

# **Butterfly responses to weather anomalies depend on local adaptation and range position**

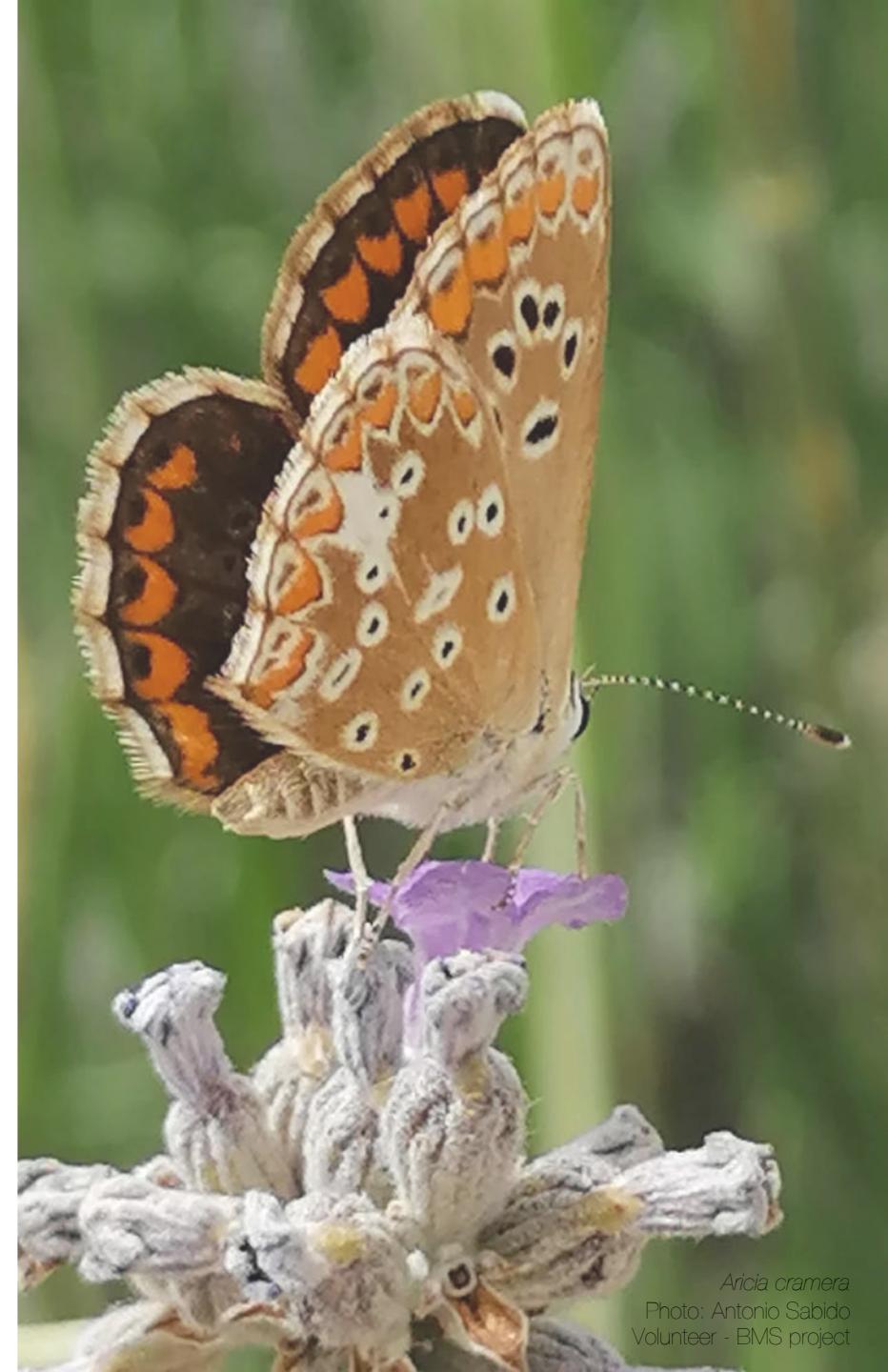
Yolanda Melero, Luke Evans, Mikko Kuussaari, Reto Schmucki, Constantí Stefanescu, David Roy, Tom Oliver



UNIVERSITAT DE  
BARCELONA



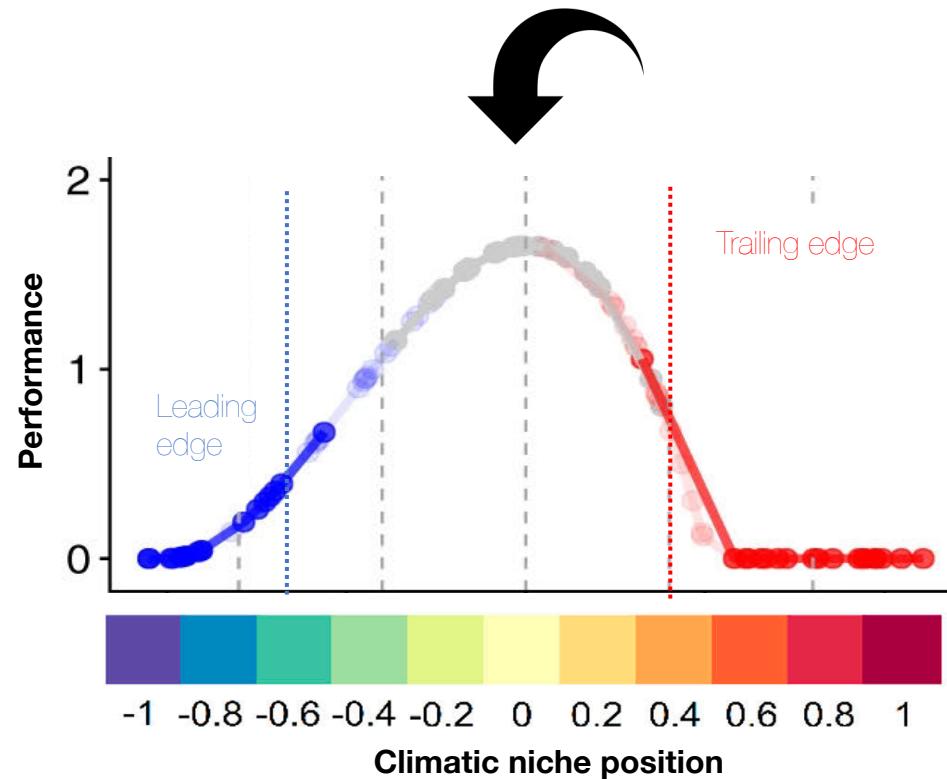
University of  
Reading



*Aricia cramera*

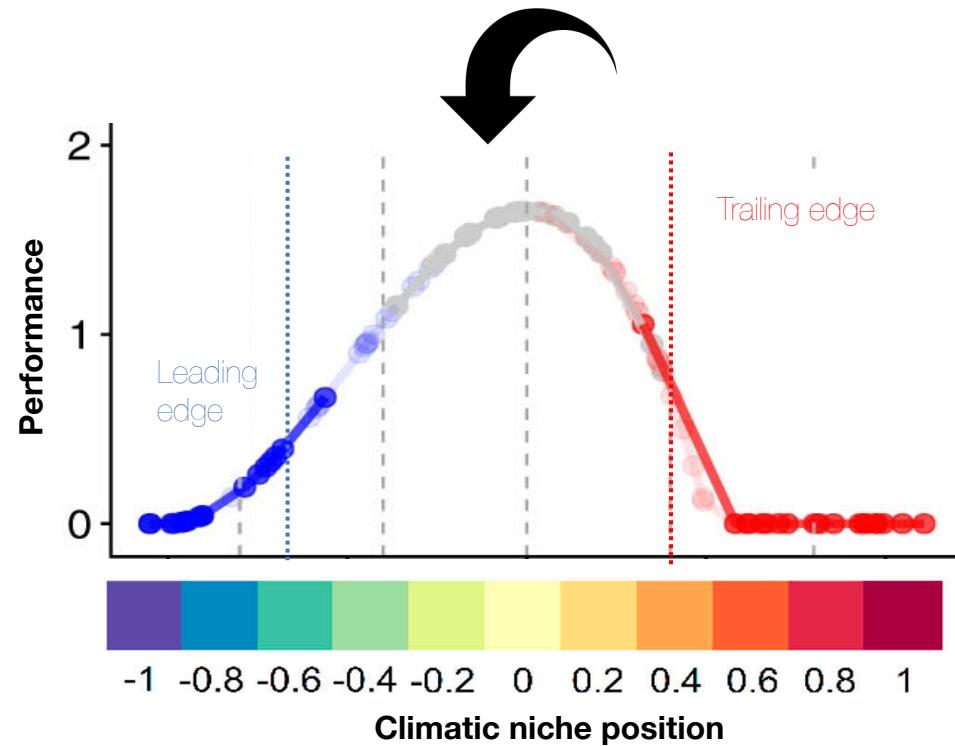
Photo: Antonio Sabido  
Volunteer - BMS project

