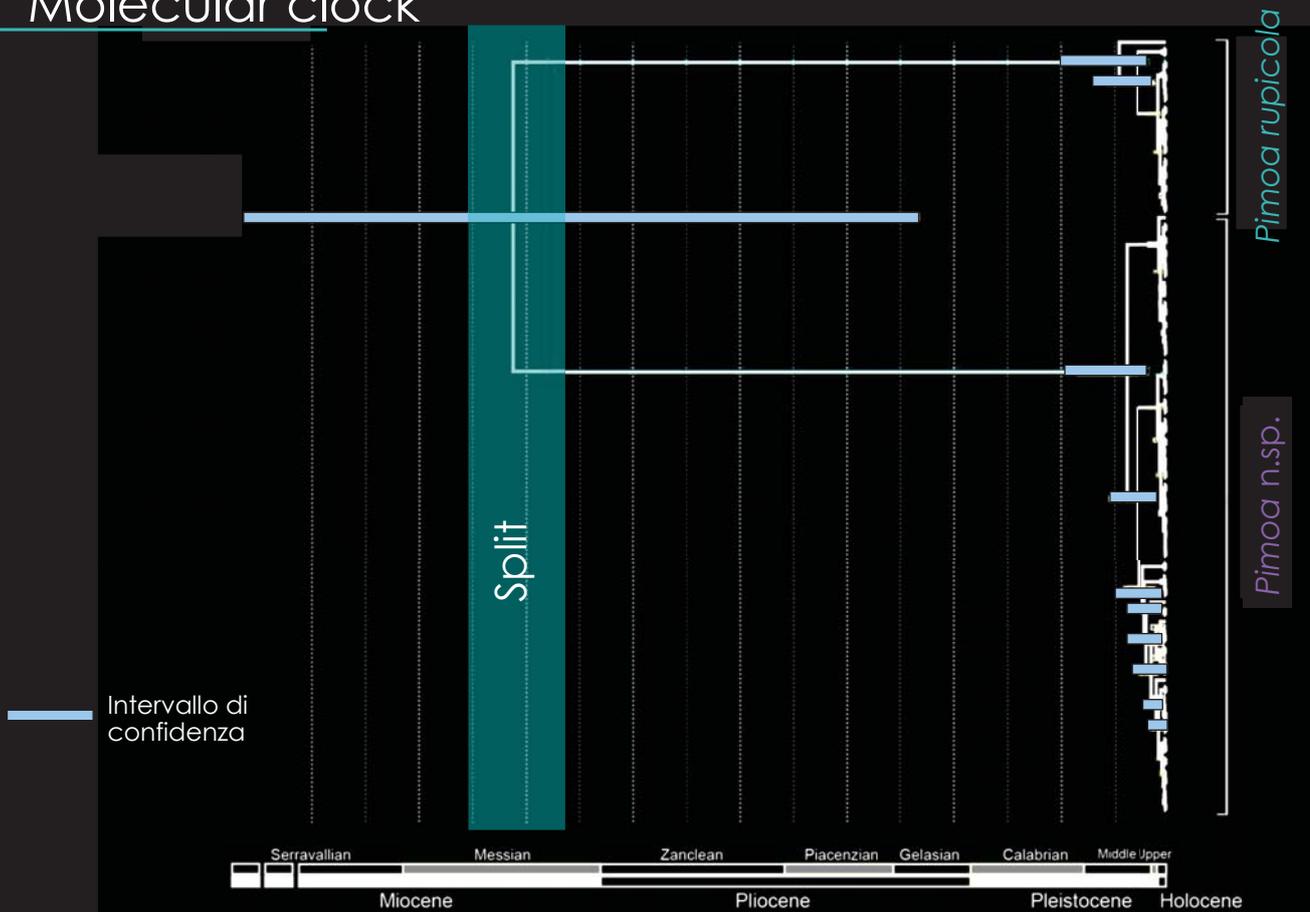
Filogenesi



Molecular clock



Molecular clock

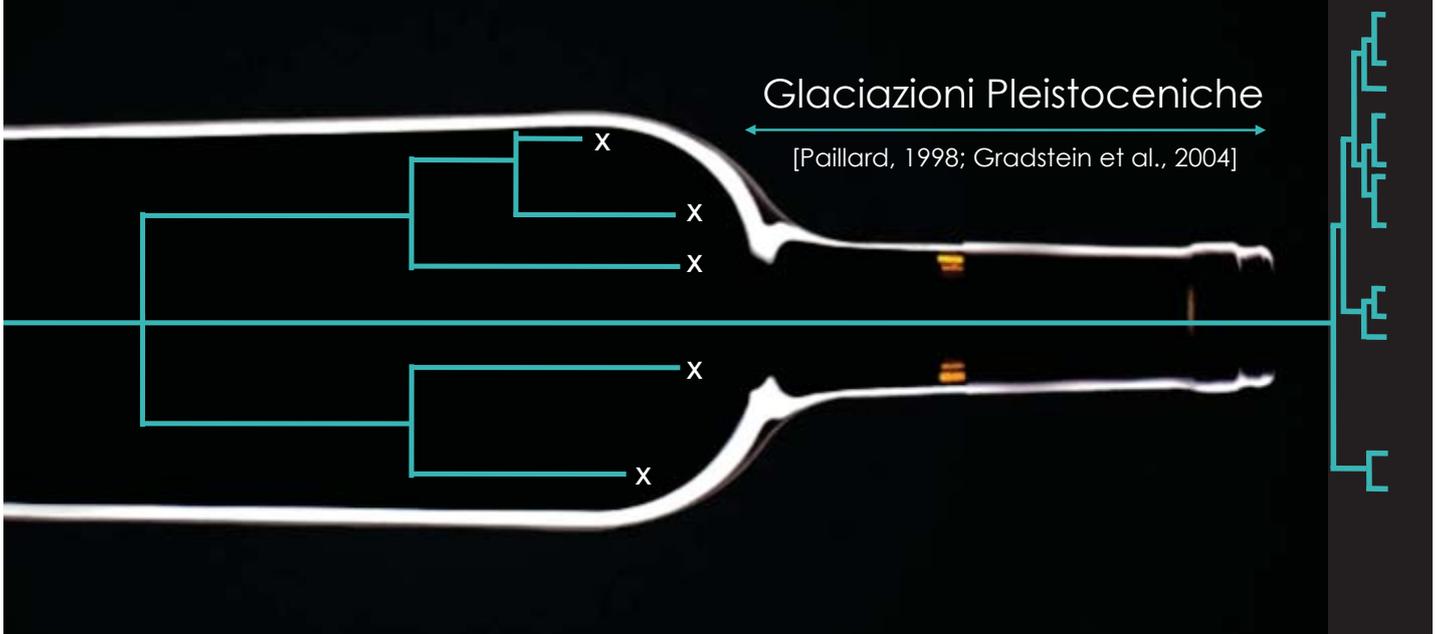


Molecular clock



Glaciazioni Pleistoceniche

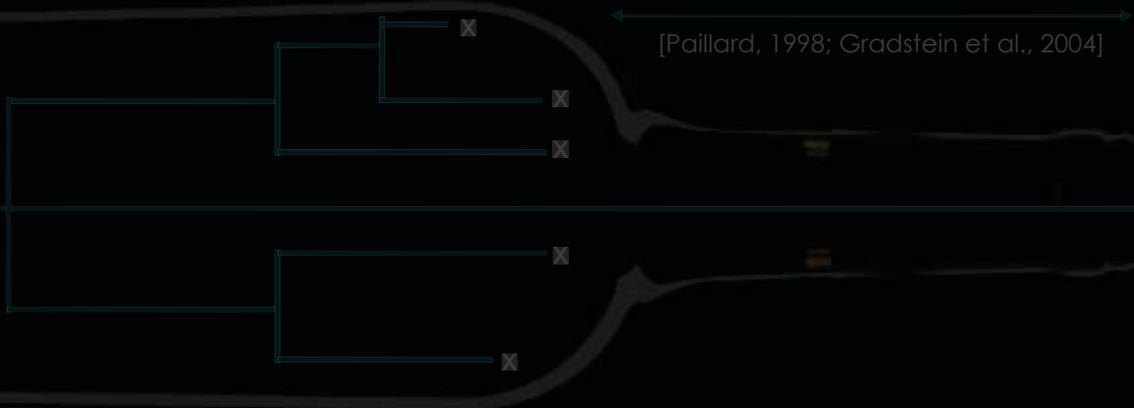
[Paillard, 1998; Gradstein et al., 2004]



Come sono sopravvissute in questo periodo avverso ?

