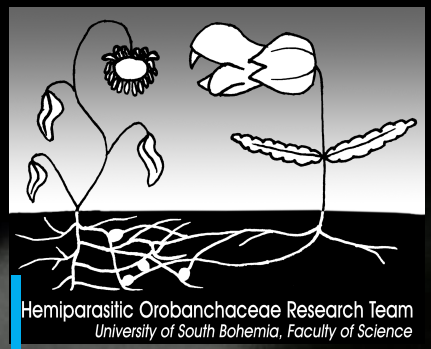

Modelling of niche: a case study on Central European root-hemiparasitic species

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Root hemiparasites

- Green photosynthetic plants that parasitize on other plant species
- Highly ecologically significant
  - effects on competitive relationships in host communities
  - effects on nutrient cycling
  - suppression of host growth
  - some species considered "Ecosystem engineers"
- BUT we actually do not know, where they grow in the landscape, i.e. what is their ecological niche
- currently, just informal field experience

Specific questions

- In which plant communities do the hemiparasites grow?
- What are the species with which they co-occur?
- How is their pattern of occurrence related to environmental and functional traits gradients?
- Is their presence in communities associated with high species richness?

The data

- Stratified version of the Czech National Phytosociological Database
  - over 30k reasonably independent relevés
  - formal phytosociological classification into classes and alliances
  - Mean annual precipitation and temperature data
- Databases
  - List of Ellenberg indication values
  - traits: LEDA, BiolFlor, Seed DB

Communities – Alliance(Class)

- *B. alpina* # releves = 26
  Caricion canescenti-nigrae (RB) 10, *Agrostion alpinae* (AC) 8, *Swertio perennis-Dichodontion palustris* (RA) 6, …
- *E. rostkoviana* # releves = 169
  Violion caninae (TE) 38, *Cynosurion cristati* (TD) 28, *Arrhenatherion elatioris* (TD) 24, …
- *O. vernus* # releves = 194
  Scleranthion annui (XB) 52, *Juncion gerardii* (TC) 34, *Deschampsion cespitosae* (TD) 15, …
- *M. pratense* # releves = 377
  Carpinion (32) 203, *Trifolion medii* (TC) 51, *Quercion pubescenti-petrae* (32) 50, …
- *R. minor* # releves = 435
  Arrhenatherion elatioris (TD) 154, *Calthion palustris* (TD) 60, *Molinion caeruleae* (TD) 40, …

Co-occurence with other species

- *B. alpina* # releves = 26
  counts: *Swertia perennis* 19, *Bistorta major* 17, *Allium schoenoprasum* 16, …
  V score: *Swertia perennis*, *Selaginella selaginoides*, *Allium schoenoprasum*, …
- *E. rostkoviana* # releves = 169
  counts: *Achillea millefolium* 130, *Plantago lanceolata* 128, *Anthoxanthum odoratum* 119, …
  V score: *Polygala vulgaris*, *Leontodon hispidus*, *Thymus pulegioides*, …
- *O. vernus* # releves = 194
  counts: *Taraxacum sect.* 92, *Ranunculus repens* 89, *Tripleurospermum inodorum* 75, …
  V score: *Trifolium fragiferum*, *Lotus tenuis*, *Pulegium vulgare*, …
- *R. minor* # releves = 435
  counts: *Plantago lanceolata* 331, *Achillea millefolium* 330, *Anthoxanthum odoratum* 301, …
  V score: *Briza media*, *Leontodon hispidus*, *Plantago lanceolata*, …

How to define the ecological niche?

Three groups of releves

Hemiparasite occurs here	Hemiparasite does not occur here, but could occur. It's a member of DARK DIVERSITY	Hemiparasite does not and cannot occur here, e.g. *Rhinanthus* in a fishpond

Q. 1) How to classify relevés in these groups?

The Beals index approach

Beals index (probability of occurrence of species j in habitat i): $p_{ij} = 1/S_i \sum_k N_{jk}/N_k$ where S_i is species richness of habitat i, N_{jk} number of joint occurrences of species j and k in database and N_k number of occurrences of species k in reference database.