Species are expected to **best perform** close to the **centre of their niche**

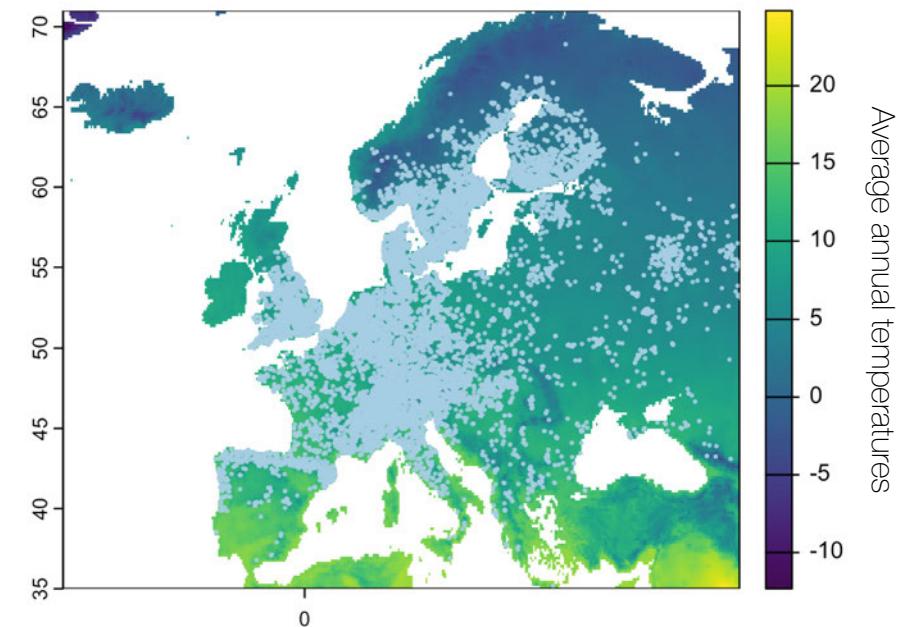


Simulated performance of a species populations across its niche positions

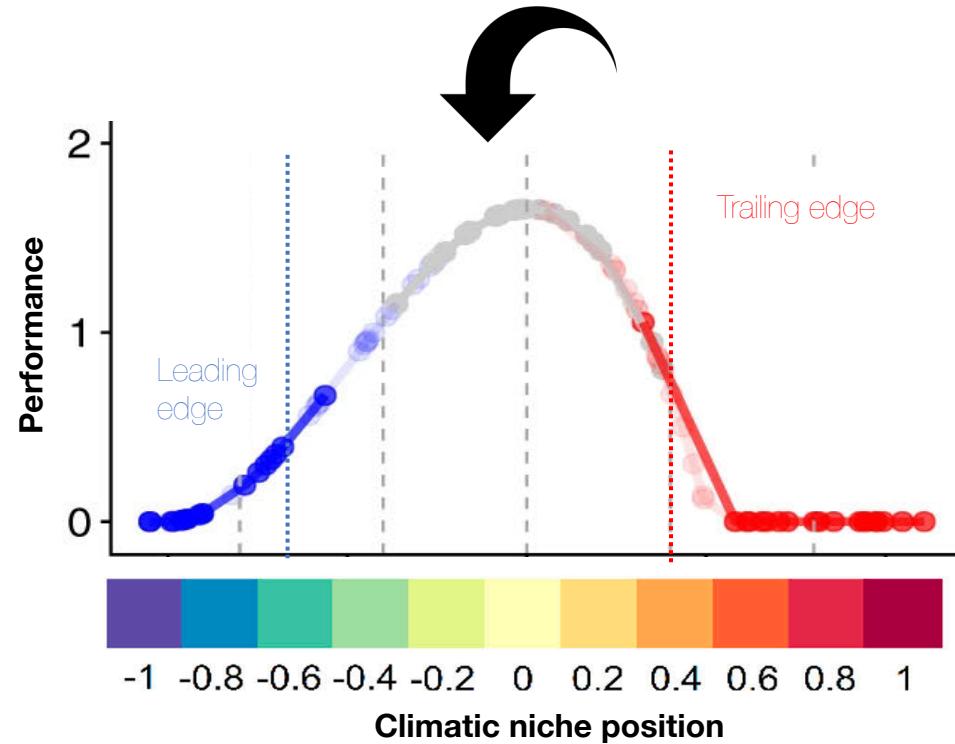
Species are expected to best perform close to the centre of their niche,  
**independently of their niche breadth**



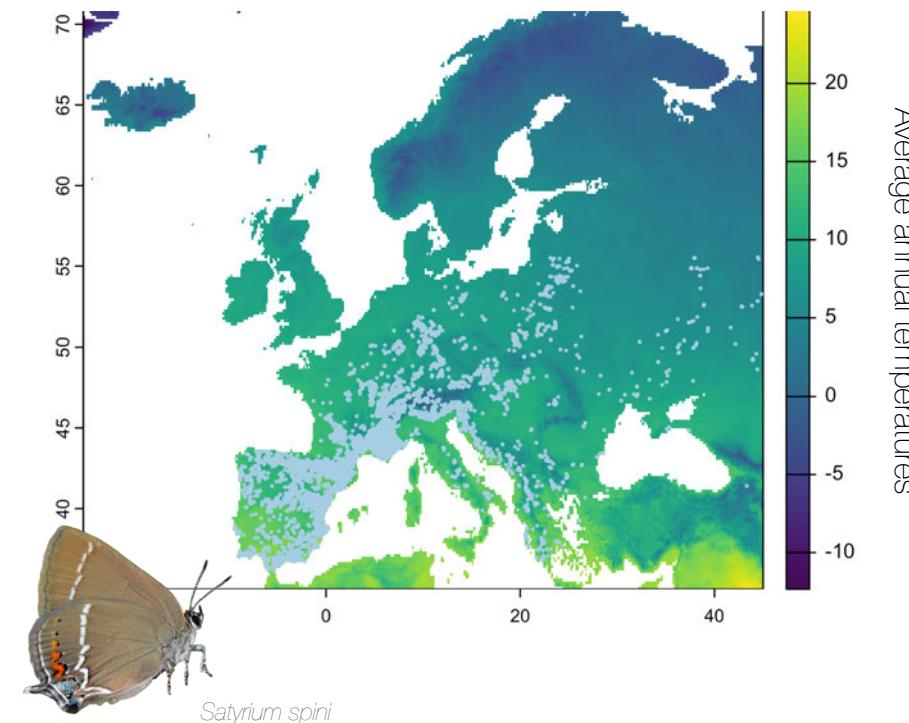
Simulated performance of a species populations across its niche positions