Glaciazioni Pleistoceniche

[Paillard, 1998; Gradstein et al., 2004]

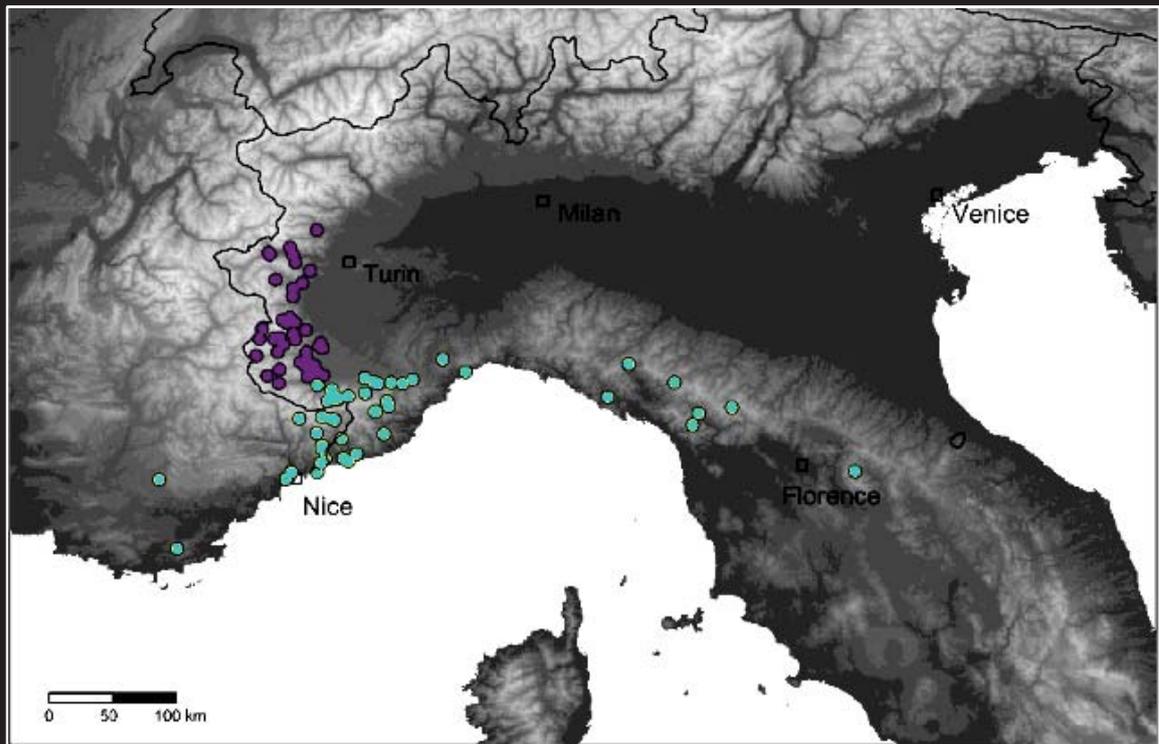


Ecological Niche Modeling



Distribuzione (Occurrence)

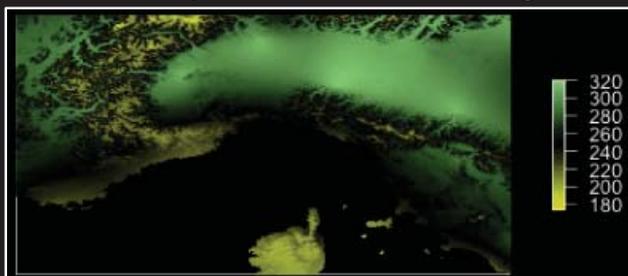
■ *Pimoa n.sp.*
■ *Pimoa rupicola*



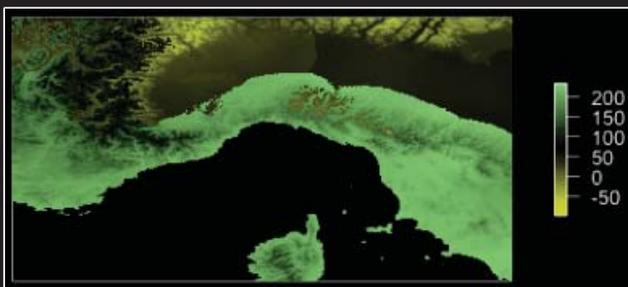
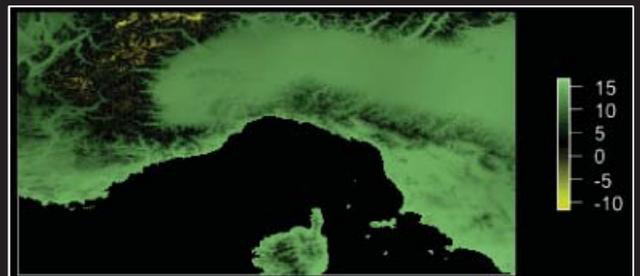
Vecchio materiale (collezione Isaia; collezione Arnò; Museo "E Caffi" Bergamo)
+ dati originali