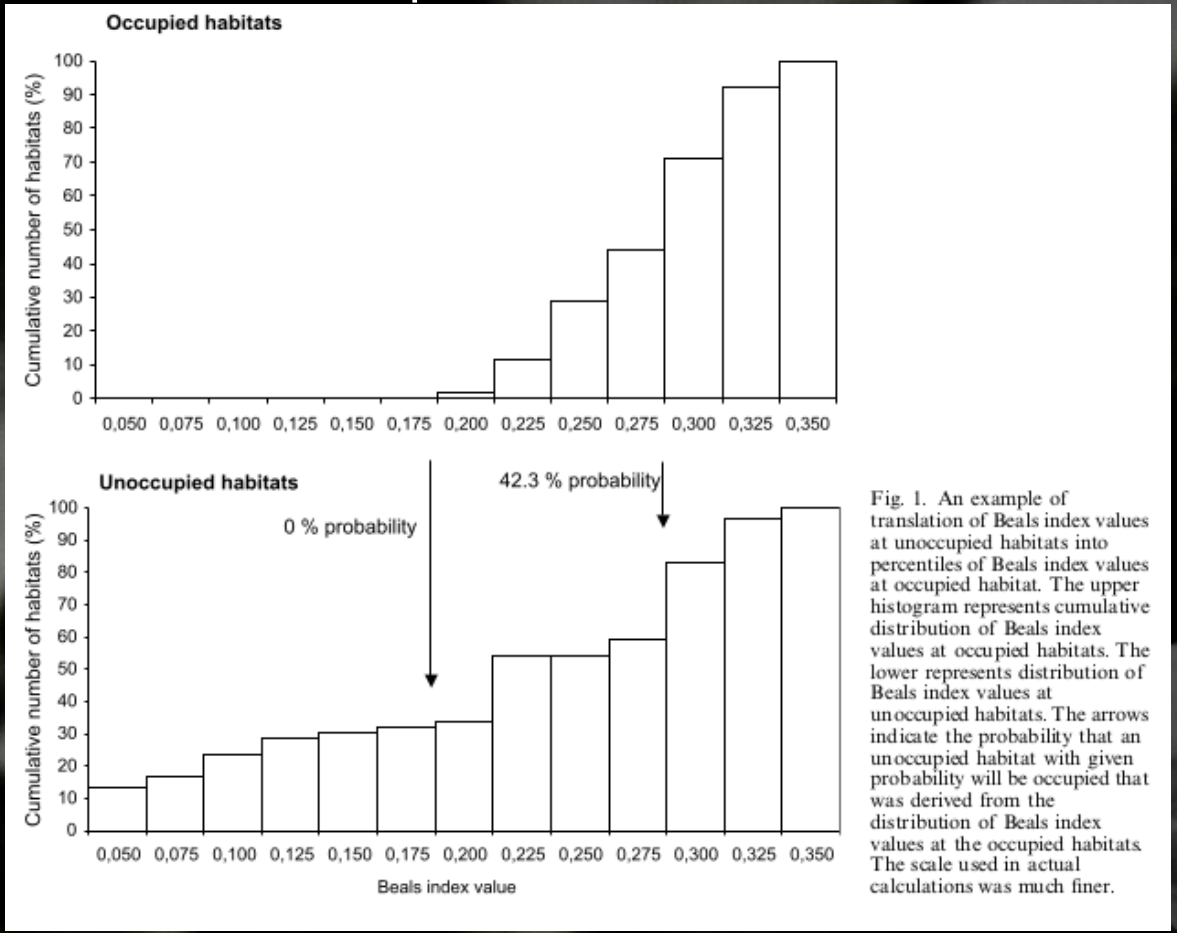
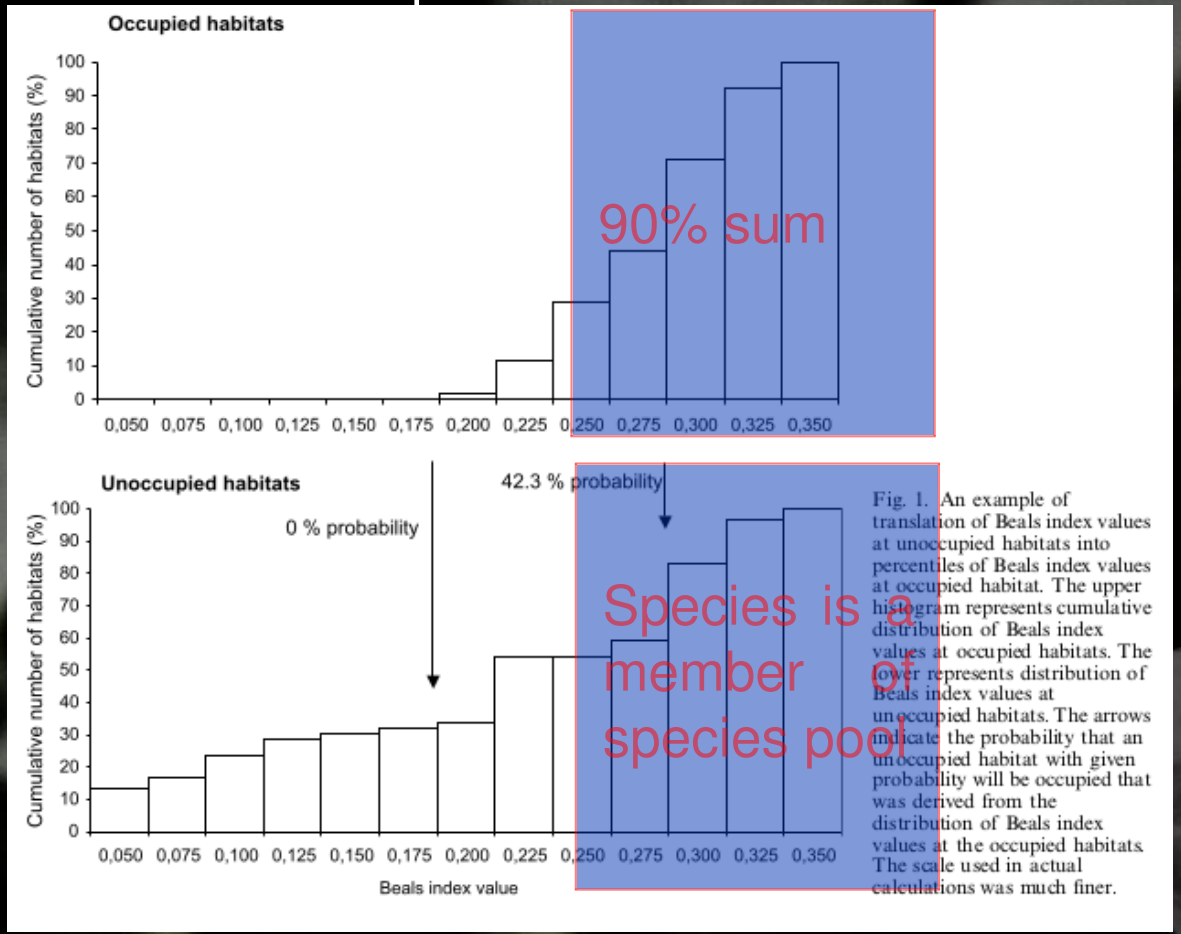


Fig. 1. An example of translation of Beals index values at unoccupied habitats into percentiles of Beals index values at occupied habitat. The upper histogram represents cumulative distribution of Beals index values at occupied habitats. The lower represents distribution of Beals index values at unoccupied habitats. The arrows indicate the probability that an unoccupied habitat with given probability will be occupied that was derived from the distribution of Beals index values at the occupied habitats. The scale used in actual calculations was much finer.

Munzbergova, Herben (2004) Identificaton of suitable unoccupied habitats in metapopulation studies using co-occurence of species. *Oikos*.

The Beals index approach

Beals index (probability of occurrence of species *j* in habitat *i*): $p_{ij} = 1/S_i \sum_k N_{jk}/N_k$ where S_i is species richness of habitat *i*, N_{jk} number of joint occurrences of species *j* and *k* in database and N_k number of occurrences of species *k* in reference database.

