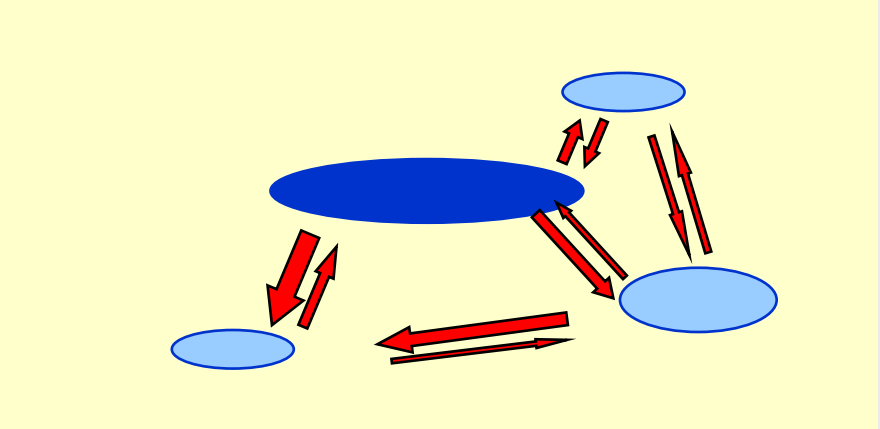
Body size and dispersal mode as key traits determining metacommunity structure of aquatic organisms

Steven Declerck

NECOV lustrum meeting
8 April 2014

Spatial dynamics in community ecology



Metacommunities:
local communities that are linked with each other through **dispersal** of multiple potentially interacting species

Leibold et al. 2004
Holyoak et al. 2005

Major community perspectives

•**Niche perspective**: compositional variation among communities is structured mainly by the interaction of species' niches with the environment and the composition of a community is shaped by the process of **species sorting** (Leibold et al. 2004).

•**Neutral perspective**: Species and habitat patches can be considered equal and variation in the compositon among communities is generated by neutral dynamics, such as drift, local stochastic extinctions, immigration and emigration (Hubbell 2001).

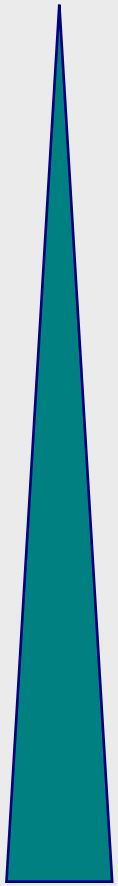
Dispersal as driving force of metacommunity structure

Neutral perspective

•Dispersal limitation allows spatial patterns in meta-communities to be generated by drift and stochastic colonisation

• Dispersal homogenizes metacommunities

DISPERSAL



Limiting

Non-limiting

Massively

Niche perspective

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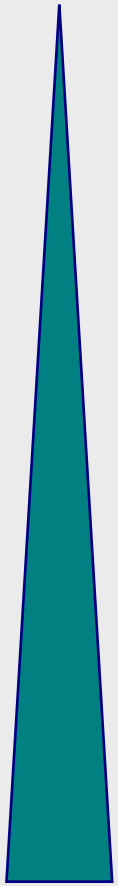

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Niche perspective

•Efficient species sorting, leading to a **good** match between community composition and the environment

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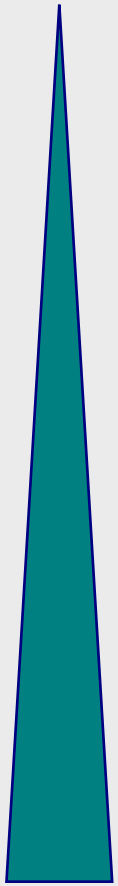

Limiting

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Niche perspective

•Dispersal limitation constrains species sorting, leading to a **poor** match between community composition and the environment
•Predominance neutral patterns

•Efficient species sorting, leading to a **good** match between community composition and the environment