Variabili climatiche

Temperature Annual Range



Mean annual temperature



Temperature of the Driest Quarter



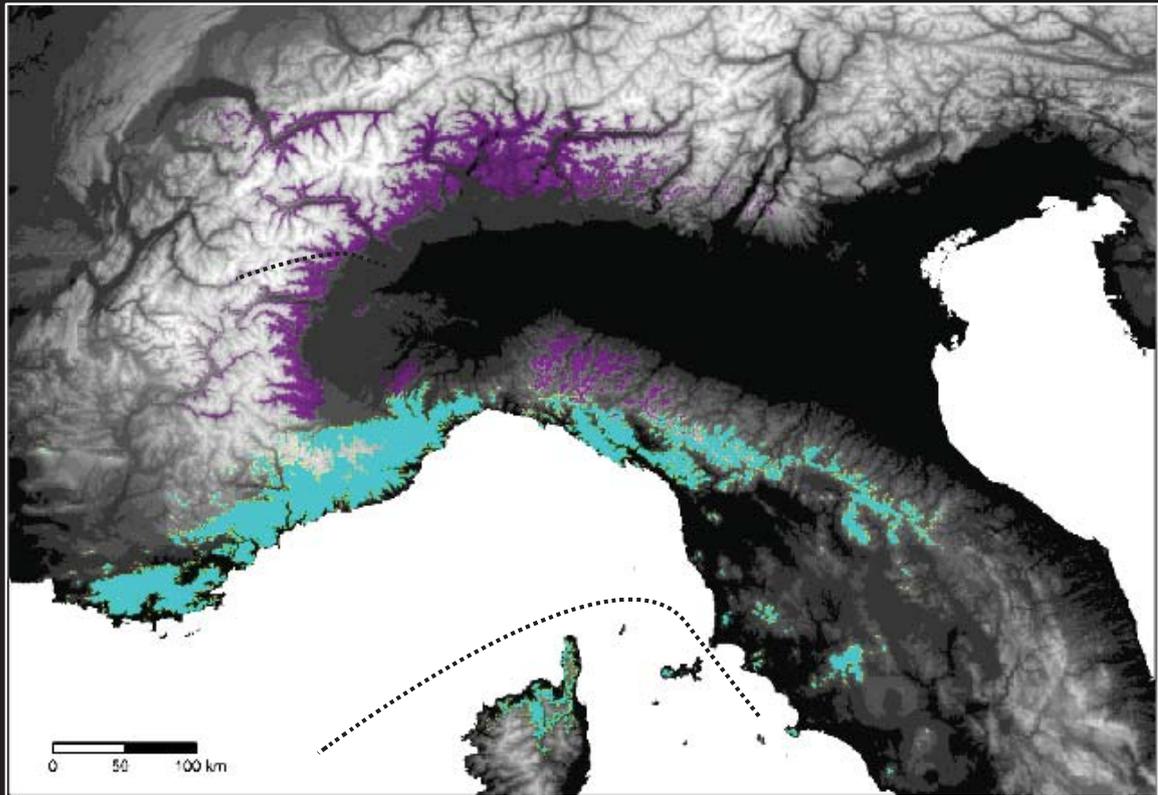
Mean annual precipitation

19 bioclimatic variables

www.worldclim.org

Present suitability

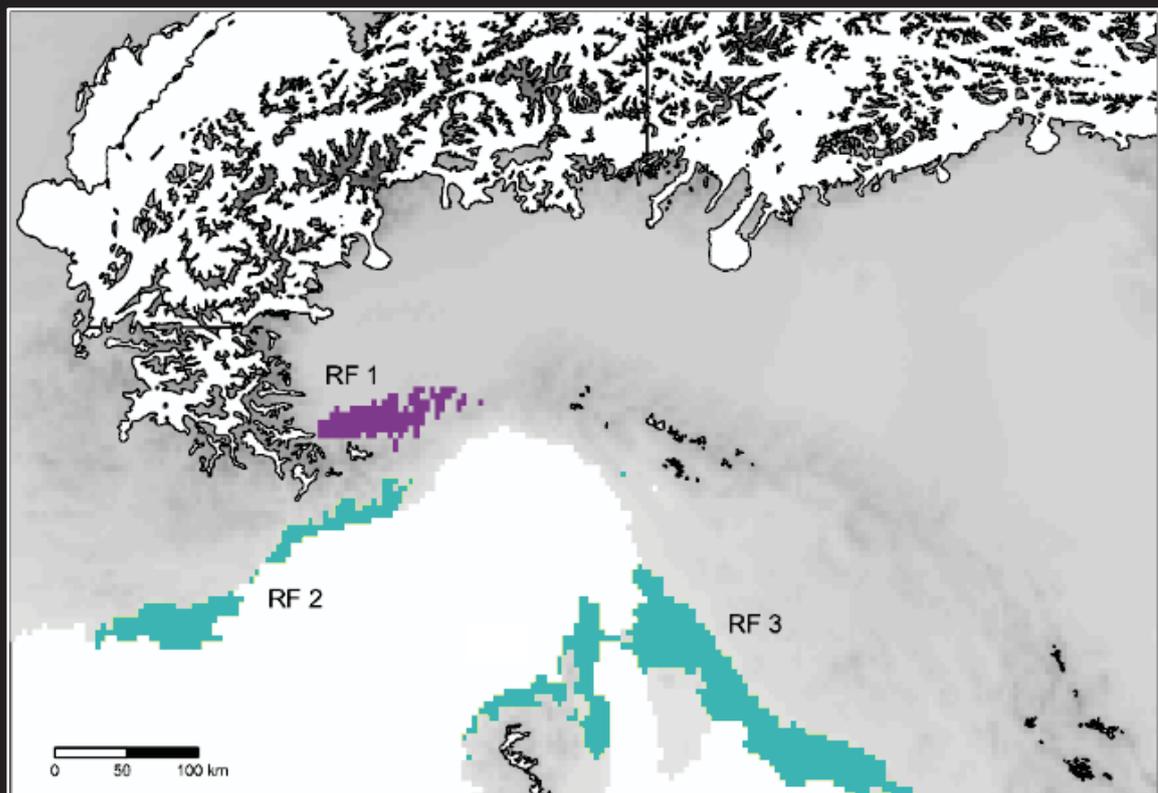
- *Pimoa n.sp.*
- *Pimoa rupicola*



[Suitability > 0.6]