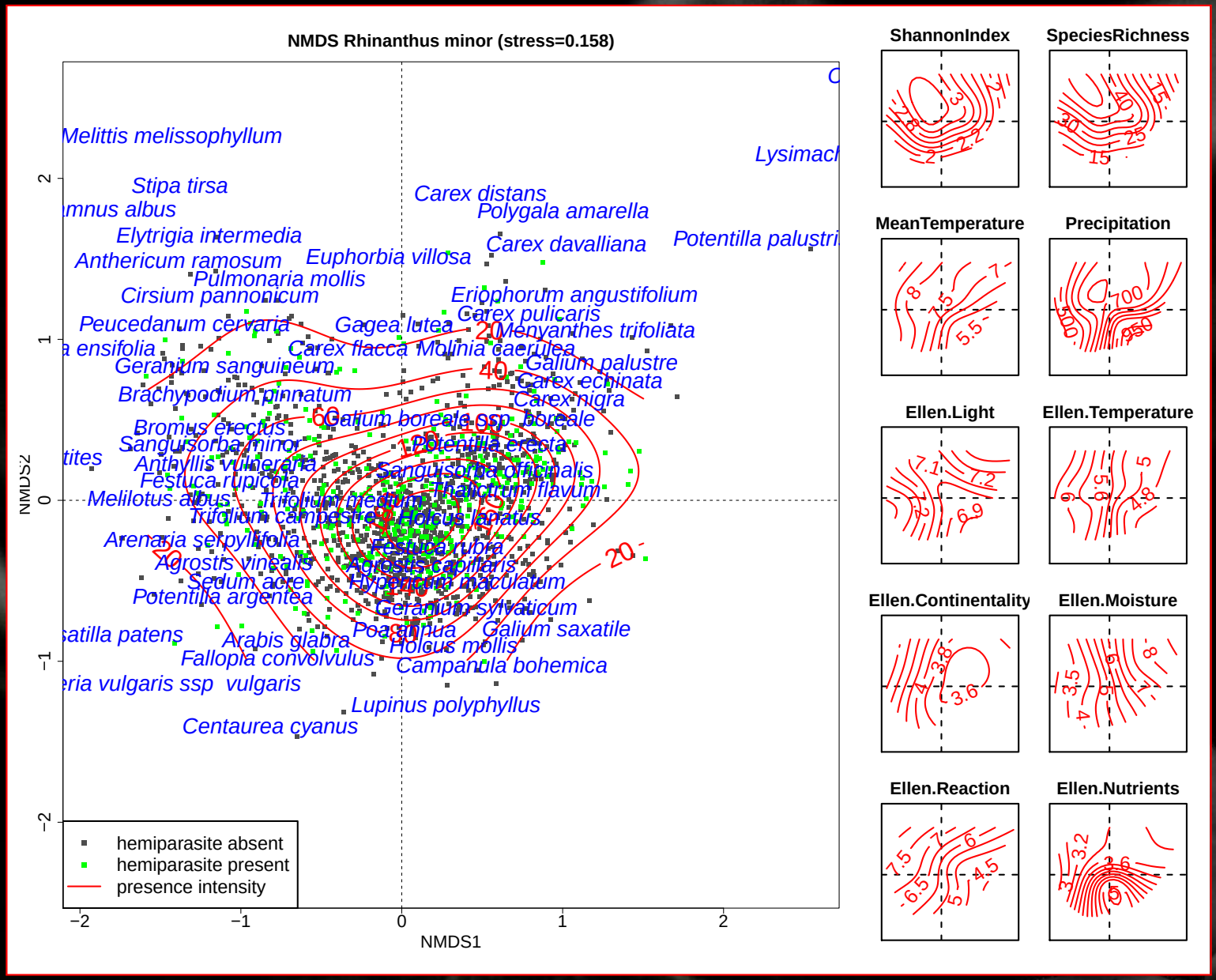


Munzbergova, Herben (2004) Identificaton of suitable unoccupied habitats in metapopulation studies using co-occurence of species. *Oikos*.