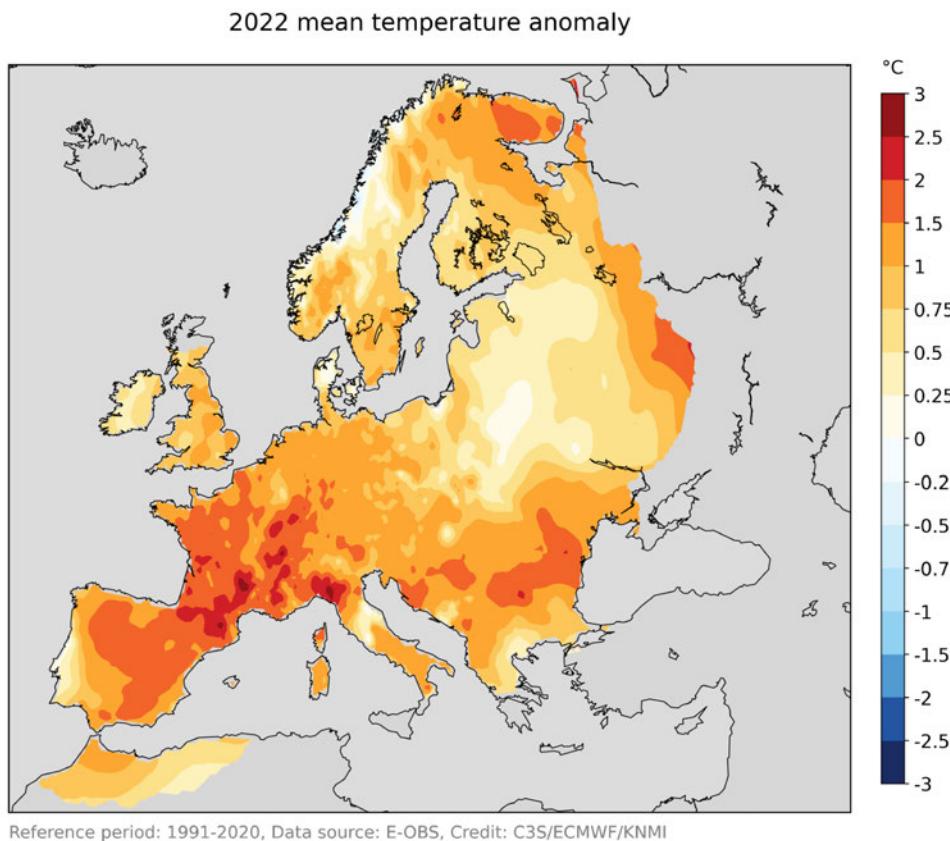
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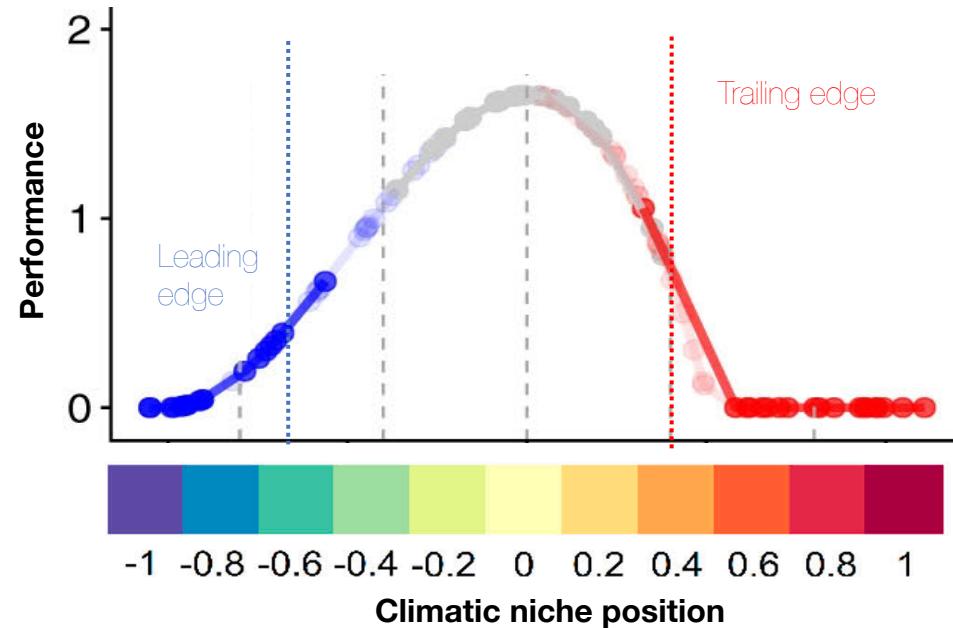
Simulated performance of a species populations across its niche positions



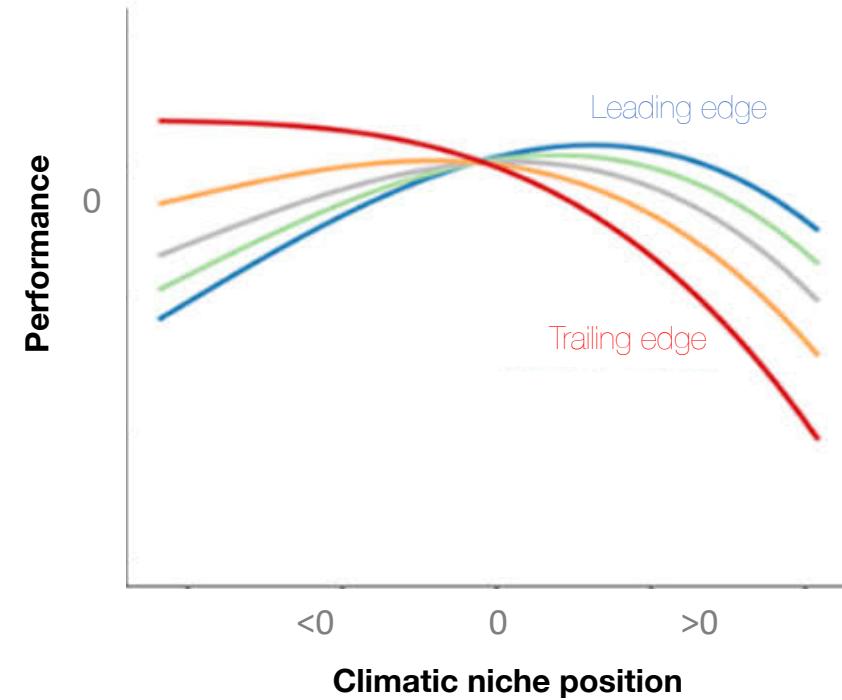
## What happens to performance when climatic anomalies occur?



Species population **respond distinctly to climatic anomalies** as per their population location