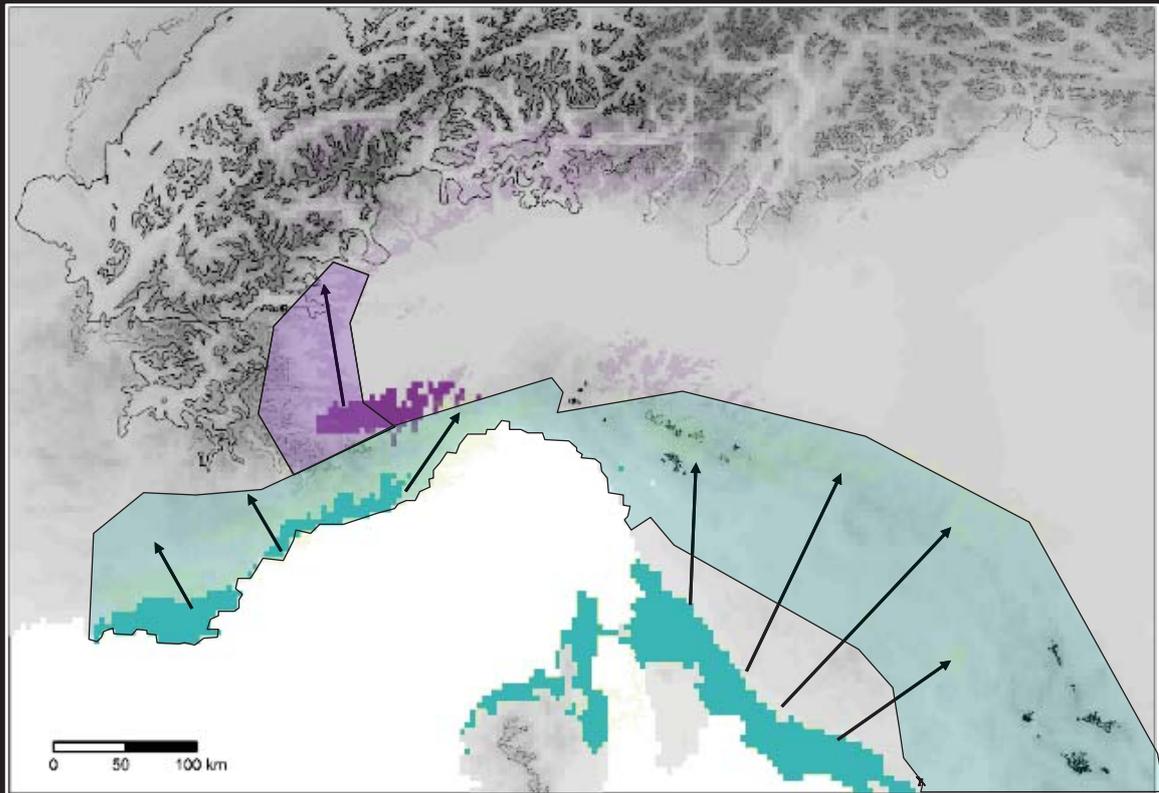
Past suitability – LGM

- *Pimoa n.sp.*
- *Pimoa rupicola*
- Limite dei ghiacci - LGM



Pattern di dispersione

■ *Pimoa* n.sp.
■ *Pimoa rupicola*



Outline

Introduzione

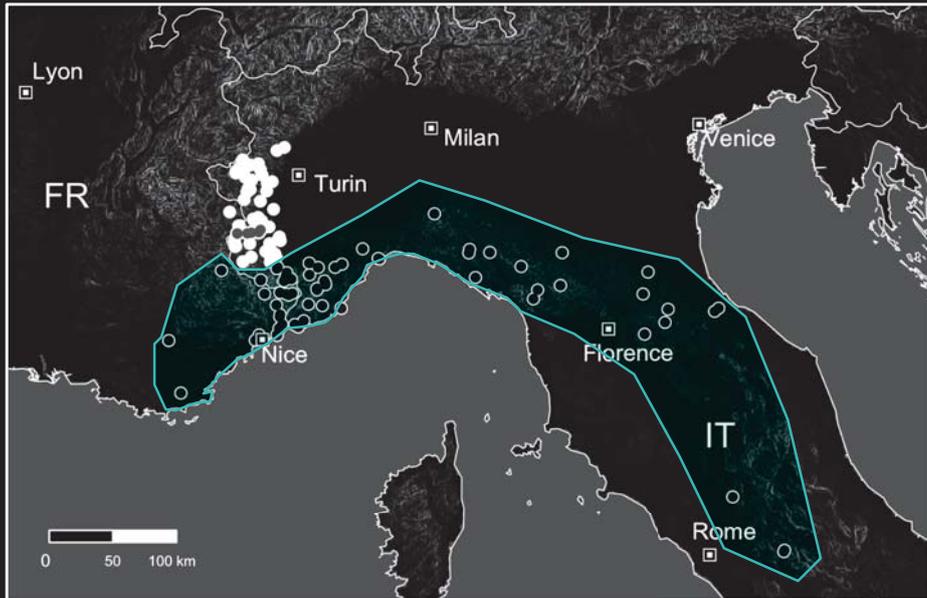
Filogeografia

● Tassonomia

Nicchia ecologica



Tassonomia



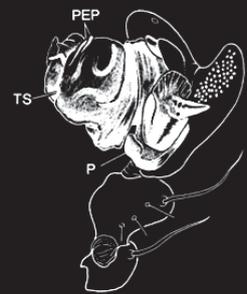
Pimoa rupicola

Italia

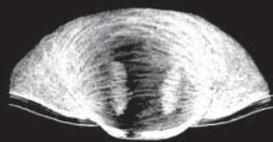
Dalla Val Gesso fino all'Appennino Laziale.

Francia

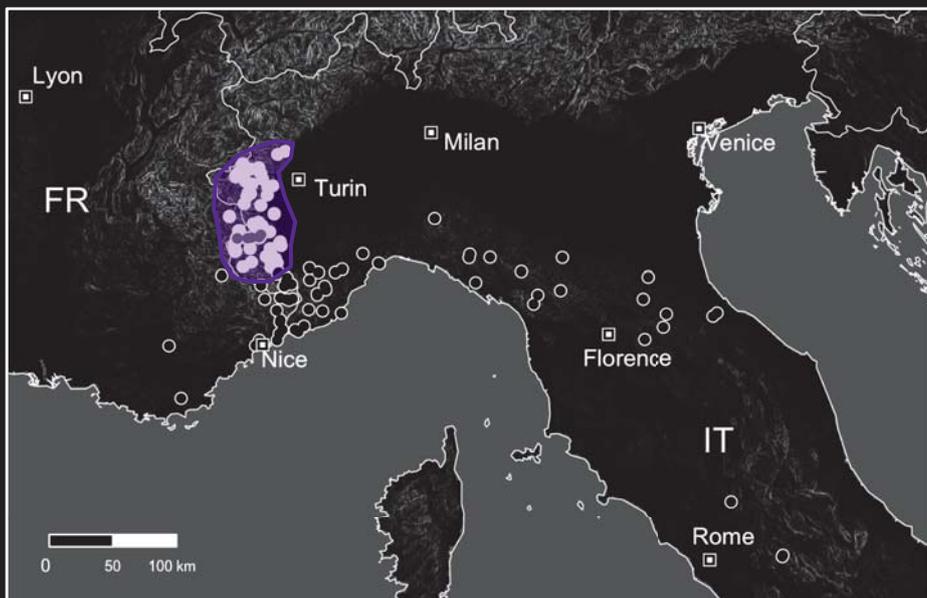
Alpes Maritimes, Var. Corsica?



Mammola, Hormiga, Arnedo & Isaia (2016)
Invertebrate systematics



Tassonomia



Pimoa graphitica

Italia

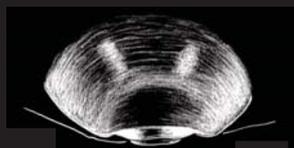
Dalla Val di Viù fino alla Valle Stura

Francia

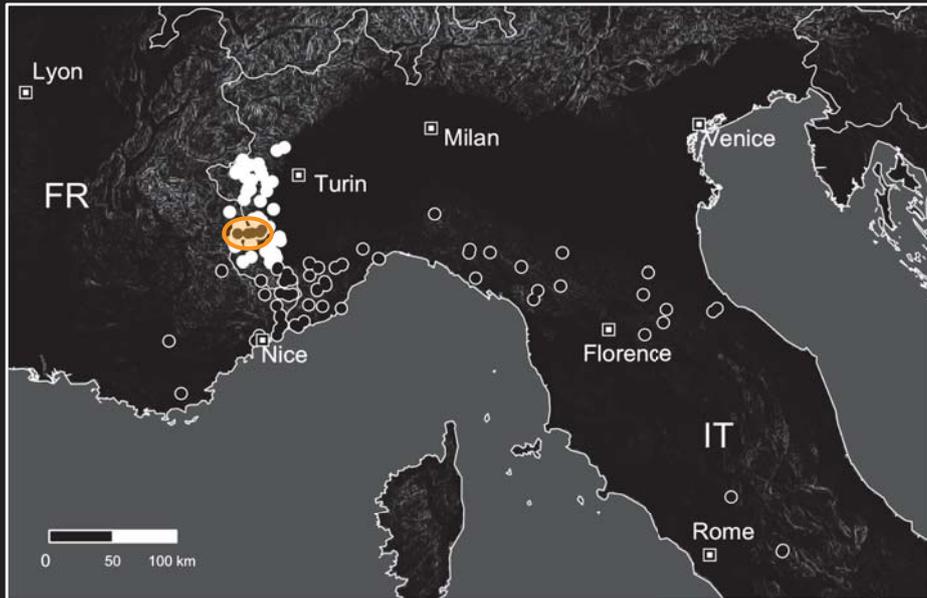
Château Queyras



Mammola, Hormiga, Arnedo & Isaia (2016)
Invertebrate systematics



Tassonomia



Pimoidae delphinica

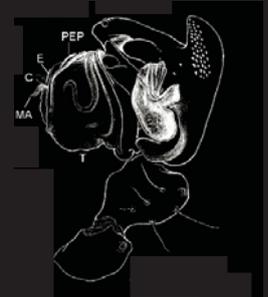
Italia

Valle Varaita - Belluno

Francia

?

