

Diversity of mycobiont-photobiont associations correlate with reproductive strategies in *Cladonia* lichen species



Jana Steinová, Pavel Škaloud, Helena Bestová and Lucia Muggia



TECHNICAL UNIVERSITY OF LIBEREC
Institute for Nanomaterials, Advanced
Technologies and Innovation

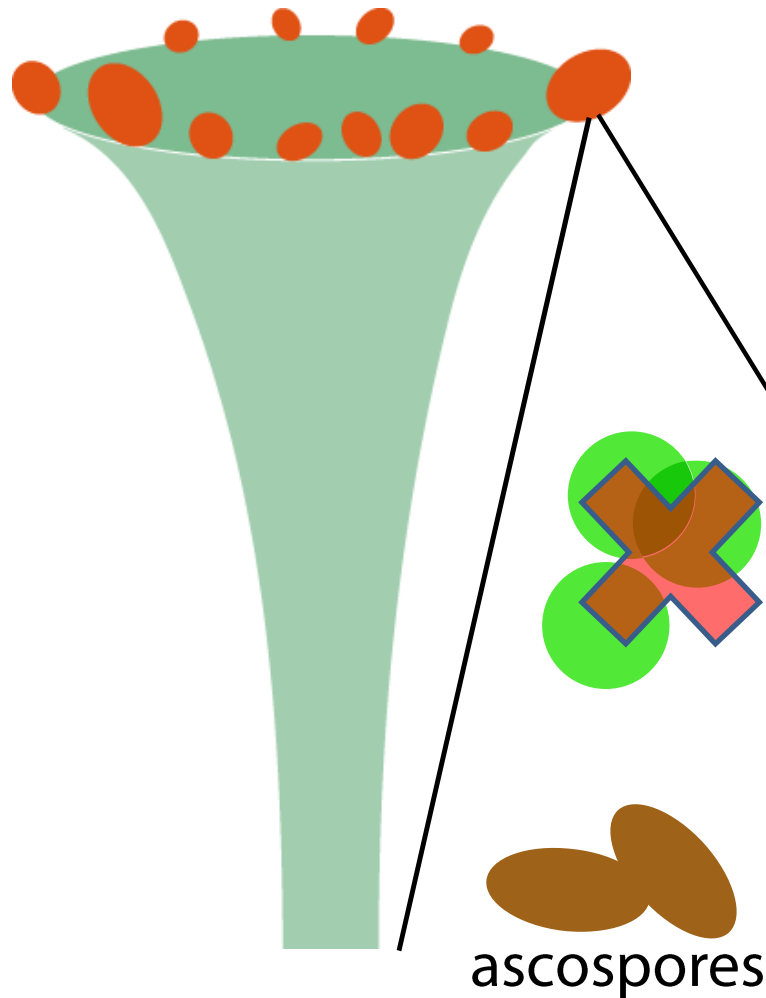


What may influence the choice of photobiont?

- 1) **Mycobiont and photobiont specificity**
- 2) **Environmental conditions** (climate, altitude, (micro)biotope, rain vs. sun exposure)
- 3) **Photobiont availability** at the locality ?
- 4) **Reproductive strategy ?**