Dispersal as driving force of metacommunity structure

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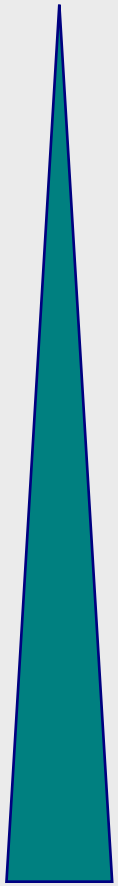

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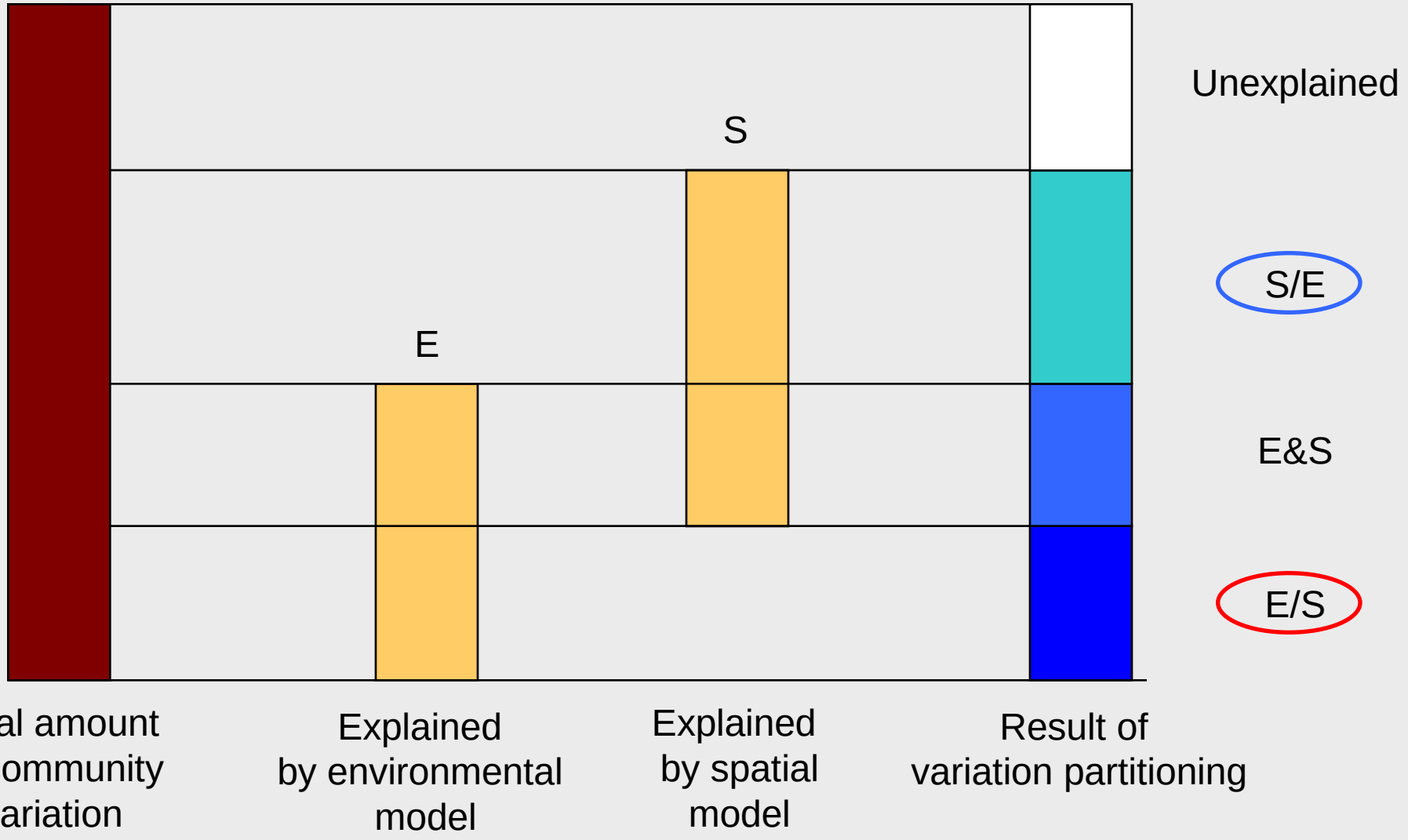
Niche perspective