Mammola, Hormiga,
Arnedo & Isaia (2016)
Invertebrate systematics



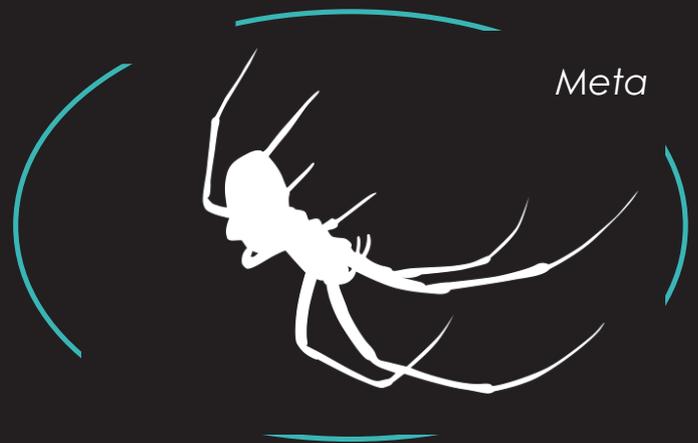
Outline

Introduzione

Filogeografia

Tassonomia

● Nicchia ecologica





Quali dinamiche permettono la coesistenza di due predatori apicali in un ambiente altamente oligotrofico ?