Sexual mode of reproduction

– by fungal spores → fungal spores must obtain a compatible partner

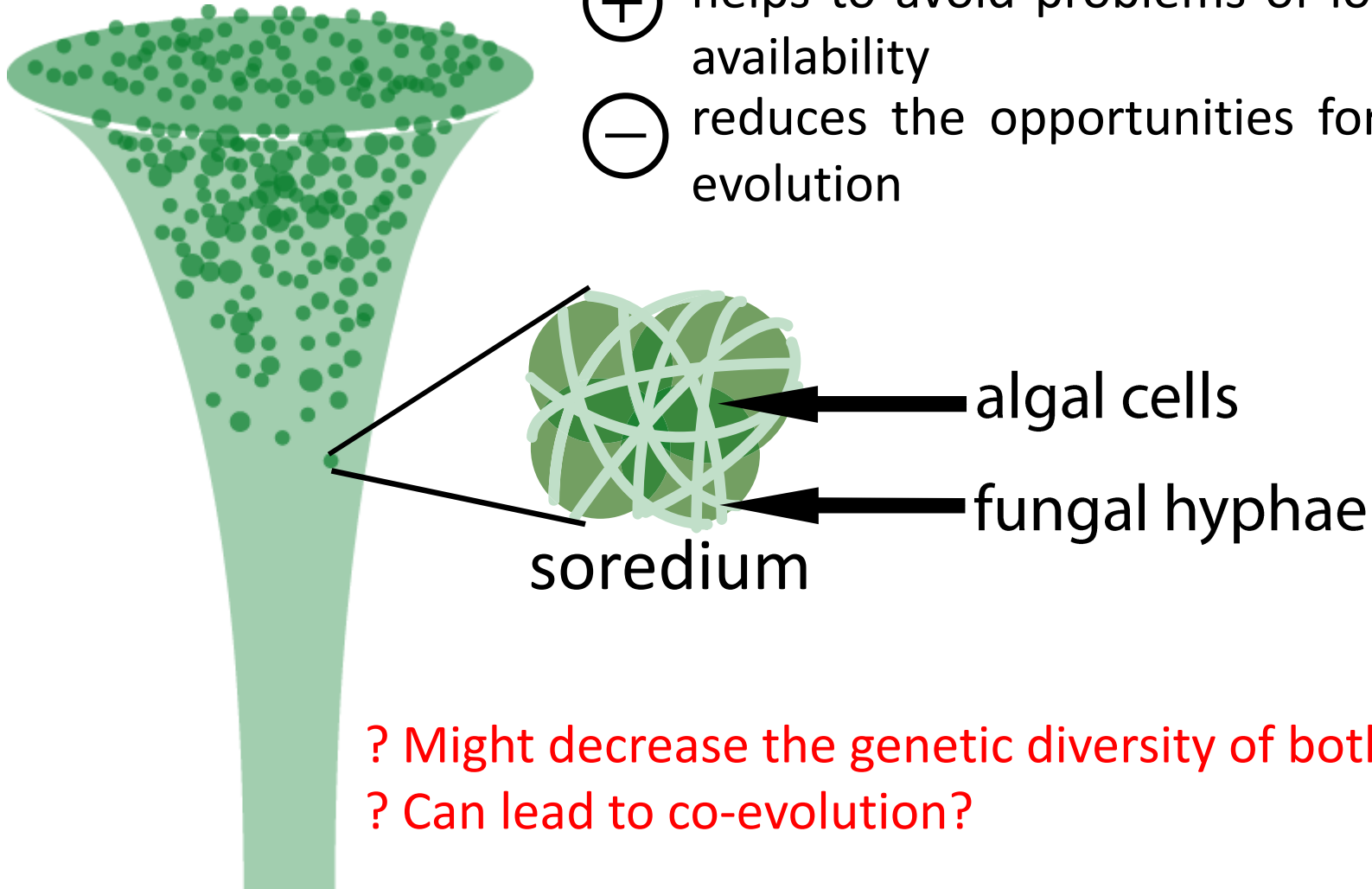


- ⊕ produces new genotypes and tends to increase the likelihood of successful dissemination by long range dispersal
- ⊖ symbiosis must be always established de novo – it might be difficult to find a partner

Asexual mode of reproduction

– both partners simultaneously dispersed within specialised asexual propagules (e.g. soredia, isidia)

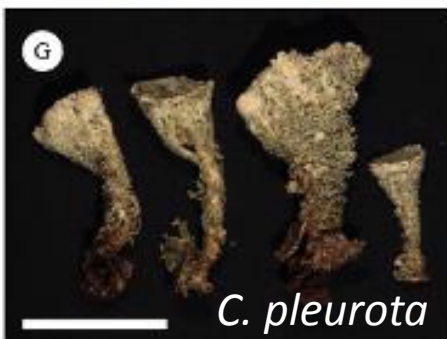
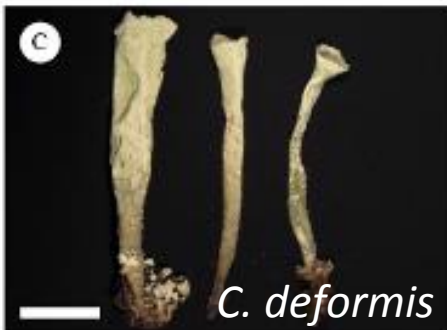
- ⊕ helps to avoid problems of low partner availability
- ⊖ reduces the opportunities for adaptive evolution



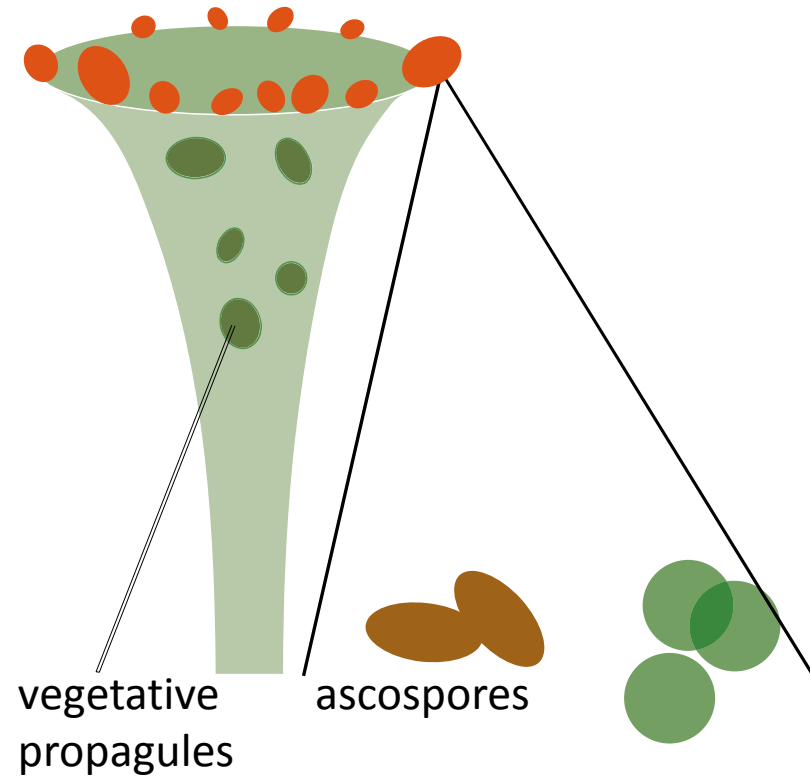
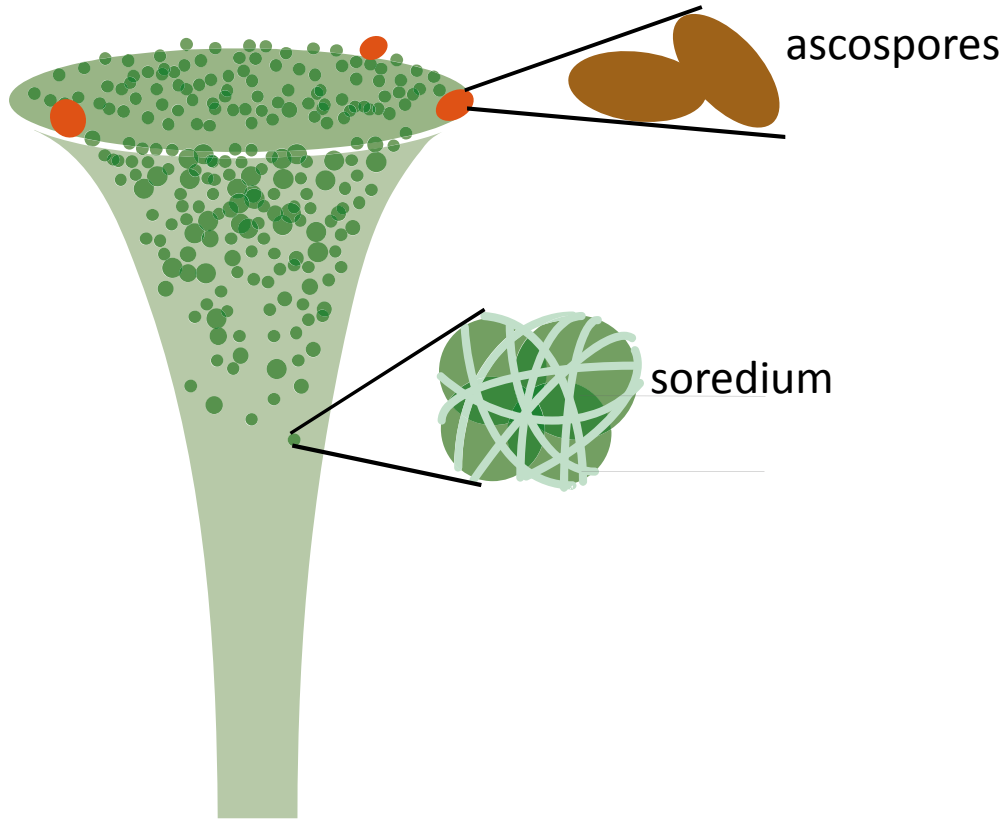
? Might decrease the genetic diversity of both partners?
? Can lead to co-evolution?