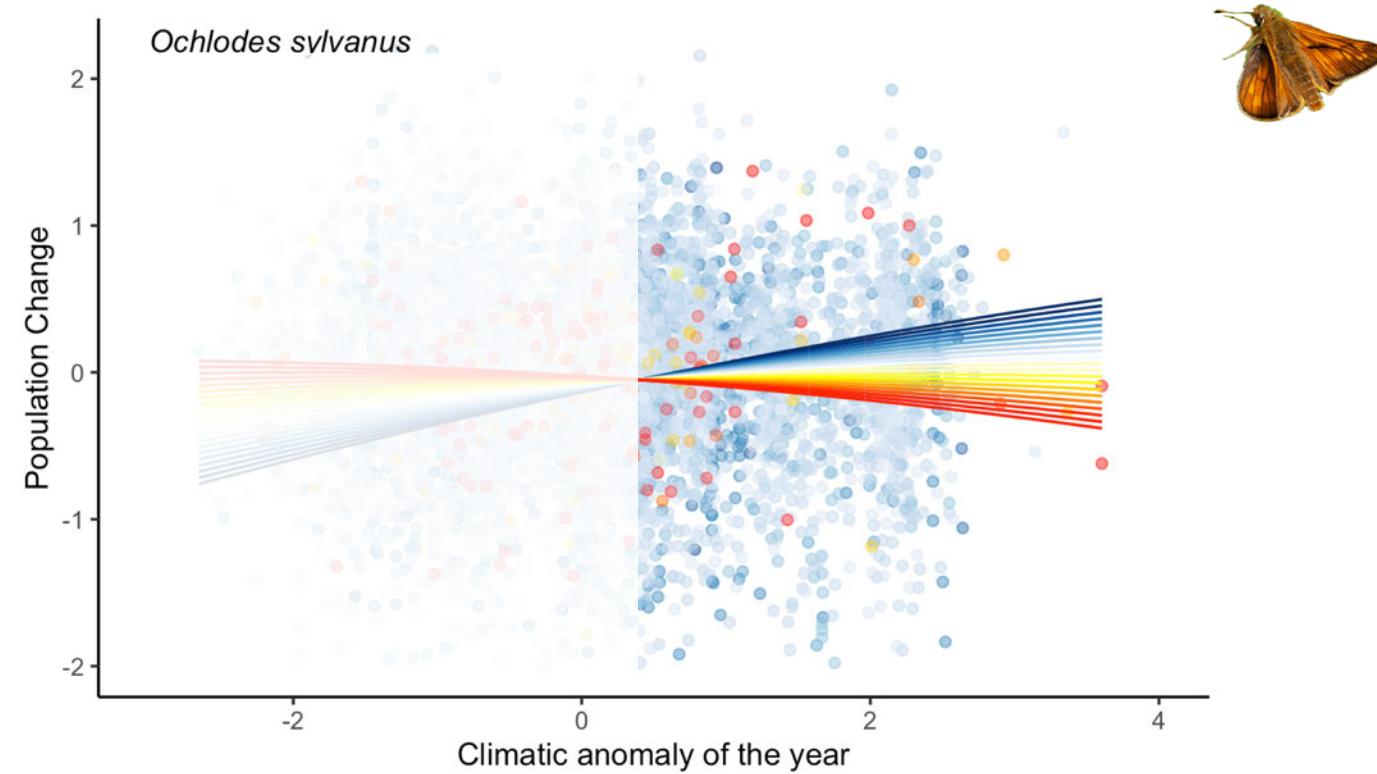


Simulated performance of a species populations across its niche

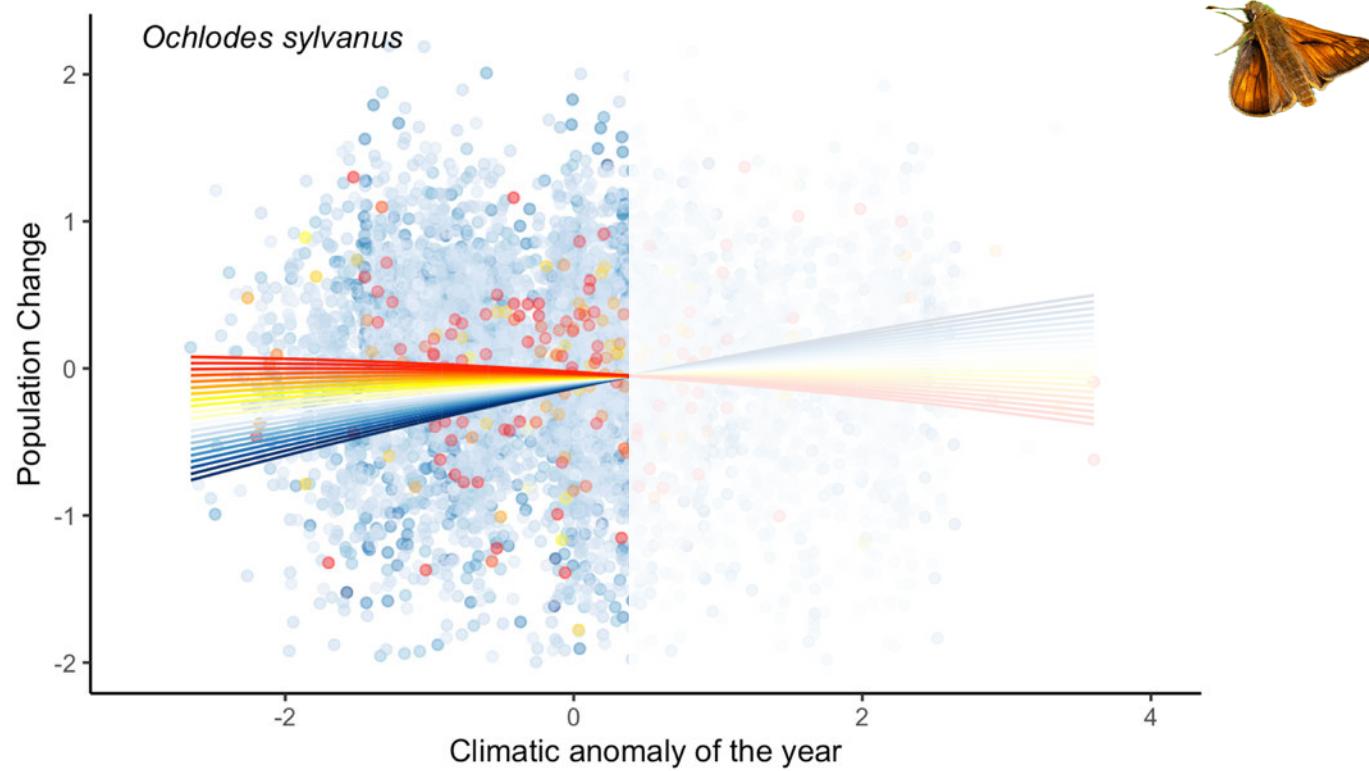


Simulated performance of a species populations when climatic anomalies occur across *its niche*