•Dispersal limitation constrains species sorting, leading to a **poor** match between community composition and the environment
•Predominance neutral patterns

•Efficient species sorting, leading to a **good** match between community composition and the environment

•Communities are quantitatively affected by dispersal from source into sink habitats, leading to a **poor** match between community composition and the environment

The method of variation partitioning



Use of variation partitioning results to infer metacommunity processes

Purely environmental [E/S]	Purely spatial [S/E]	
not significant	significant	**Dispersal limitation**
significant	not significant	**Species sorting**
significant	significant	**Species sorting constrained by dispersal limitation**

Metacommunity structure will depend on the interaction of organism traits and landscape connectivity

Debain et al. 2003
Hillebrand 2001
Finlay et al. 2002
Shurin et al. 2009
Ptacnik et al. 2010

(1) Prediction for passive dispersers:
signature of dispersal limitation will increase with body size

- Larger propagules > lower dispersal distances

- Smaller populations > production of lower amounts of propagules
  > more prone to local extinction

Characteristics of the organism

(1) Prediction for passive dispersers:
signature of dispersal limitation will **increase** with body size

(2) Prediction for active dispersers:
signature of dispersal limitation will **decrease** with body size

Characteristics of the organism

(1) Prediction for passive dispersers:
signature of dispersal limitation will **increase** with body size

(2) Prediction for active dispersers:
signature of dispersal limitation will **decrease** with body size

(3) Active dispersers more or less dispersal-limited than passive dispersers?

- Higher dispersal abilities (?)
- Active habitat choice
- But smaller populations

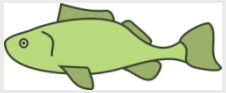
Metacommunity structure, body size and dispersal mode