Zeorin-containing red-fruited *Cladonia* species

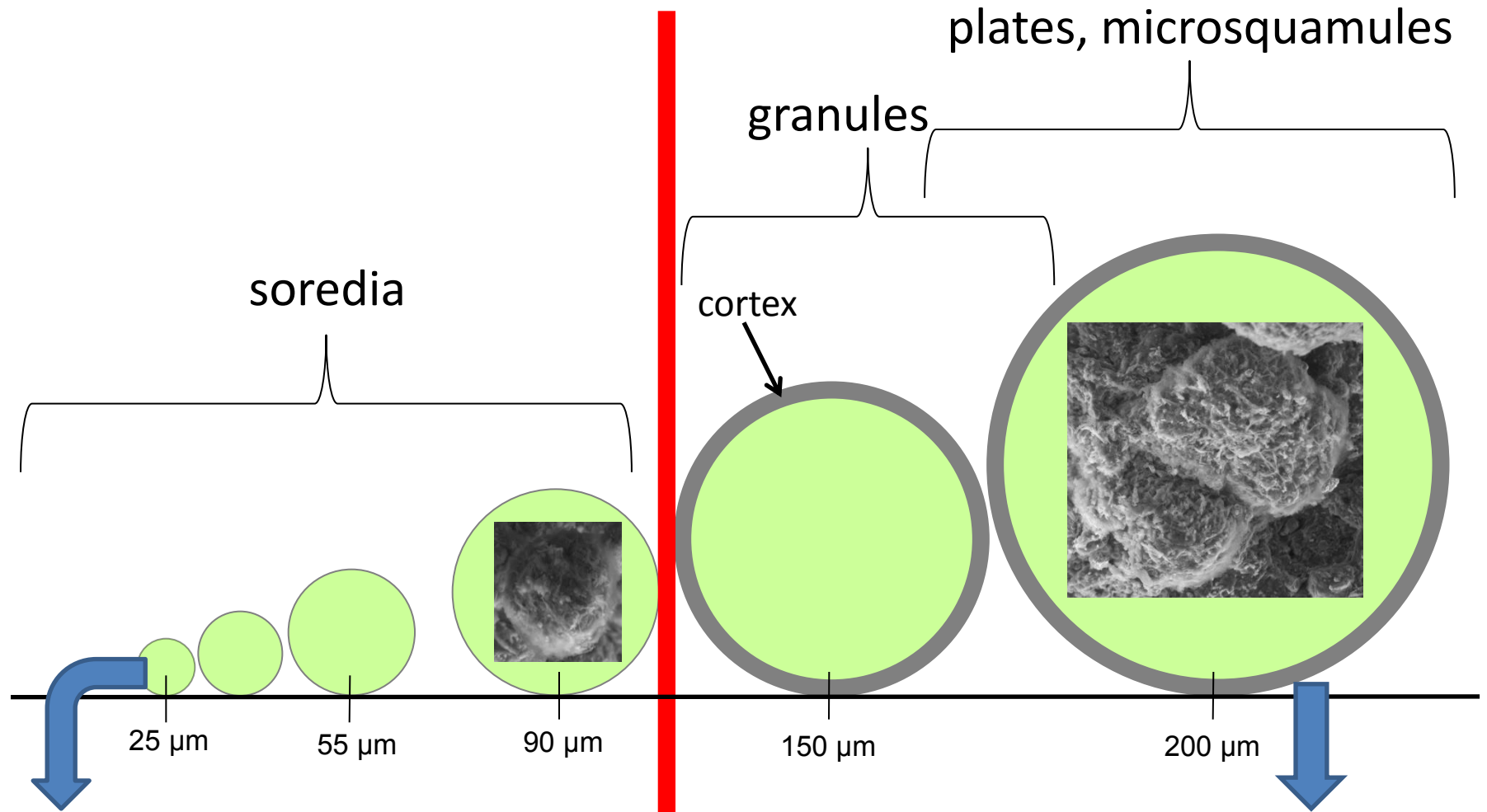
- genus *Cladonia*, section *Cocciferae*
- associated with *Asterochloris* spp.
- 5 species worldwide, 4 species in Europe: soresciate *Cladonia deformis*, *C. pleurota* and esoresciate *C. coccifera* and *C. diversa*
- chemically almost identical – species delimitation based on morphology
- different distribution patterns