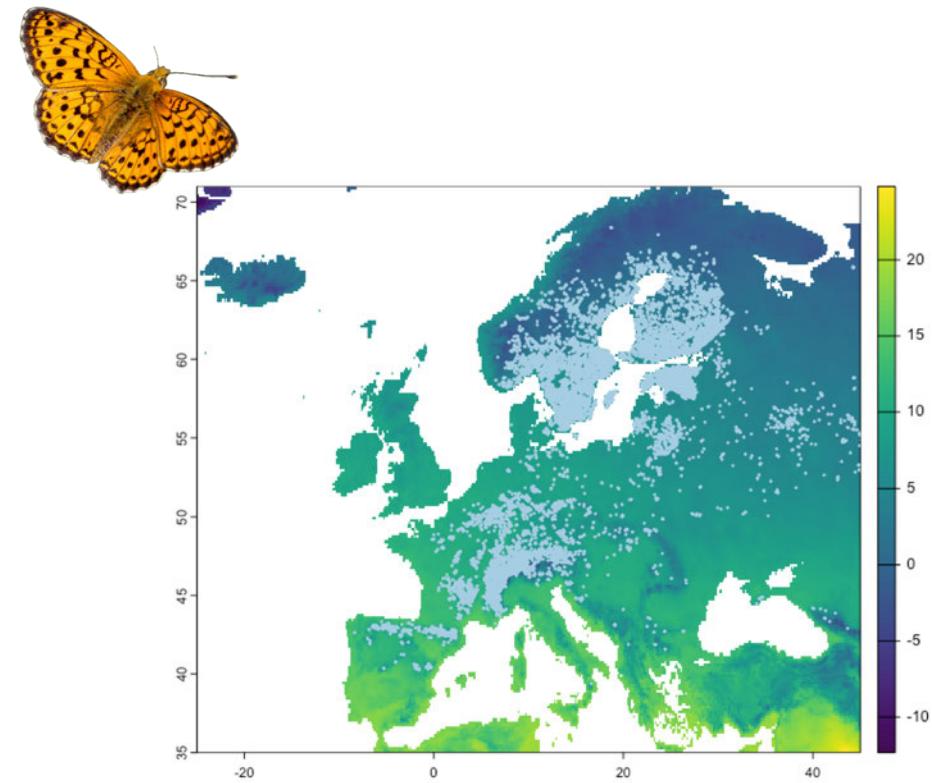
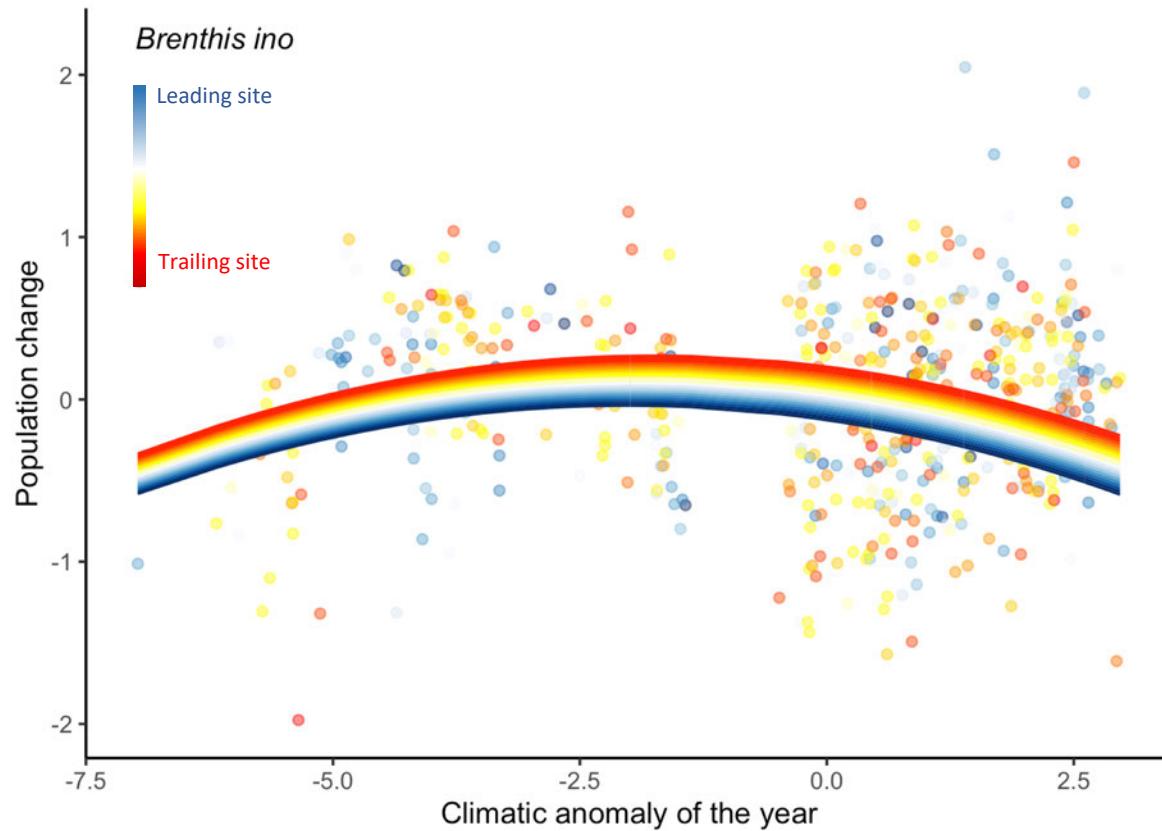
For example, a large-scale **heatwave increases** population **growth** of the Large Skipper  
**at leading (cold) sites but reduces it at trailing (hot) sites**



And, a large-scale **cold anomaly** decreases population **growth** of the Large Skipper  
at leading (cold) sites but increases it at trailing (hot) sites

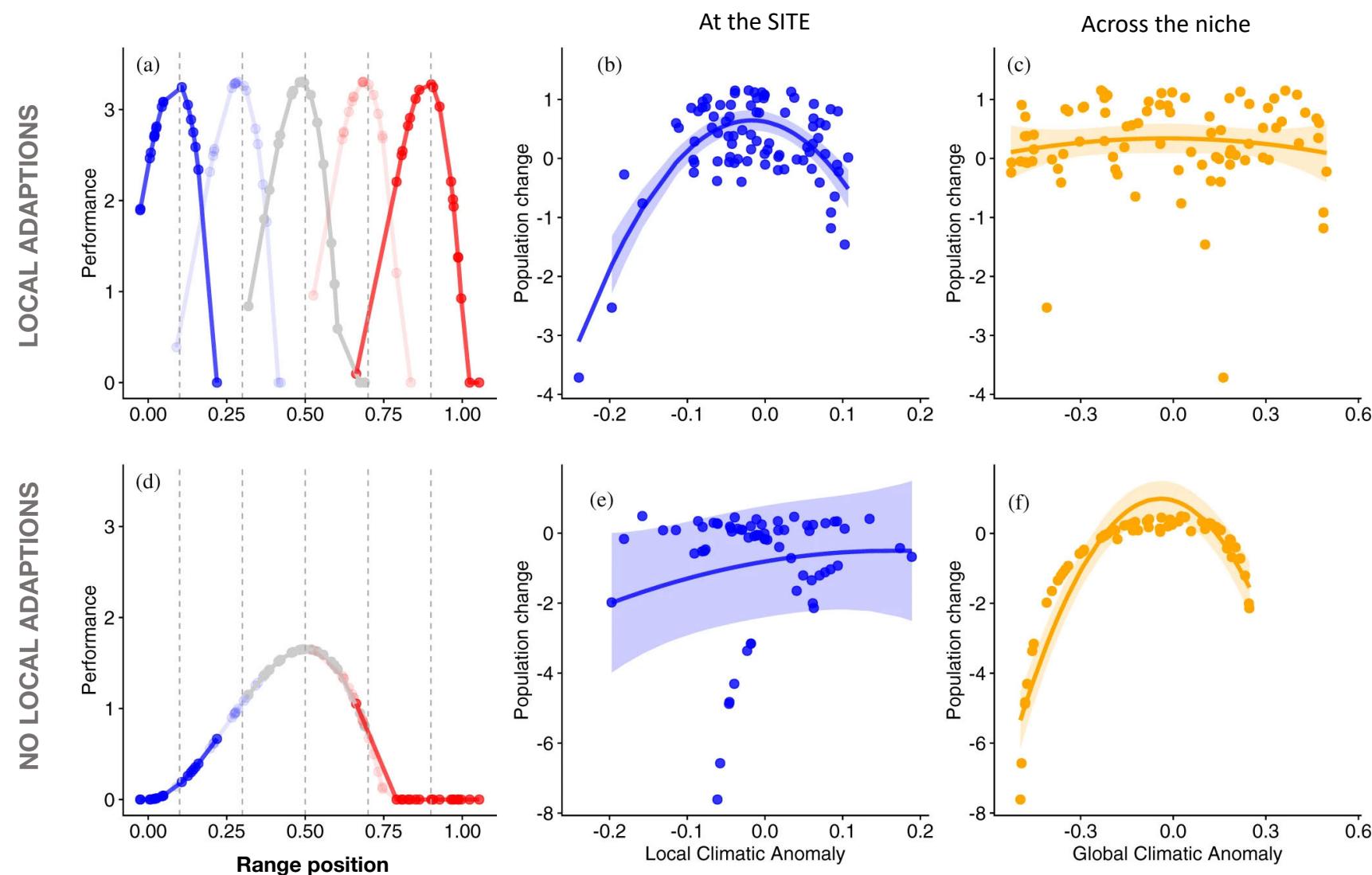


However, not all species respond that way to climatic anomalies,  
some species show similar population growths at all sites



Why populations of some species respond synchronically to large-scale climatic anomalies?