Tom De Bie

12 different organism groups

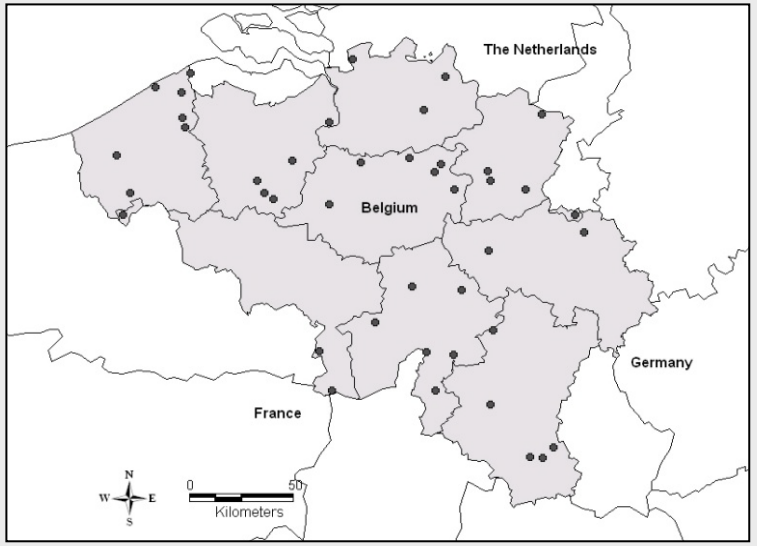






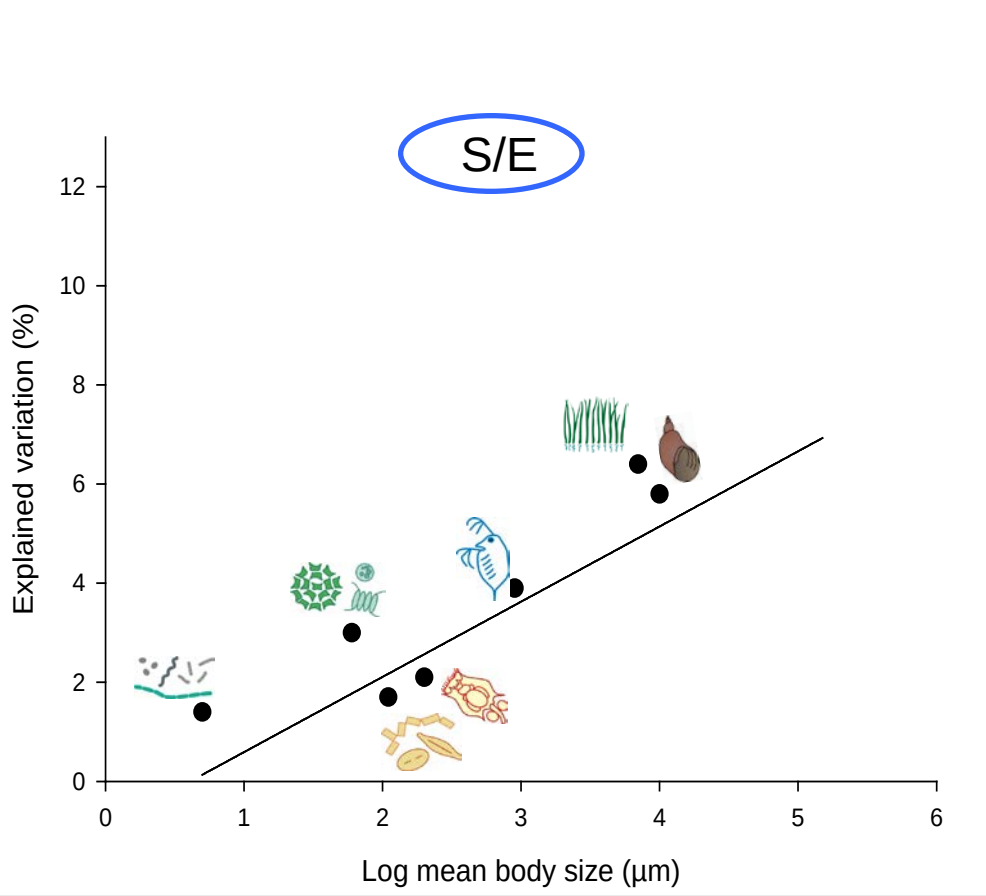




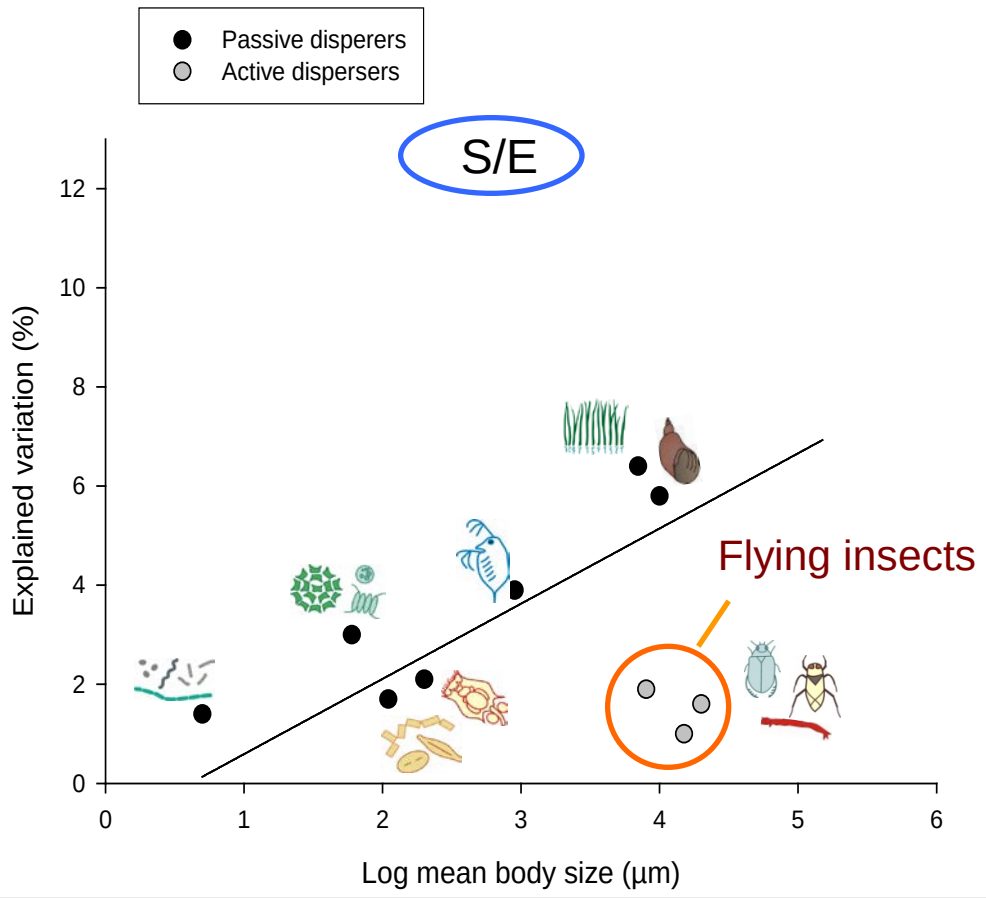
Metacommunity structure, body size and dispersal mode