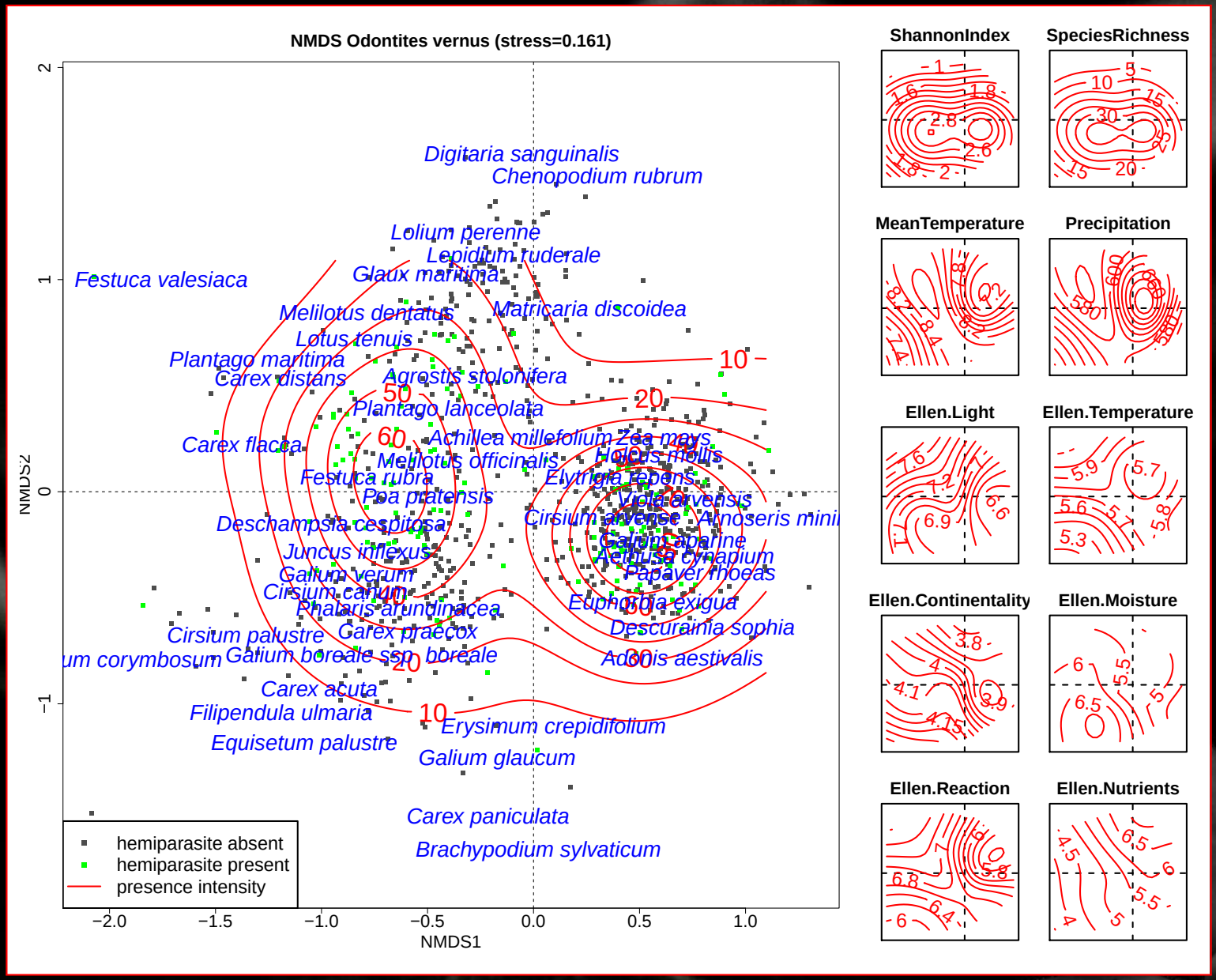
Complications with Beals index

- Different vegetation types (classes/alliances) have different size of species pool and turnover patterns
  - Beals index is averaging that - doesn't work across vegetation classes (and maybe even alliances)
    e.g. for *Rhinanthus minor* - too strict *Festuco-Brometea* in but too loose in *Molinio-Arrhenatheretea* (e.g. *Calthion*)
    - constantly predicting a high probability of occurrence in dense *Phragmites australis* stands
- Beals index computed separately for each class, where a hemiparasite occurs. Finally, individual class sets are pooled together.

NMDS of *Rhinanthus minor*



NMDS of *Odontites vernus*



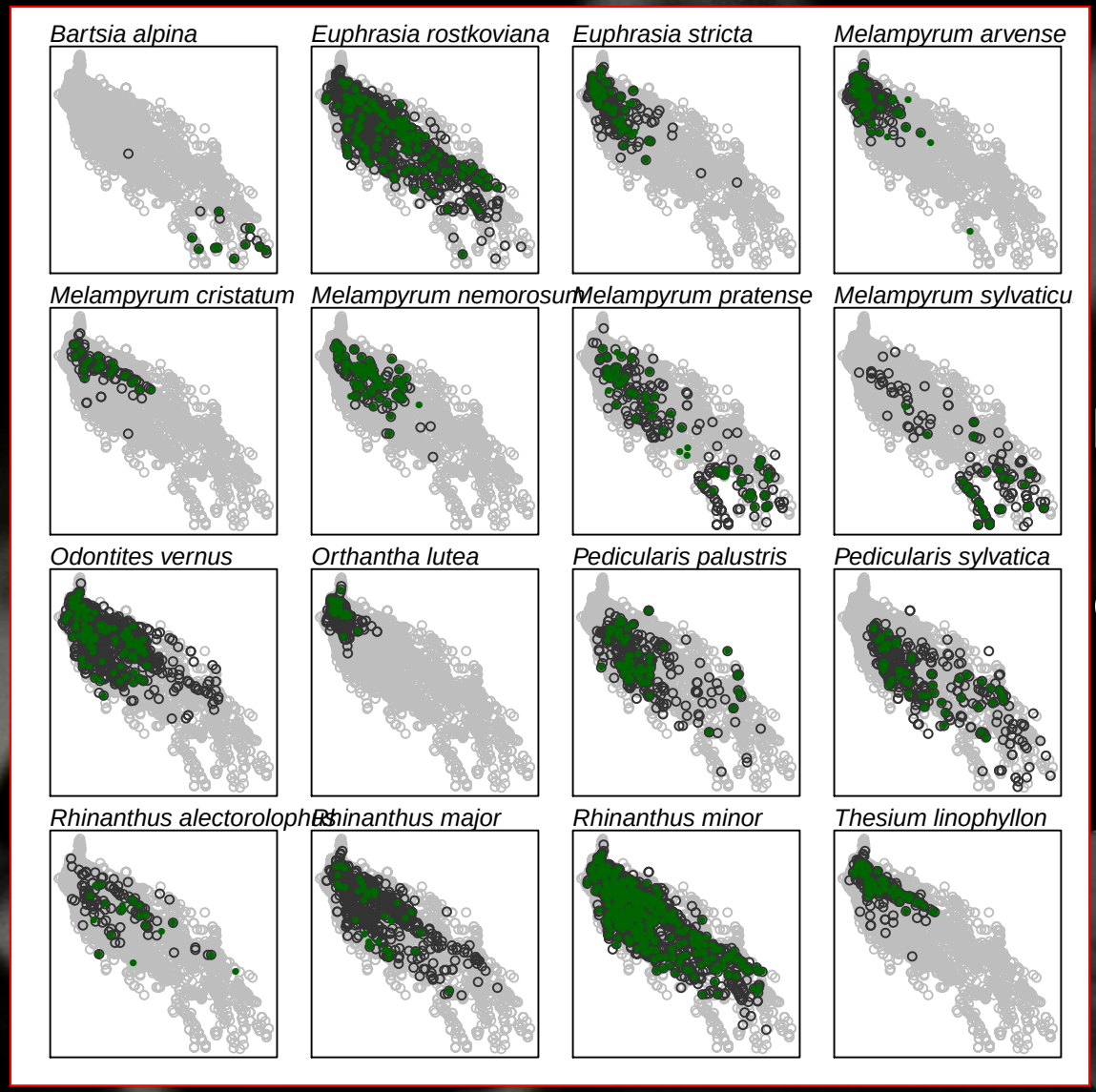
What to compare?

Hemiparasite occurs here	Hemiparasite does not occur here, but could occur. It's a member of DARK DIVERSITY	Hemiparasite does not and cannot occur here, e.g. *Rhinanthus* in a fishpond

Q. 2) What are the differences among the three groups of relevés? But what to compare?

- Black vs. grey – no differences expected (and in fact detected)
- Black vs. grey+white – often compared but misleading
- Black+grey vs. white – this is relevant for the niche (**beta-niche**)!