Area di studio



Val Chisone

Prospetti di Miniera

Tornini



Bonouso I



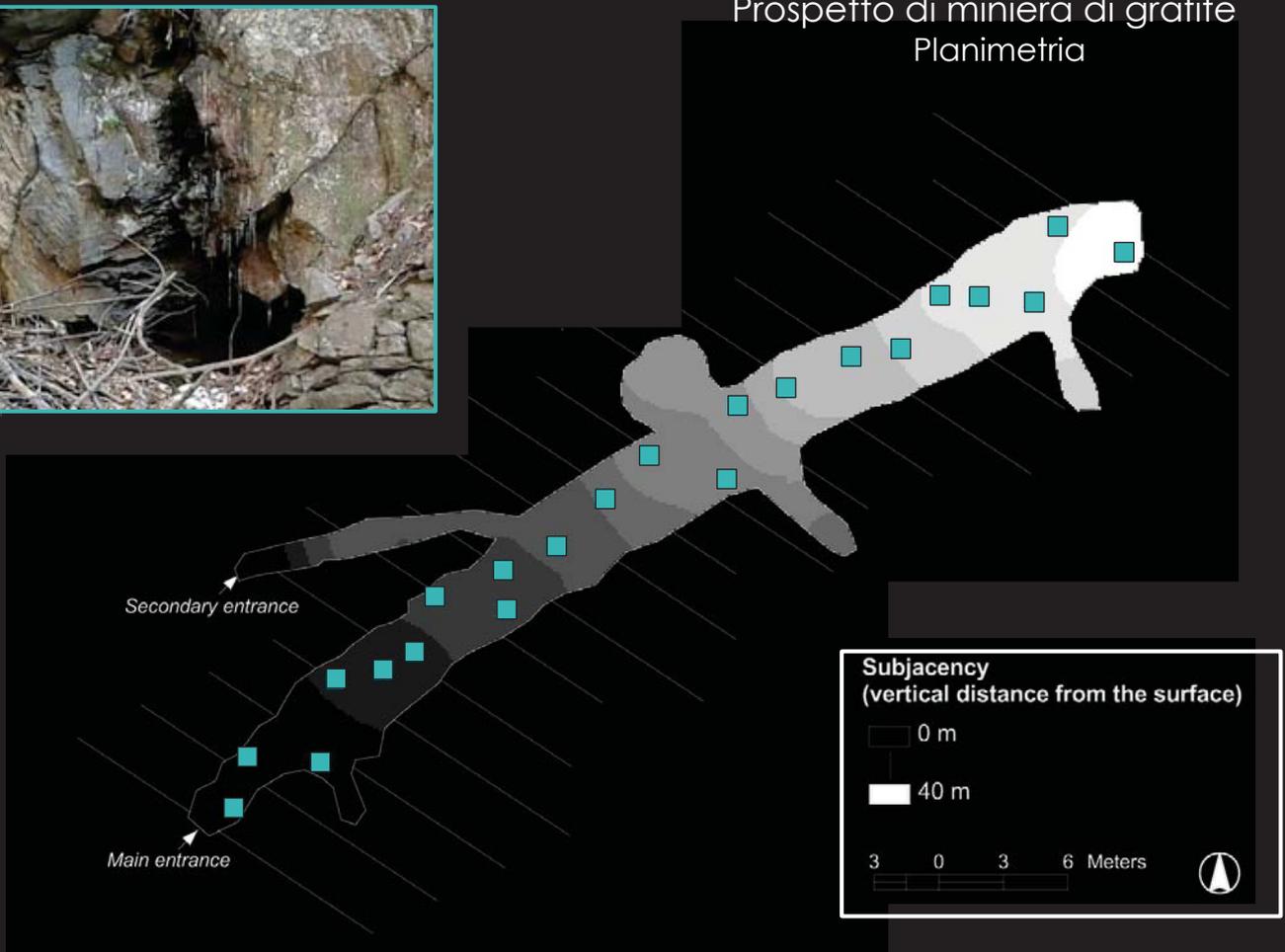
Pons



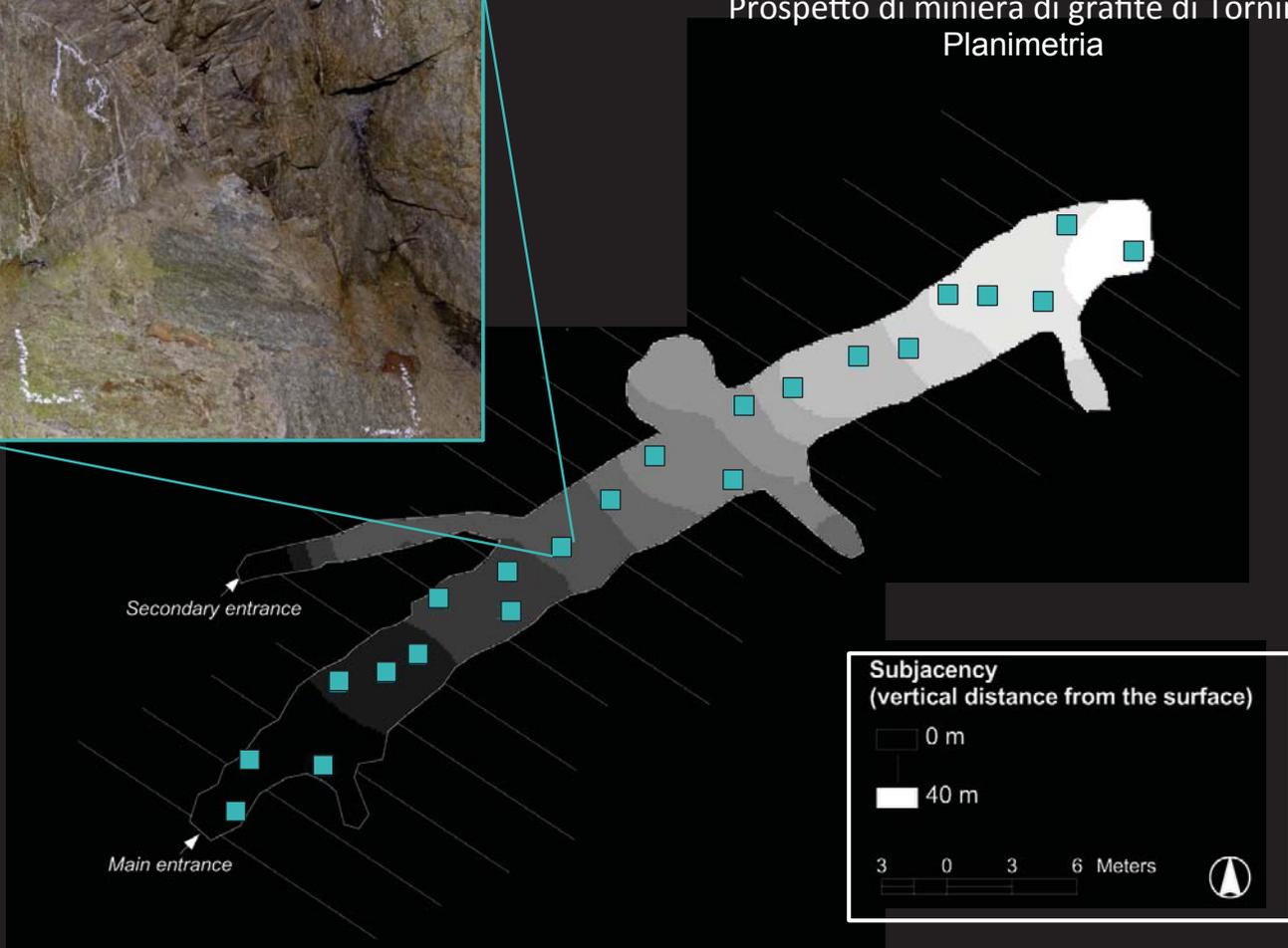
Fornaisa



Prospetto di miniera di grafite
Planimetria



Prospetto di miniera di grafite di Tornini
Planimetria



Monitoraggio mensile (12 uscite)

Variabili dipendenti



Conteggi



Variabili indipendenti

Variabili dipendenti



Conteggi



Variabili indipendenti

Abiotic

Distanza dall'ingresso

Complessità strutturale del substrato

Illuminance (lx)

Condizioni Microclimatiche (T°, RH)

Variabili dipendenti



Conteggi



Variabili indipendenti

Abiotic

Distanza dall'ingresso

Complessità strutturale del substrato

Illuminance (lx)

Condizioni Microclimatiche (T°, RH)