Combined mode of reproduction



Vegetative propagules of zeorin-containing *Cladonias*



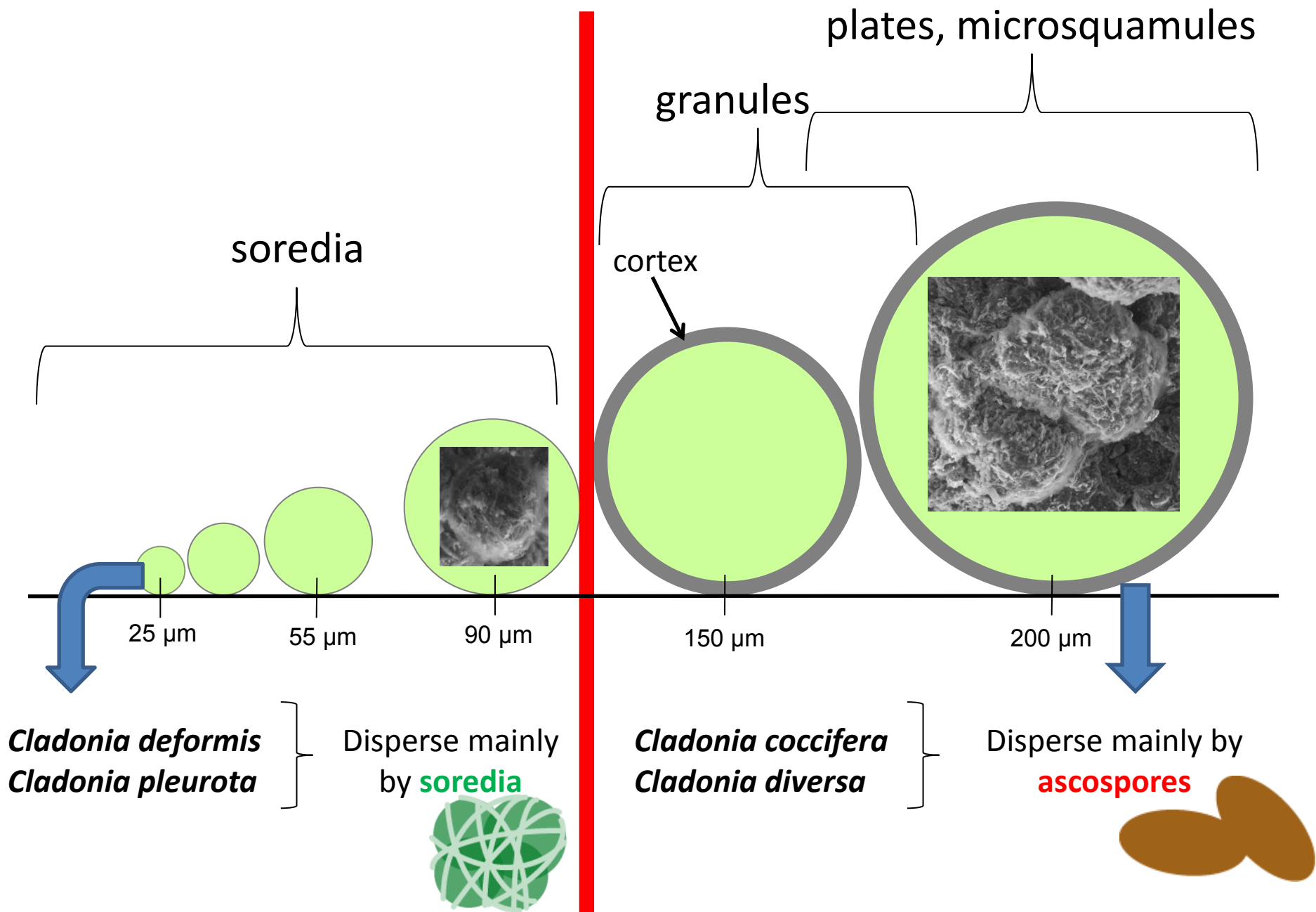
Long-distance dispersal:

- small soredia are light and detach easily
- propagules produced in large amounts

Short-distance dispersal:

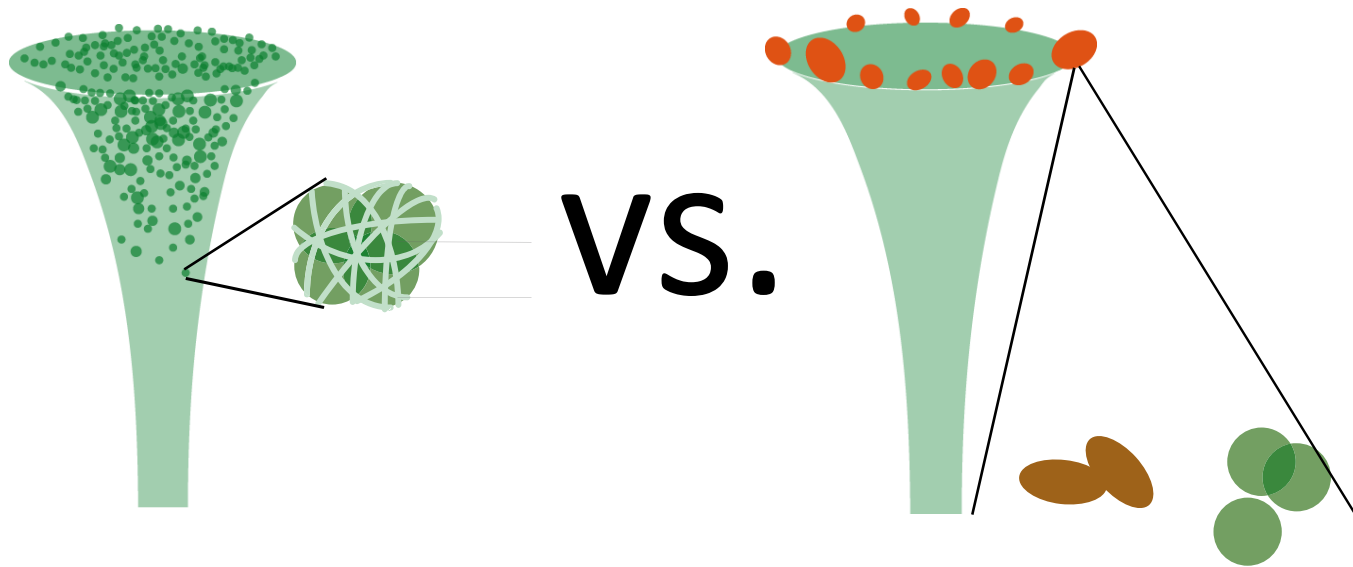
- hard to detach (e. g. splash-cup mechanism during heavy rain)
- produced in smaller amounts