Precipitation and temperature

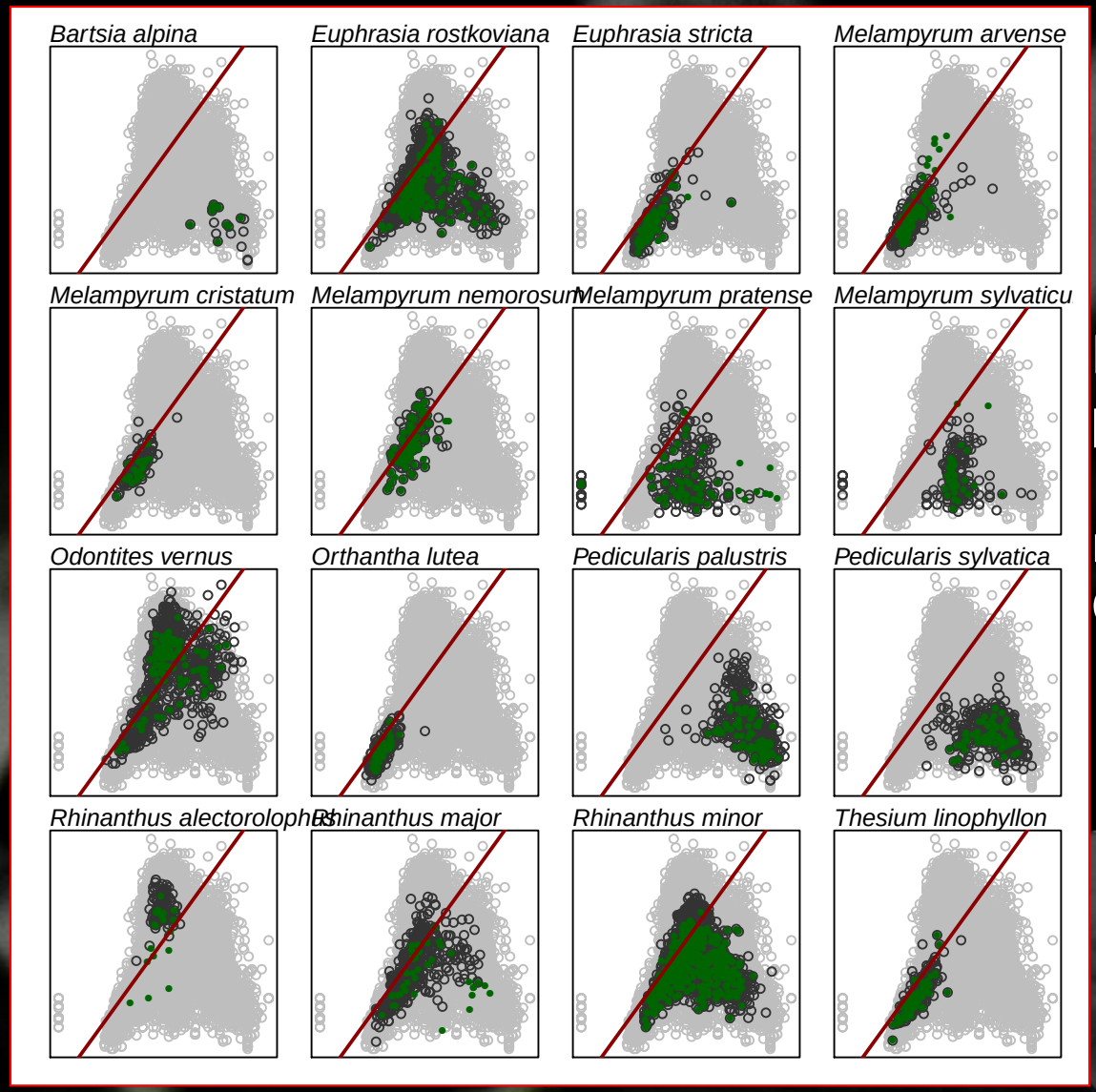


Annual temperature

Annual precipitation

Light gray -non presence,
Dark gray - inside niche,
Green - presence

Ellenberg moisture and nutrients