# H1: Species show local adaptations, i.e. best performing at their site independently of their location

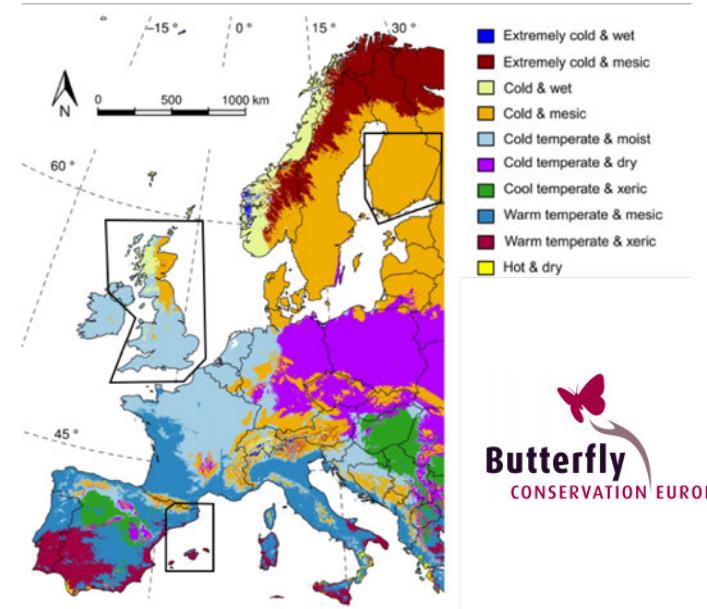


A comparative multiple species analysis to test for adaptations to climatic anomalies (at the site and at the entire distribution).

Count data of **143** butterflies species.

Along **172** sites within six European bioclimatic regions in three different countries.

During **18y** of data collected weekly from March to April by volunteers (eBMS).



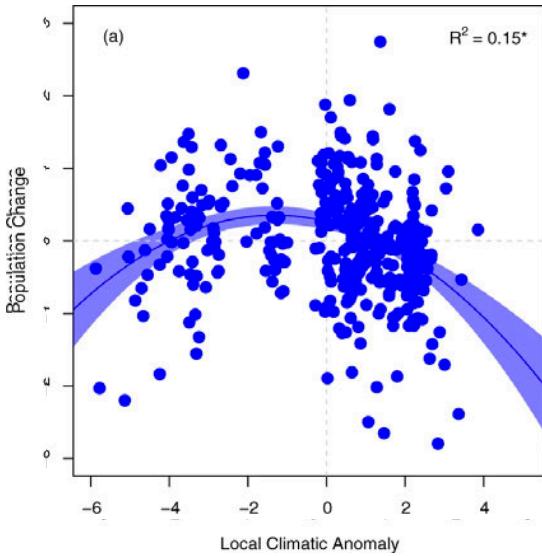
Bioclimatic regions across Europe, marked those areas covered by the study.



A group of eBMS-volunteers during a course in Barcelona  
Photo: Xavi Redon.

Some species respond better to the climatic anomalies occurring at their site, while others to anomalies occurring at their niche

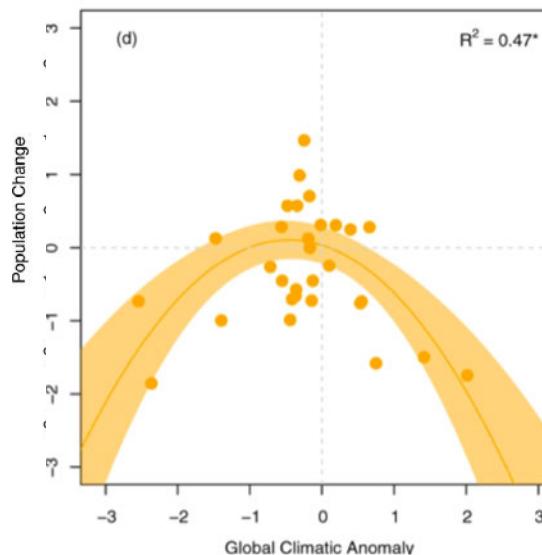
LOCAL ADAPTIONS



*Brethis ino*

Populations changes best explained ( $R^2$ ) by the anomalies from average local conditions