Vegetative propagules of zeorin-containing *Cladonias*



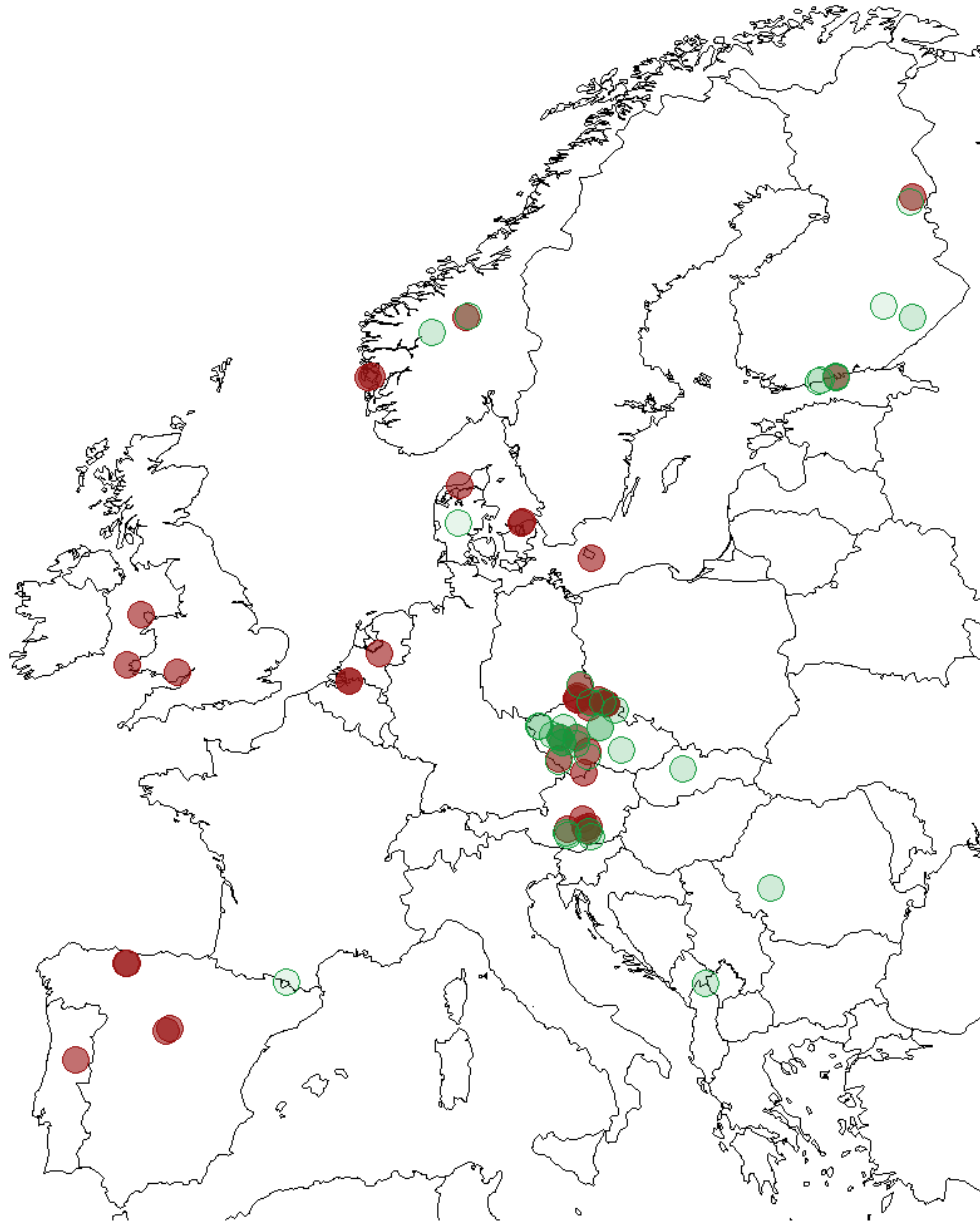
Is photobiont diversity of zeorin-containing *Cladonias* influenced by prevailing distribution strategy?

- 43 sorediate (*C. deformis* and *C. pleurota*) and 42 esorediate (*C. coccifera* and *C. diversa*) samples from Europe



- Algal internal transcribed spacer region (ITS) and partial actin I
- Fungal internal transcribed spacer region (ITS) and β -tubulin
- → comparing photobiont diversity

Sampling



● **Sorediate taxa** (*Cladonia deformis* + *C. pleurota*)

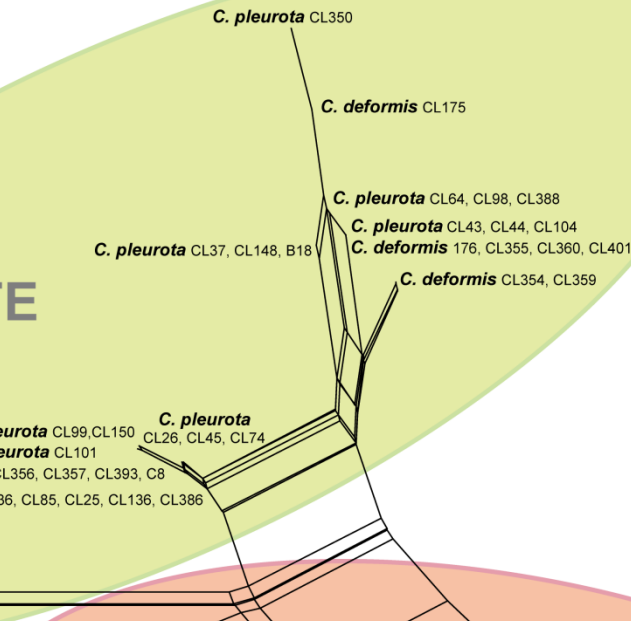
● **Esorediate taxa** (*Cladonia coccifera* + *C. diversa*)

Esorediate and sorediate taxa collected several times at the same site.