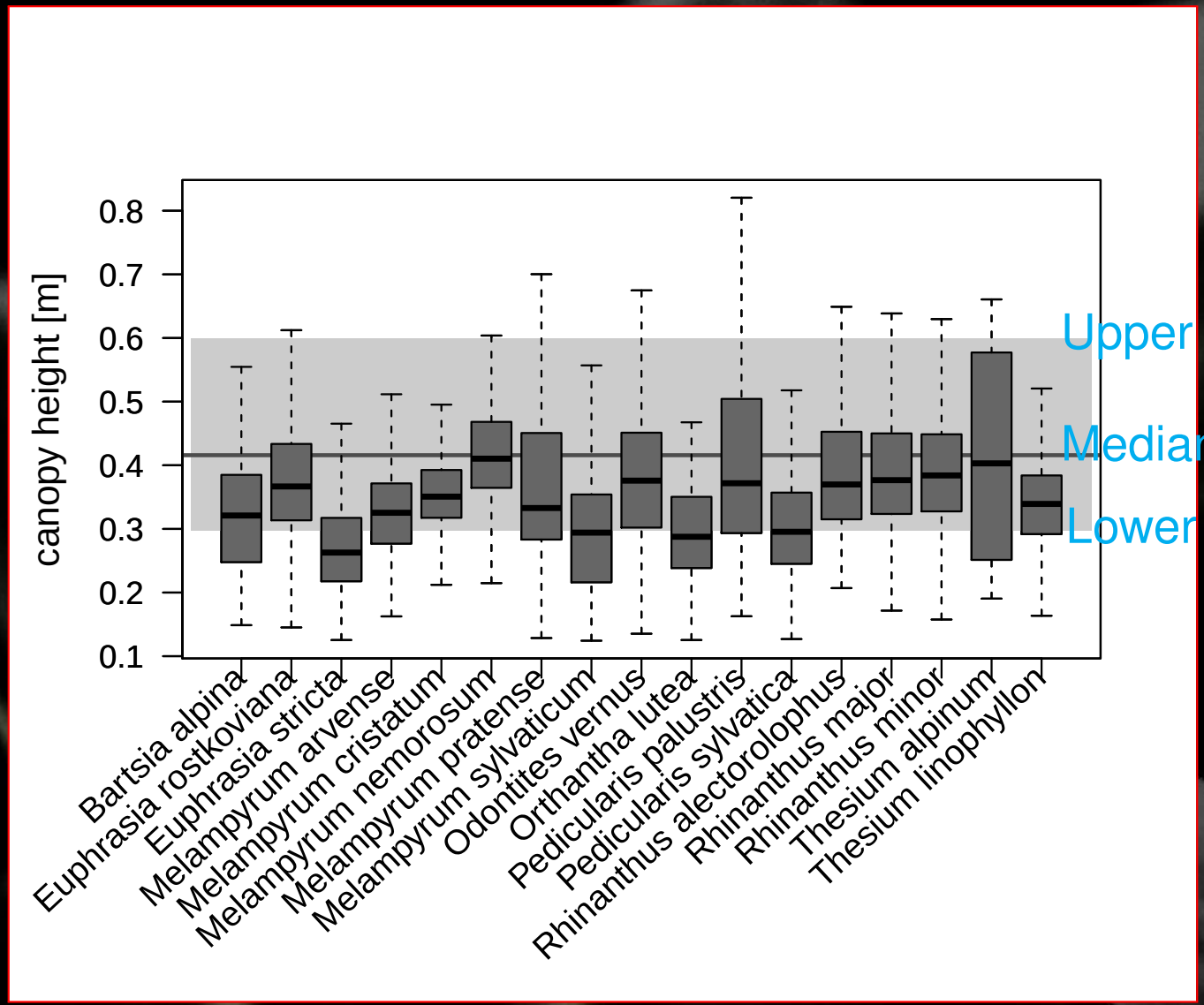


Ellenberg nutrients

Ellenberg moisture

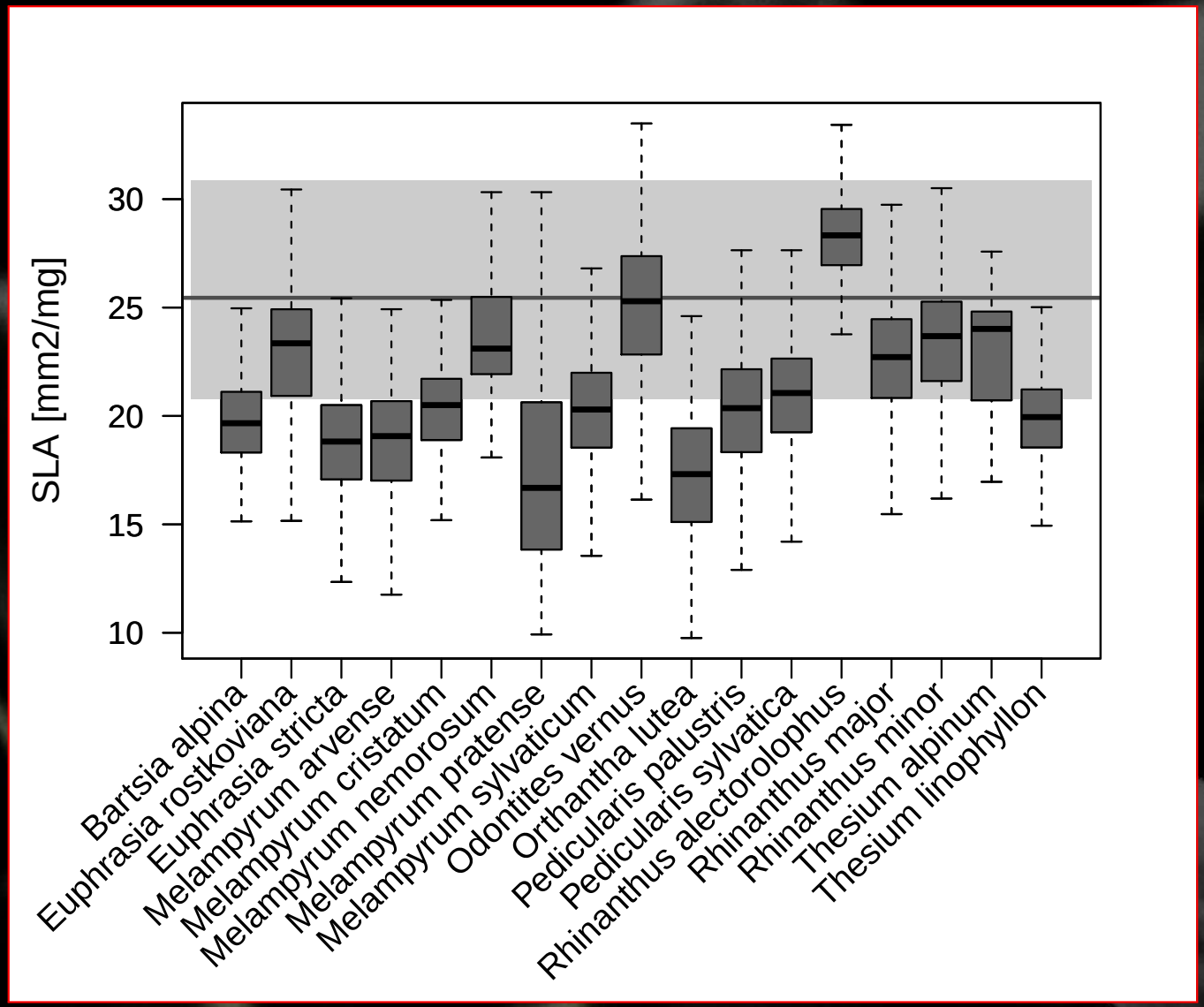
Light gray - non presence,
Dark gray - inside niche,
Green - presence