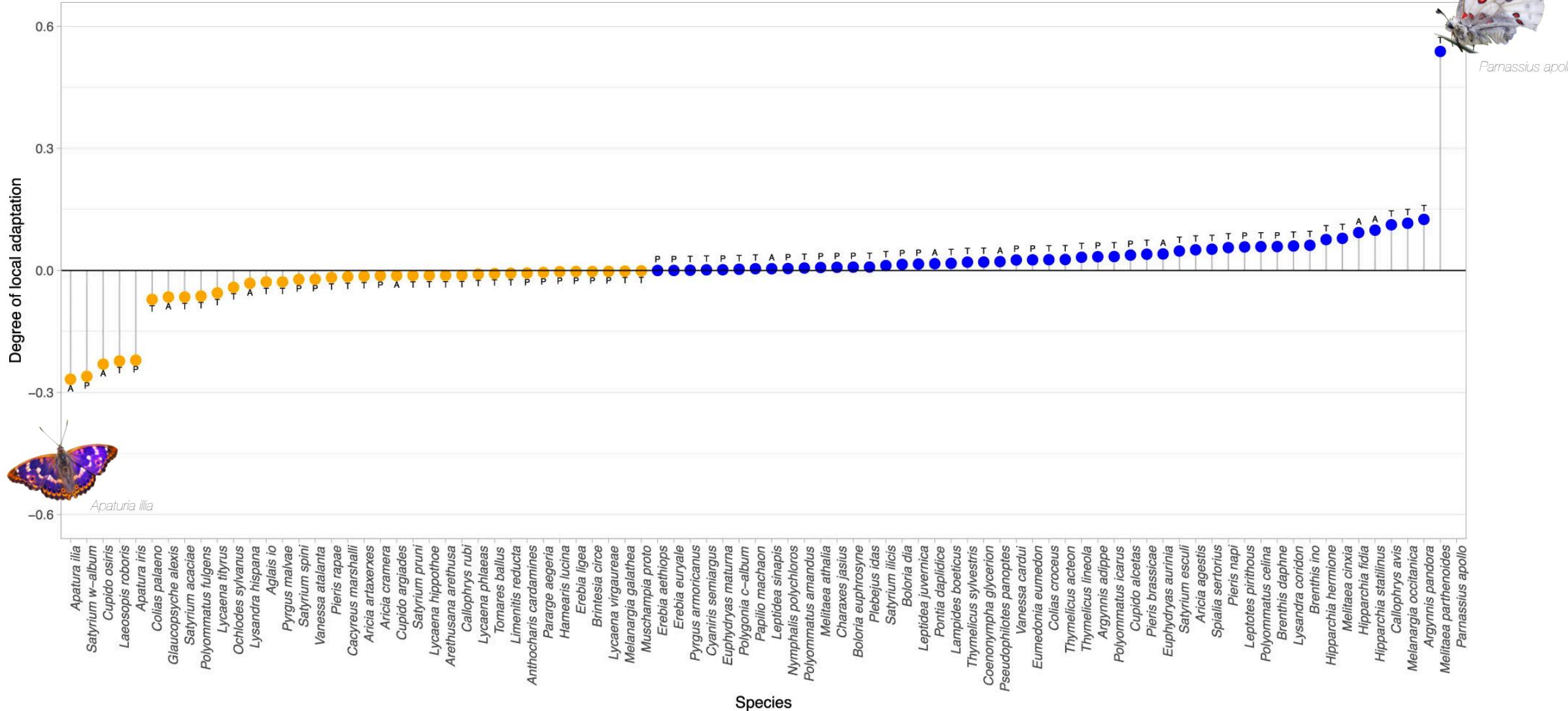
NO LOCAL ADAPTIONS



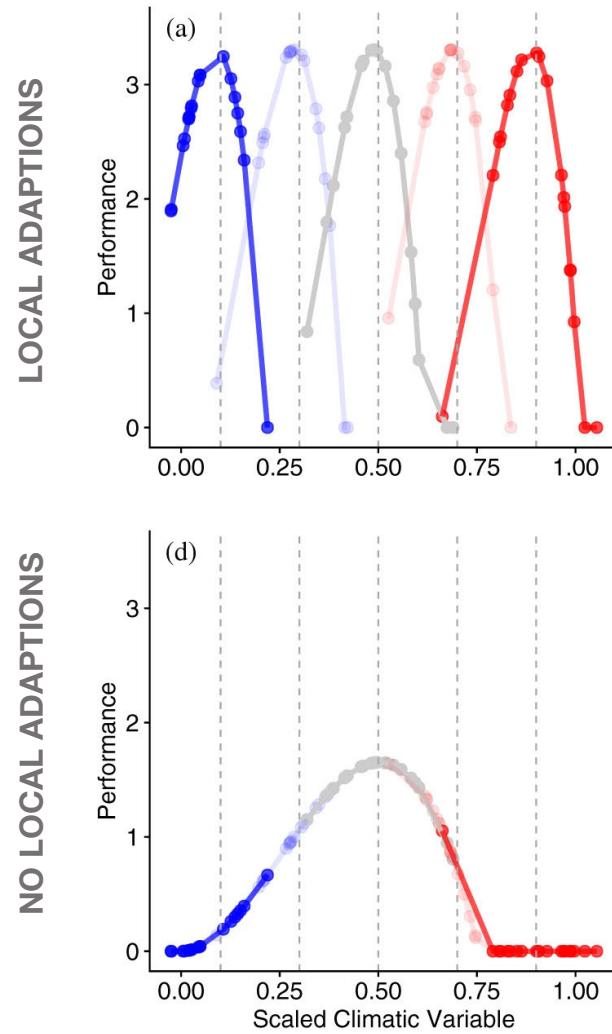
*Cupido osiris*

Populations changes best explained ( $R^2$ ) by the anomalies from average conditions of their niche

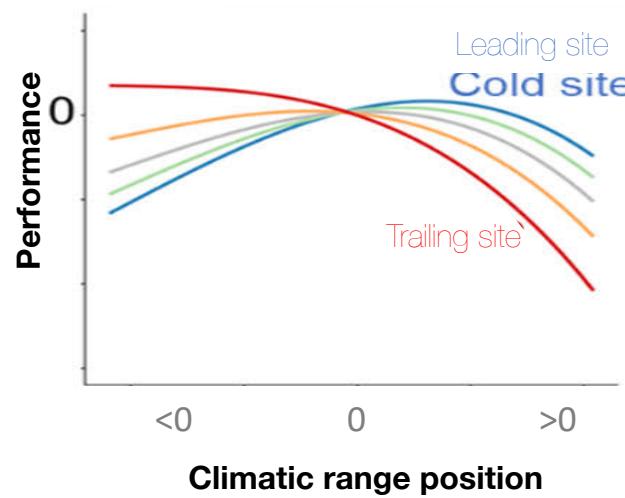
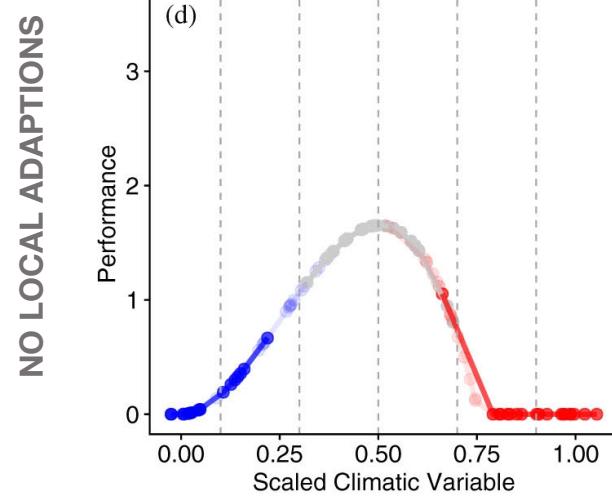
There is a **continuum of adaptation** between species, from most **locally** adapted to most **niche-adapted**



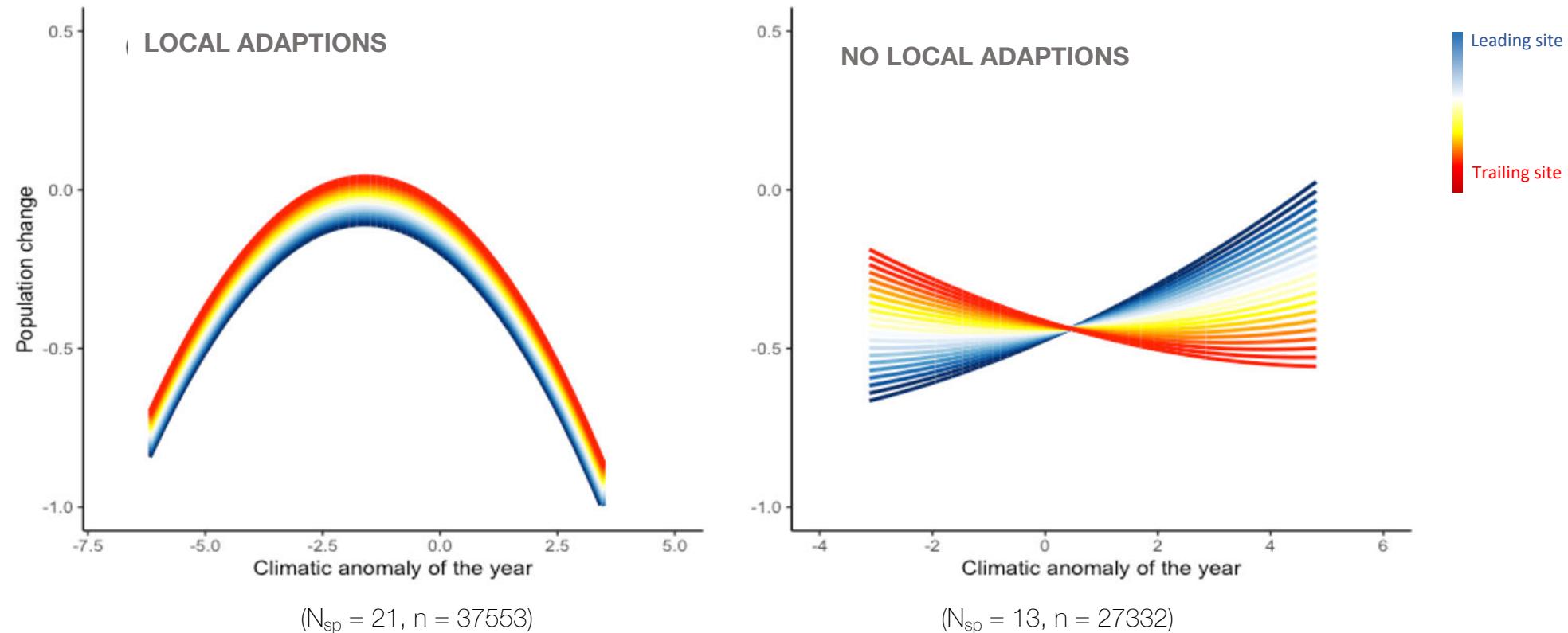
## H2: The degree of local adaptation mediates species populations responses to local climatic anomalies across their climatic niche