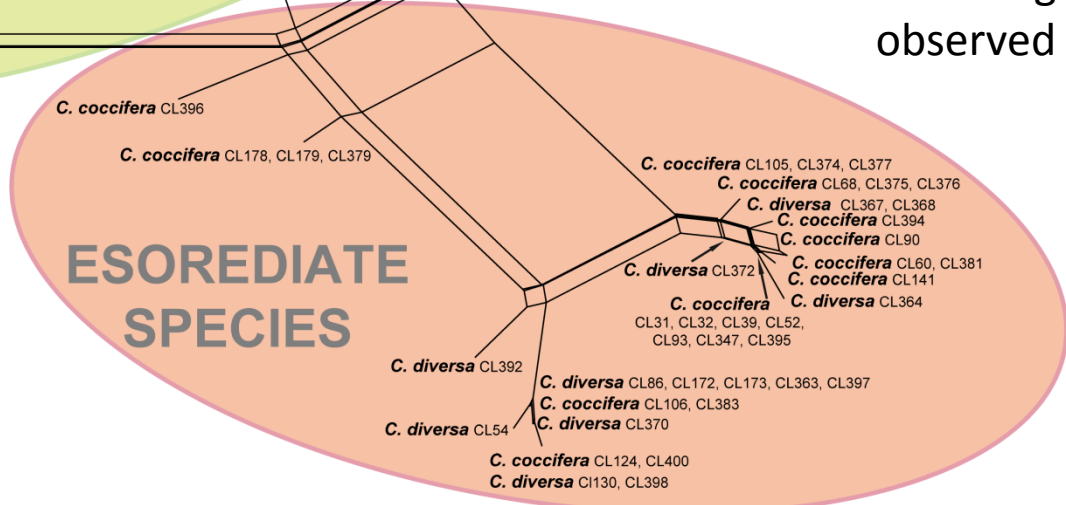
Fungal molecular diversity

ITS rRNA + β -tubulin

SOREDIAE SPECIES



ESOREDIAE SPECIES



- **delimitation of individual species not supported** (incomplete lineage sorting? , hybridization?)
- no chemical, geographical or ecological pattern observed

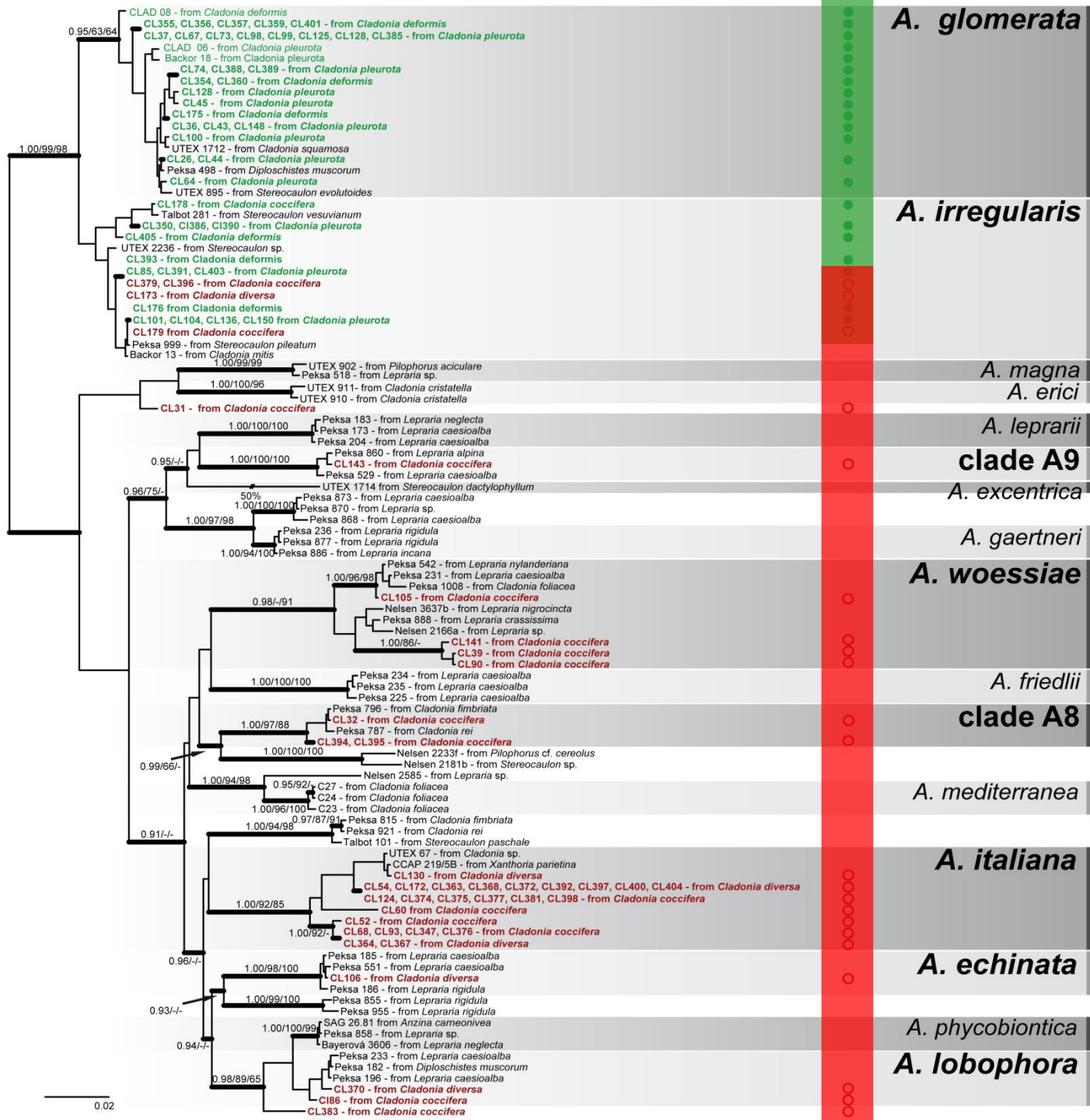
Algal molecular diversity

sorediate taxa

esorediate taxa

Sorediate taxa associated with 2 algal lineages whereas esorediate taxa contained 7 photobiont species.