Canopy height



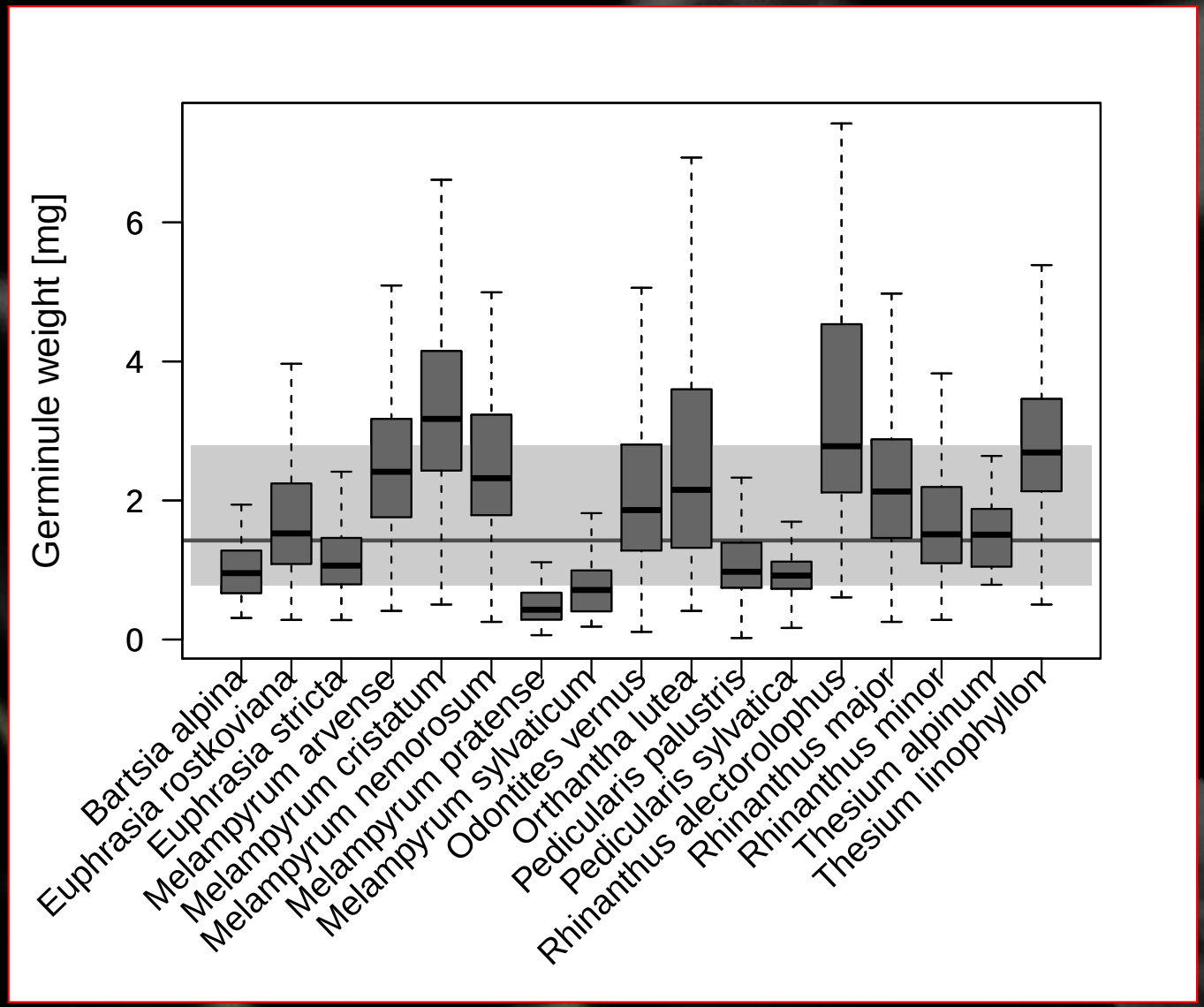
Trait community weighted means (CWM) for black and grey relevés vs. all grassland relevés in DB.

SLA



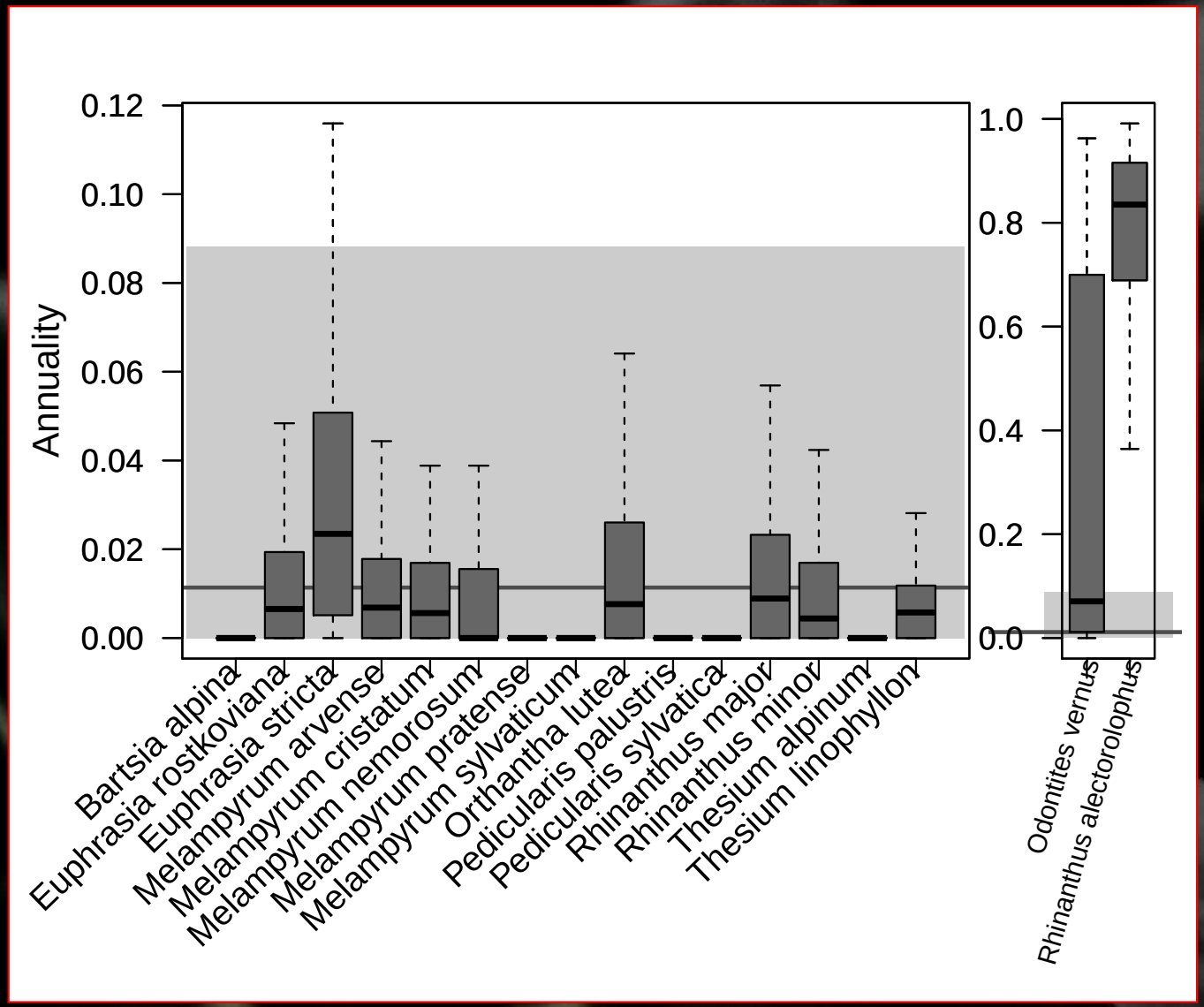
Trait community weighted means (CWM) for black and grey relevés vs. all grassland relevés in DB.