Variation partitioning of RDA-models



Metacommunity structure, body size and dispersal mode

Variation partitioning of RDA-models



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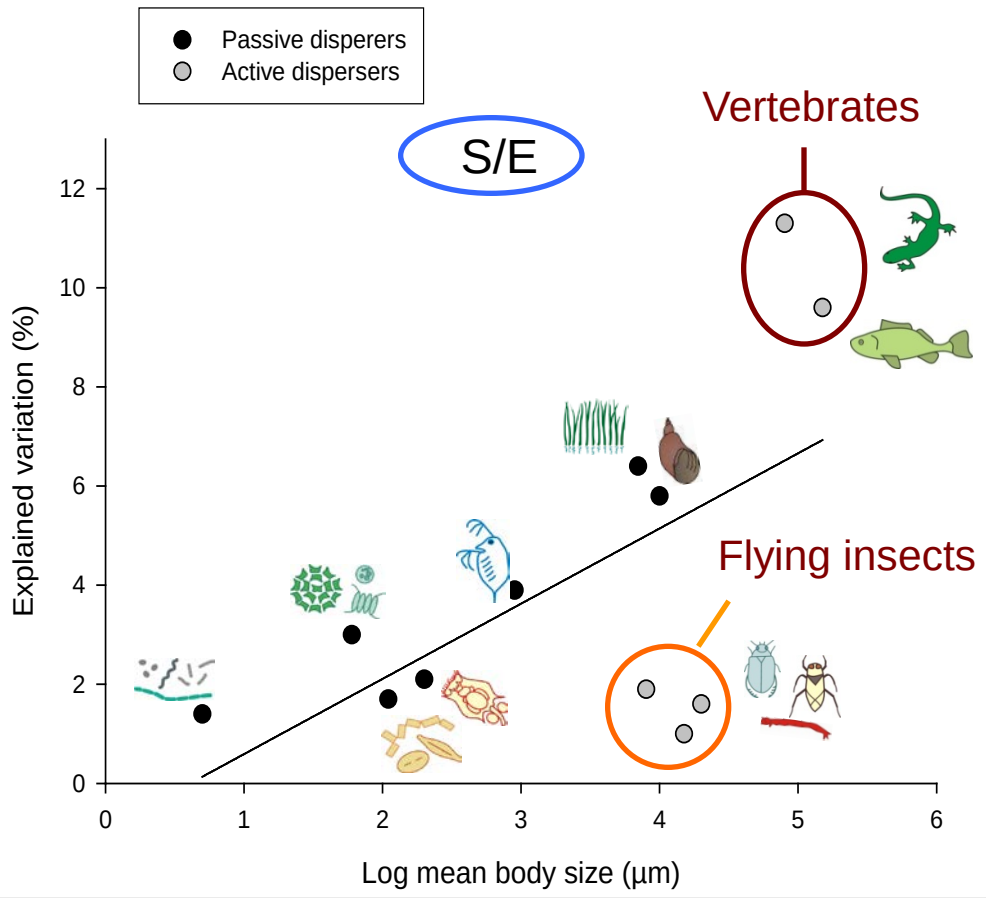