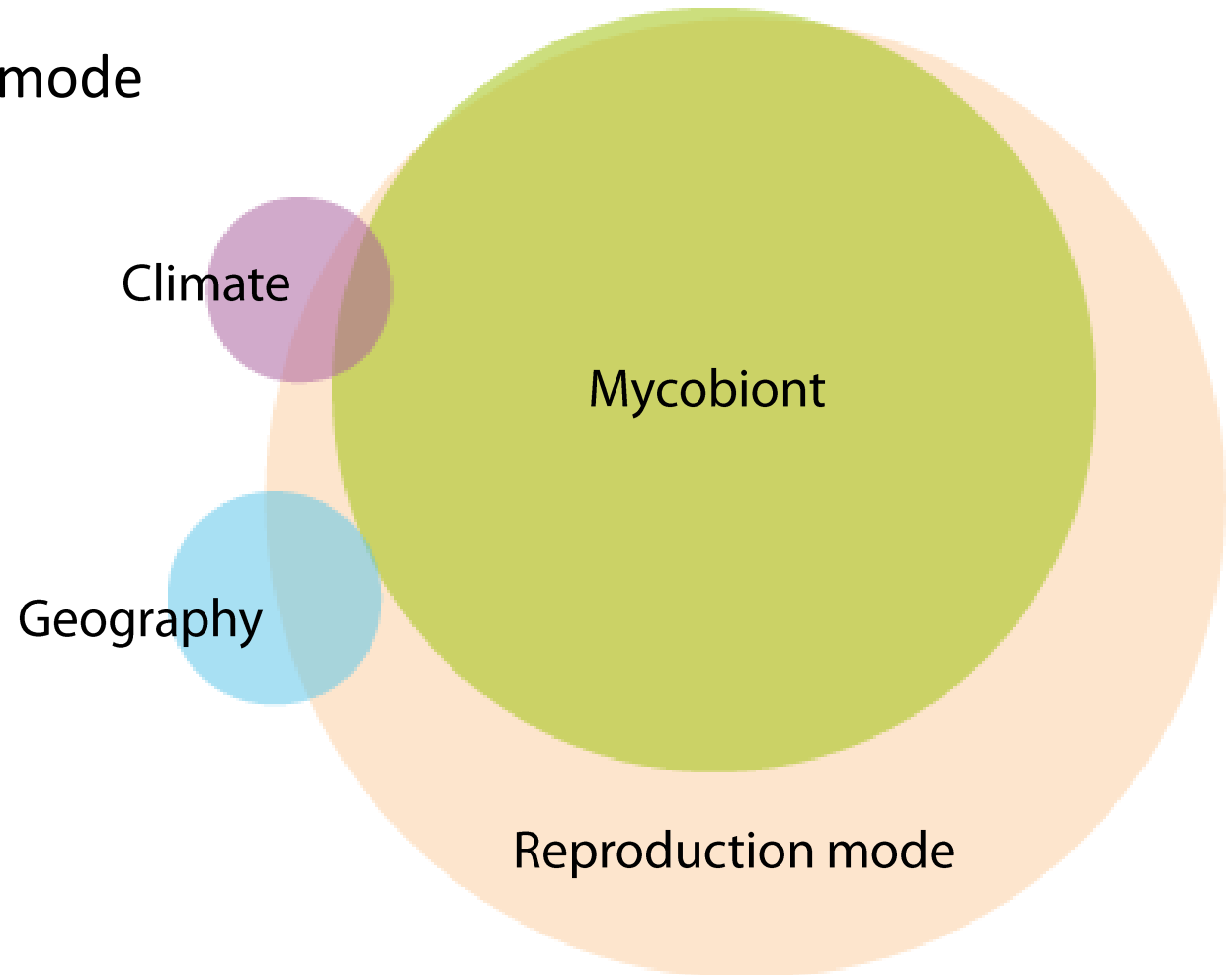
Esorediate and sorediate samples collected at the same site contained different photobionts!



Variation partitioning

Photobiont diversity explained by ?:

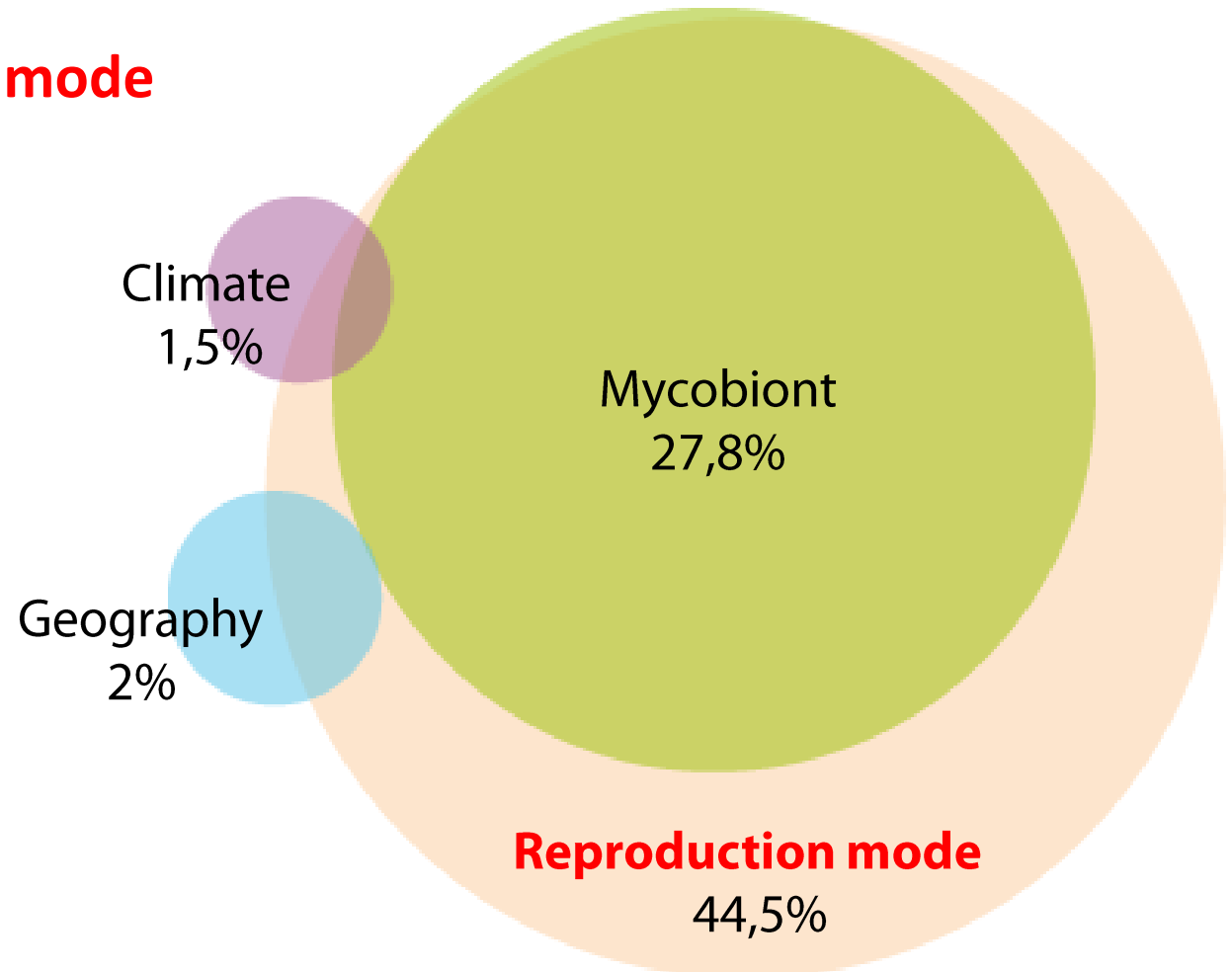
1. Mycobiont (ITS + β -tubulin)
2. Climate
3. Geography
4. Reproduction mode