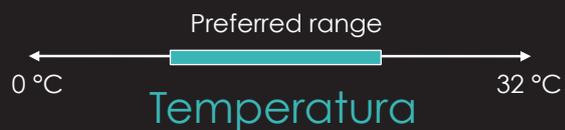
Biotic

Prede



Nicchia Ecologica

Nicchia unidimensionale

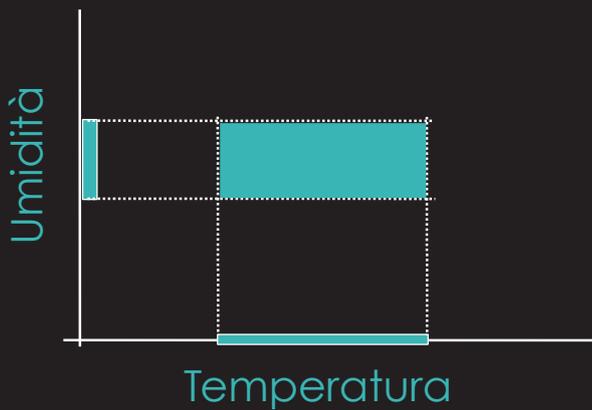


Nicchia Ecologica

Nicchia unidimensionale

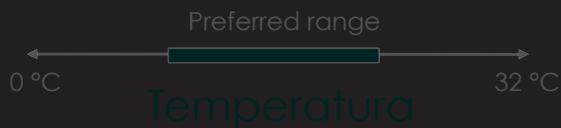


Nicchia bidimensionale

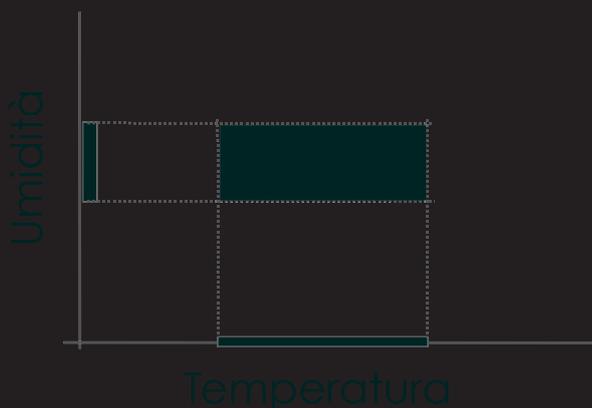


Nicchia Ecologica

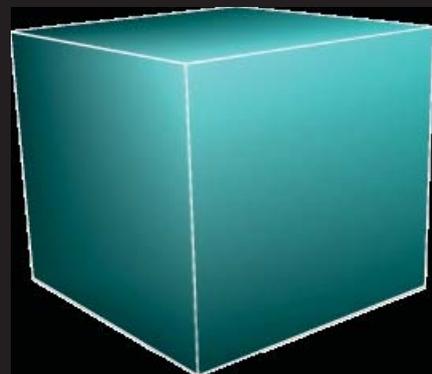
Nicchia unidimensionale



Nicchia bidimensionale



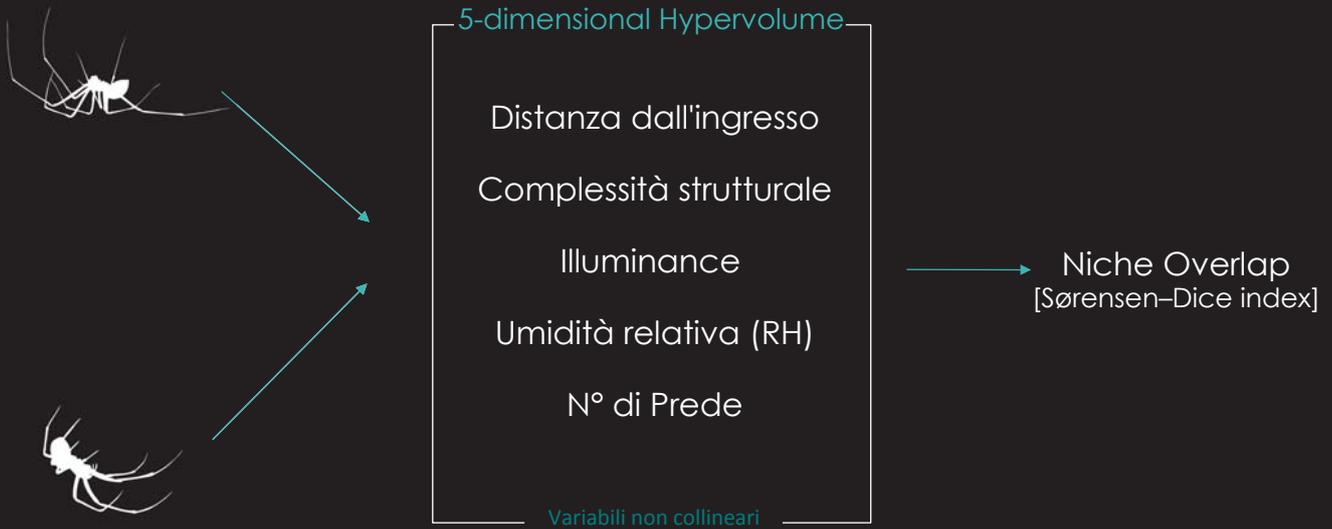
Nicchia tridimensionale



... n-dimensional hypervolume

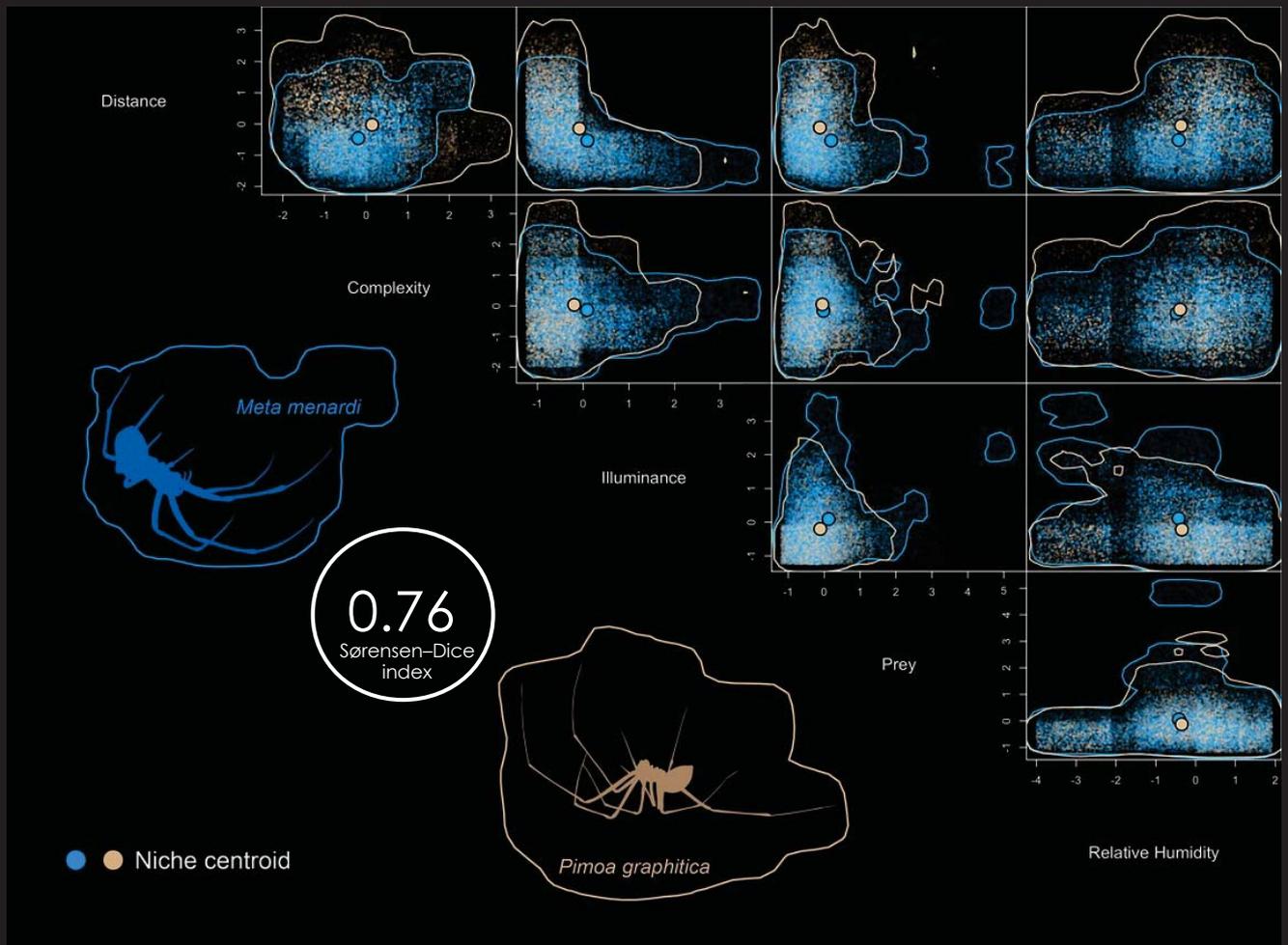
Hutchinson, 1957

Nicchia Ecologica

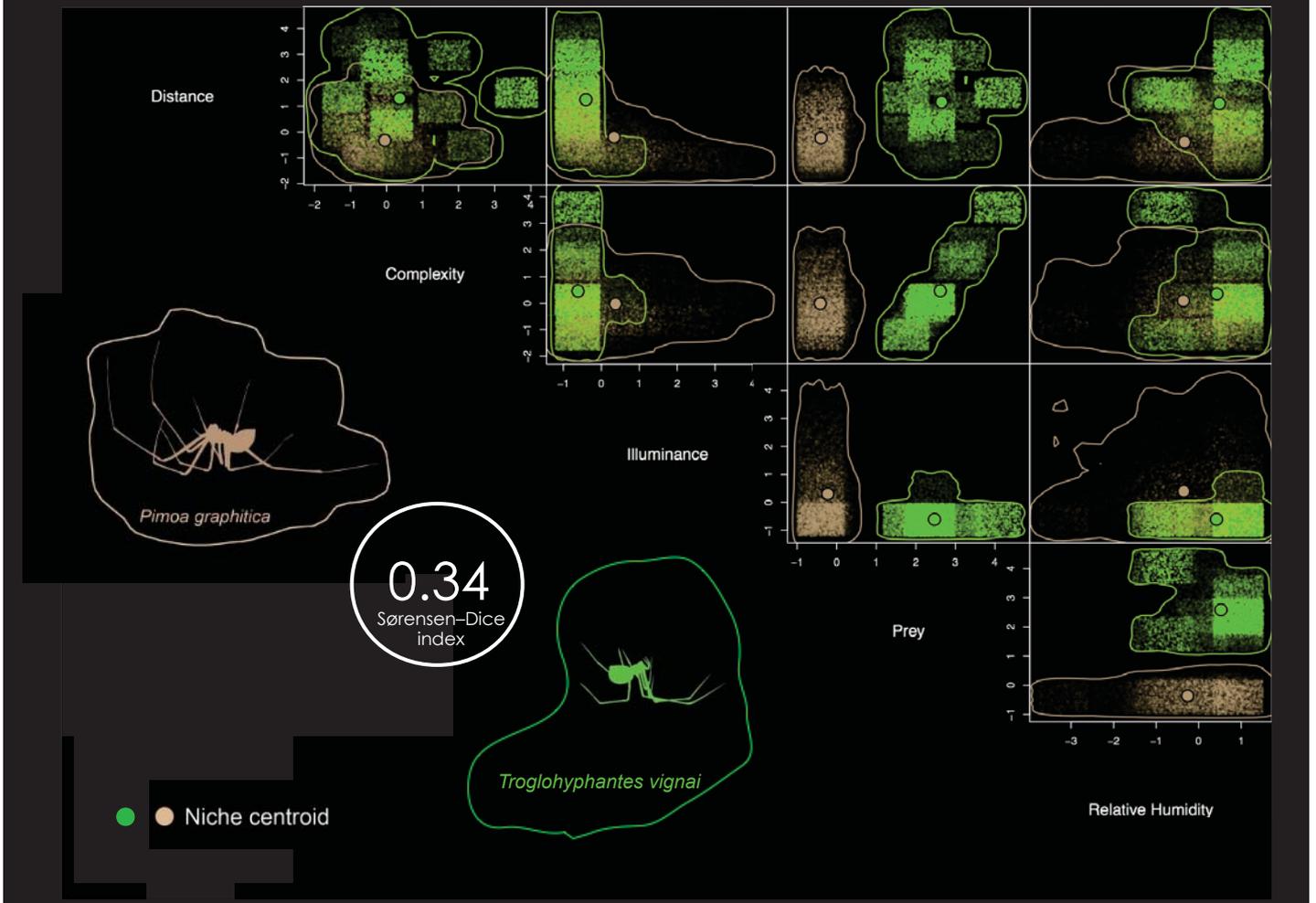


Hypervolume R package
Blonder et al. (2014); Blonder (2015)