Seed weight



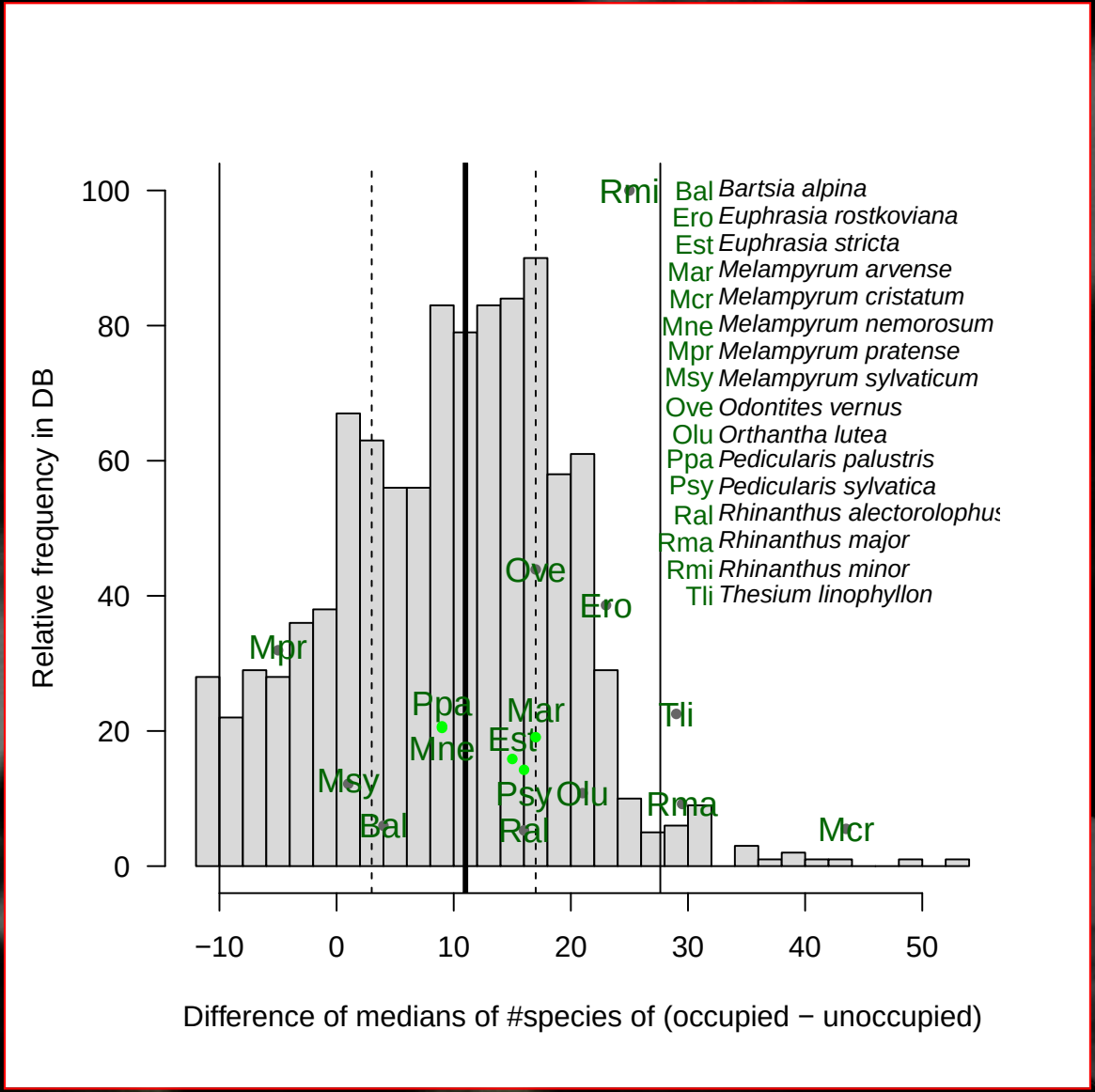
Trait community weighted means (CWM) for black and grey relevés vs. all grassland relevés in DB.

Annuality



Trait community weighted means (CWM) for black and grey relevés vs. all grassland relevés in DB.

Associations with species richness

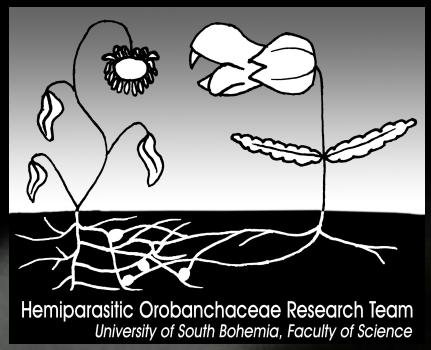


Comparison between hemiparasites and other species (grey distribution).

Conclusions

- We managed to identify vegetation types where hemiparasites occur (easy)
- The ecological niche can be identified based on Beals index + formalized vegetation classification approach
- The niche and major environmental gradients within it can be visualized by NMDS
- Niche can be also defined by functional traits
- Some of the hemiparasites tend to be associated with species-rich vegetation

Questions



THANK YOU FOR ATTENTION.
Questions
and/or
comments?