Variation partitioning

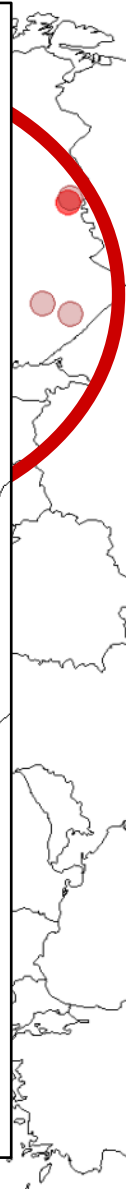
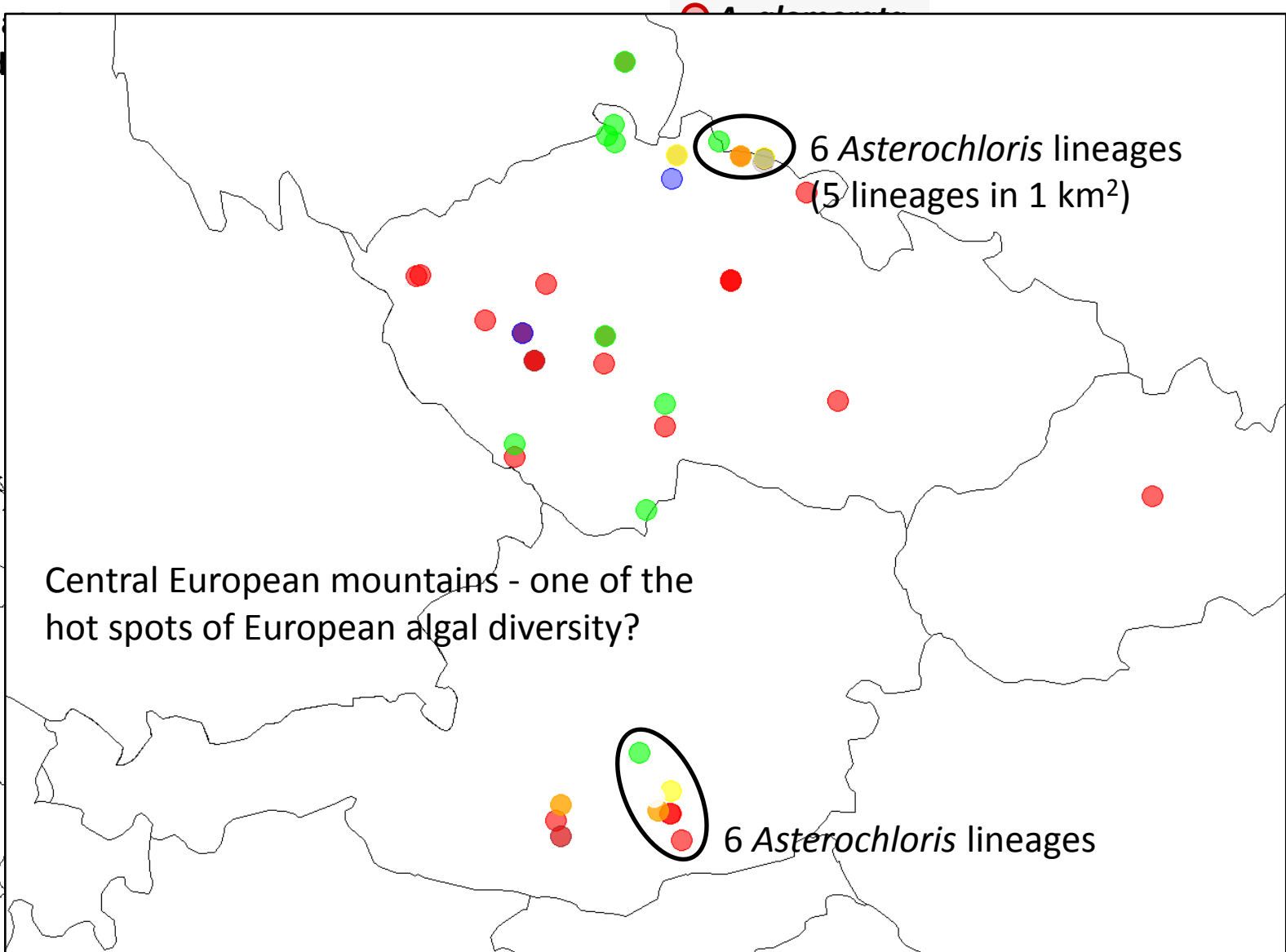
Photobiont diversity explained by ?:

1. Mycobiont (ITS + β -tubulin)
2. Climate
3. Geography
- 4. Reproduction mode**



Photobiont diversity in Europe

- Soredi
- Esored



Conclusions

- **Reproduction strategy (production of soredia) influences the photobiont diversity in zeorin-containing red-fruited *Cladonia* species** – lichens reproducing mainly by ascospores are less selective compared to the lichens producing soredia.
- Sorediate taxa can propagate by ascospores too - but they associate only with *A. glomerata* or *A. irregularis*.
- At the same sampling site sorediate and esorediate species contain different photobiont species (with the exception of area of Fennoscandia).
- Photobiont availability might influence lichen distribution?
(*C. deformis* and *C. pleurota* lacking in areas dominated by *A. italiana*??)

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