[Variabili riscalate]



[Variabili riscalate]



0.76

Meta

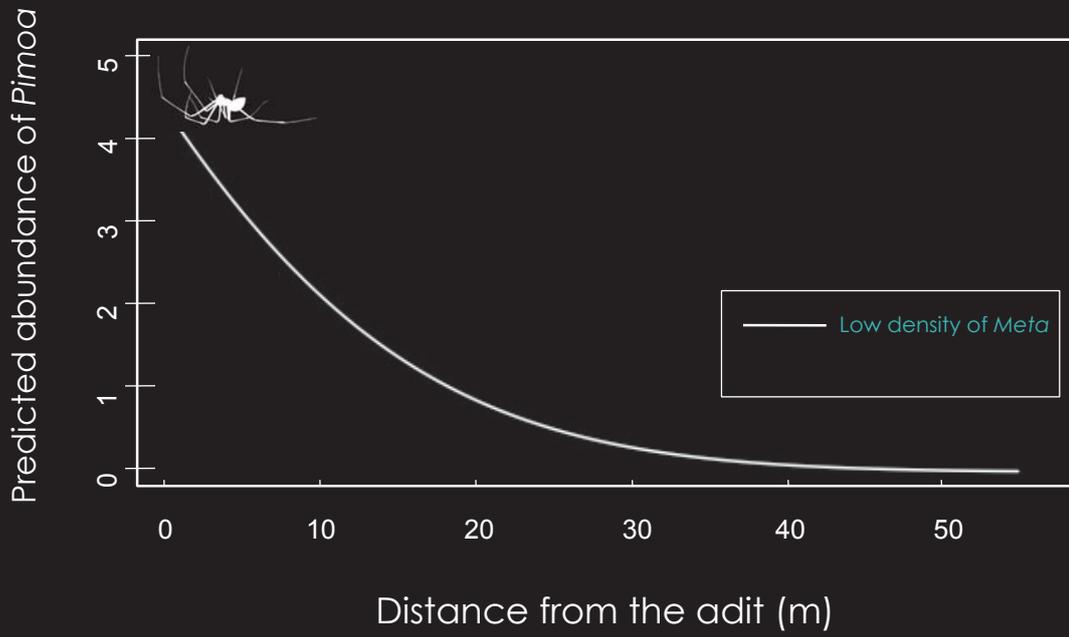
Pimoa



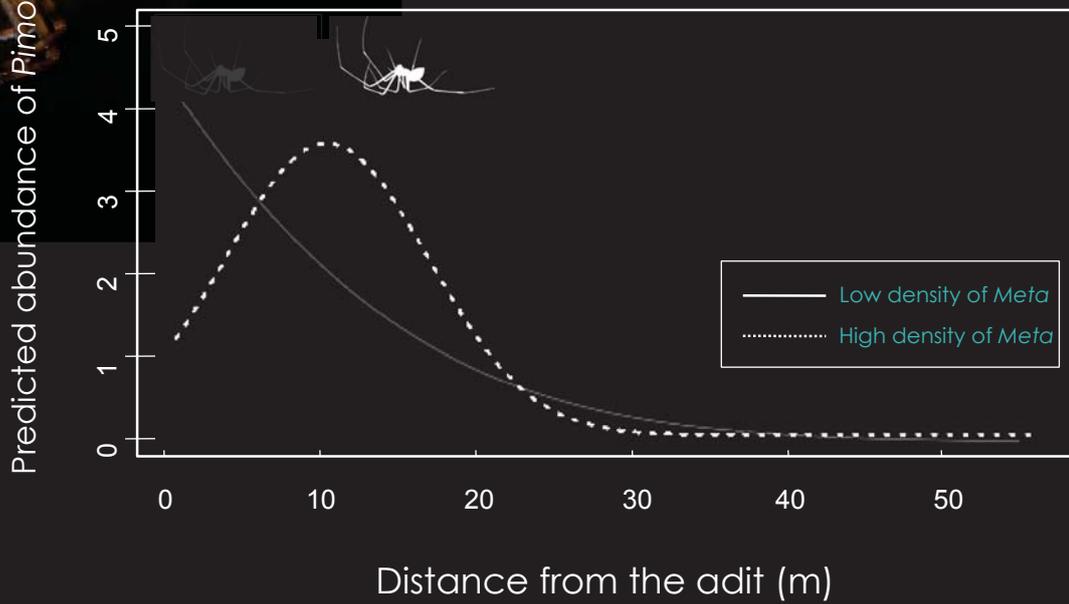
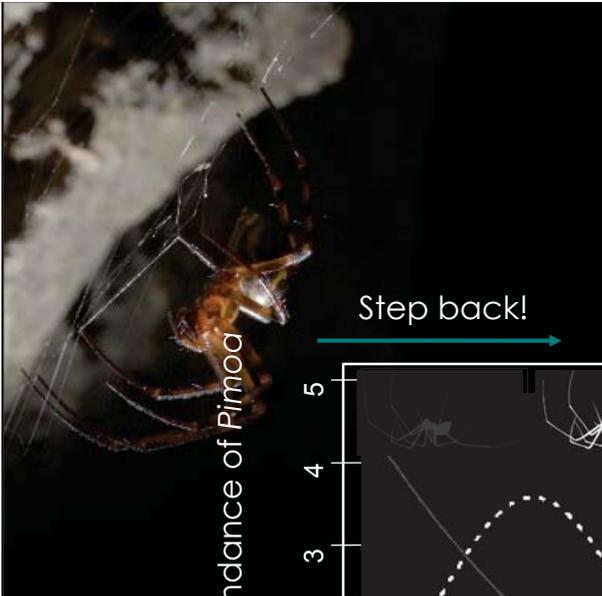
Competizione diretta ?

GLMM-p:

Abundance of *Pimoa* ~ environmental variables + abundance of *Meta*



GLMM-p: META x Distance : $z=2.894$, $p=0.003$



GLMM-p: META x Distance² : $z=-2.977$, $p=0.002$

References

- Filogeografia: [Mammola, Isaia, Arnedo \(2015\)](#) Alpine endemic spider shed light on the origin and evolution of subterranean species. *PeerJ* 3:e1384
- Tassonomia: [Mammola, Hormiga, Arnedo, Isaia \(2016\)](#) Unexpected diversity in the relictual European spiders of the genus *Pimoa* (Araneae, Pimoidae). *Invertebrate systematics*, IS16017
- Nicchia ecologica: [Mammola, Piano, Isaia \(2016\)](#) Step back! Niche dynamics in cave-dwelling predators. *Acta oecologica*, 75: 35-42

Ringraziamenti

Marco Isaia (Tutor)

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Francesco Tomasinelli (Photo credits)

Paolo Pantini (Materiale museale)

Gustavo Hormiga (Tassonomia dei Pimoidae)

Elena Piano (Sr) (Coautrice)