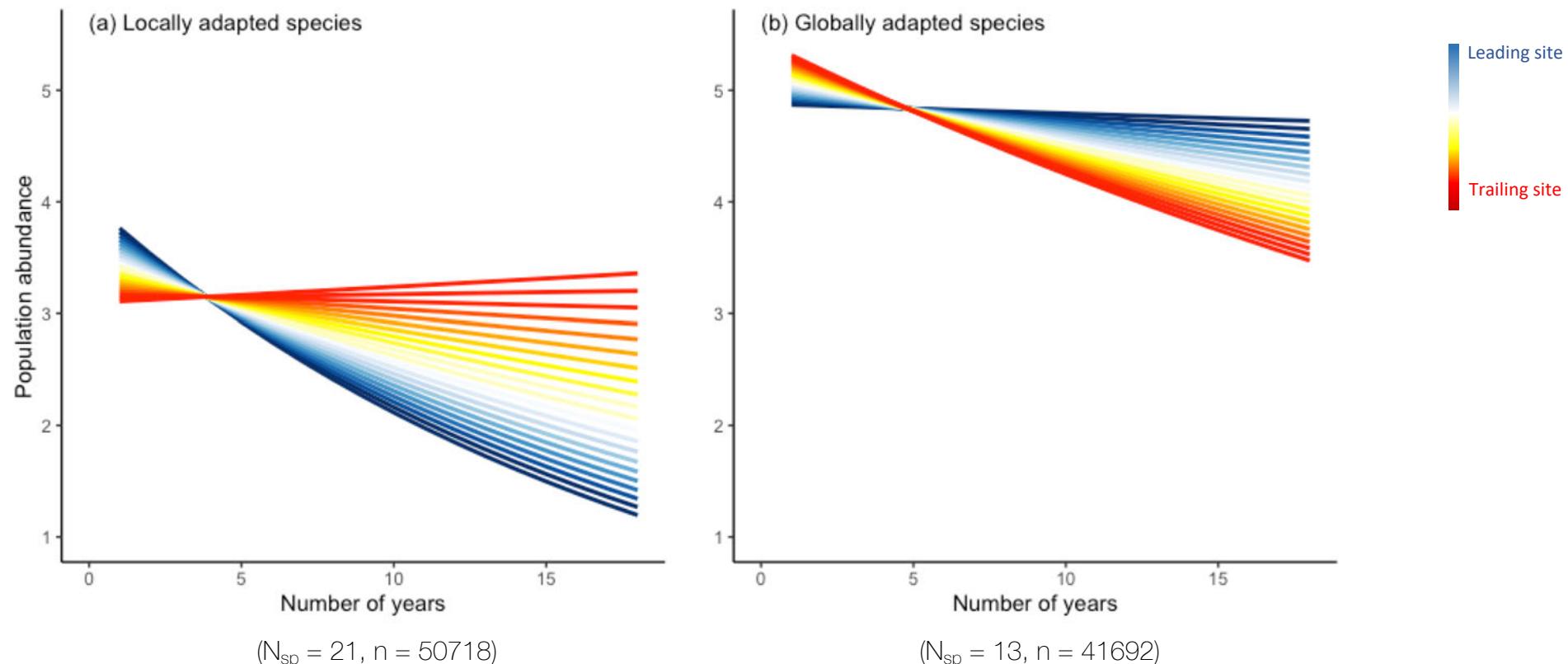
Populations performance of locally adapted species independent across sites, all anomalies will displace all populations from their optimum



The positive or negative effect of climatic anomalies depends on the degree of local adaptation of the species and on the population position within its range (niche)



As a result, population trends **of locally adapted species** showed **stable abundances over time** at the **trailing margin**, but **steep declines at the leading**; while **the rest** showed a steeper decline at the **trailing**



# Take Home Messages

## NO LOCAL ADAPTIONS

Above average anomalies favour leading populations of non adapted species & disfavour trailing

Below average anomalies favour trailing populations of non adapted species & disfavour leading

## LOCAL ADAPTIONS

All climatic anomalies disfavour locally adapted species but trades-off may disfavour leading populations



# The team thanks you for listening

## with special thanks to all BMS volunteers across Europe



Tom Oliver



Luke Evans



Constan Stefanescu



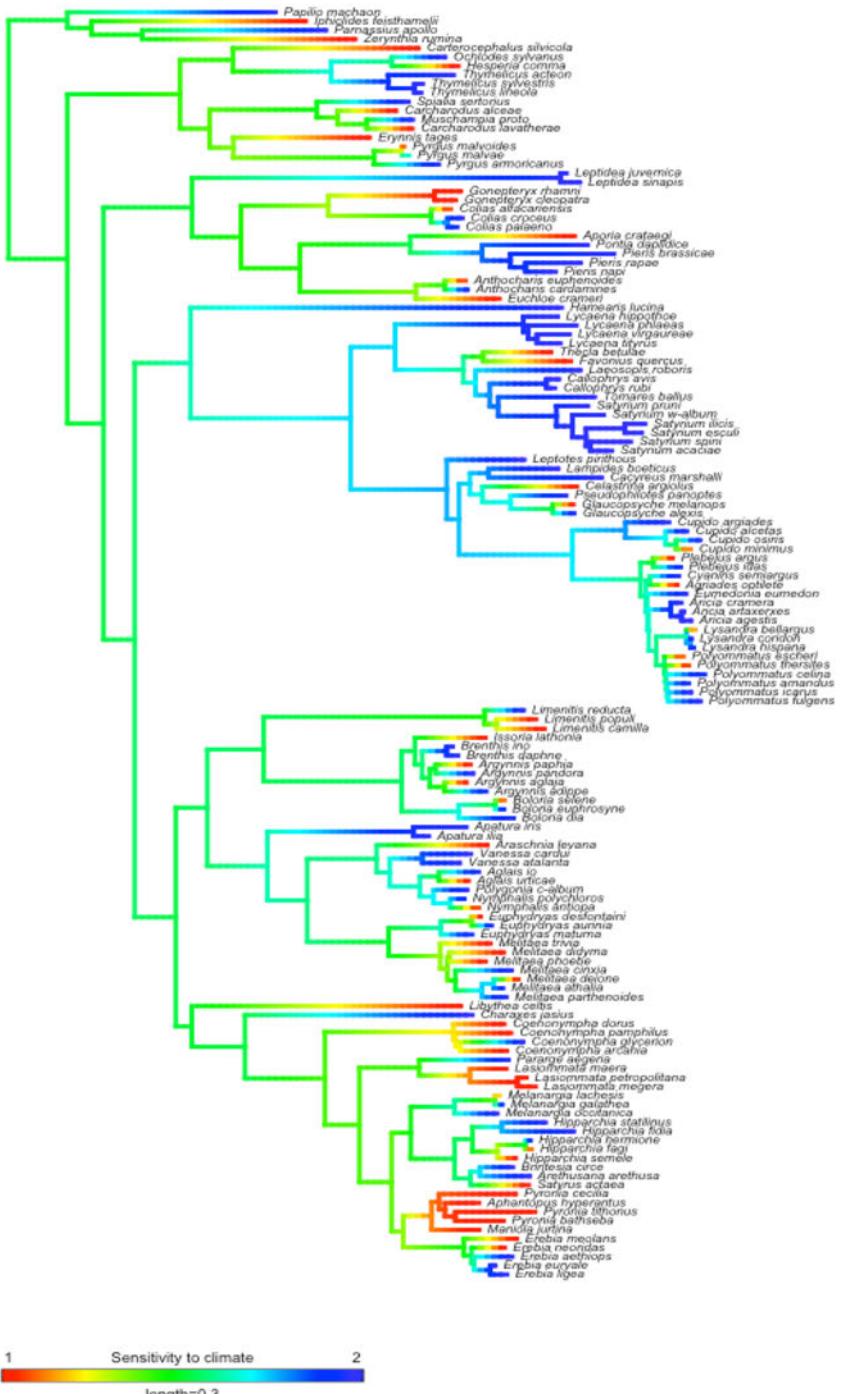
Reto Schmucki,



David Roy



Mikko Kuussaari



The degree of local adaption has **phylogenetic signal**  
**explaining ca. 80%**

**But not by mobility or reproduction rate**