Metacommunity structure, body size and dispersal mode

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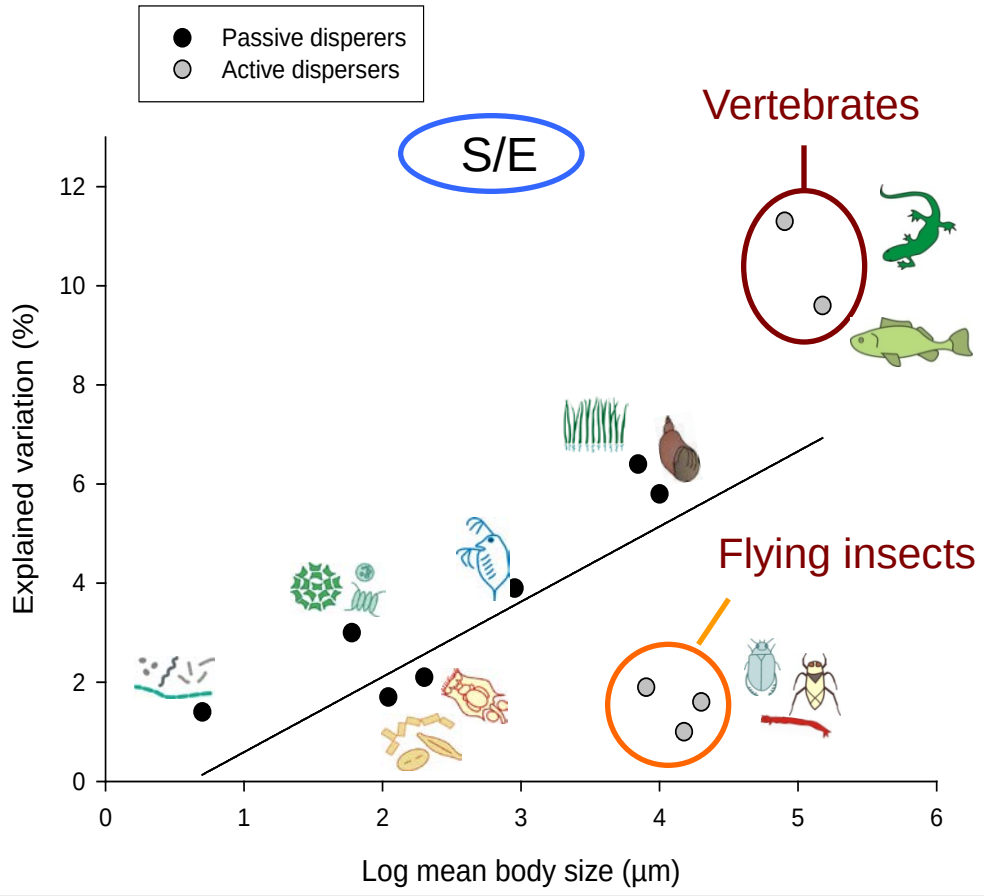
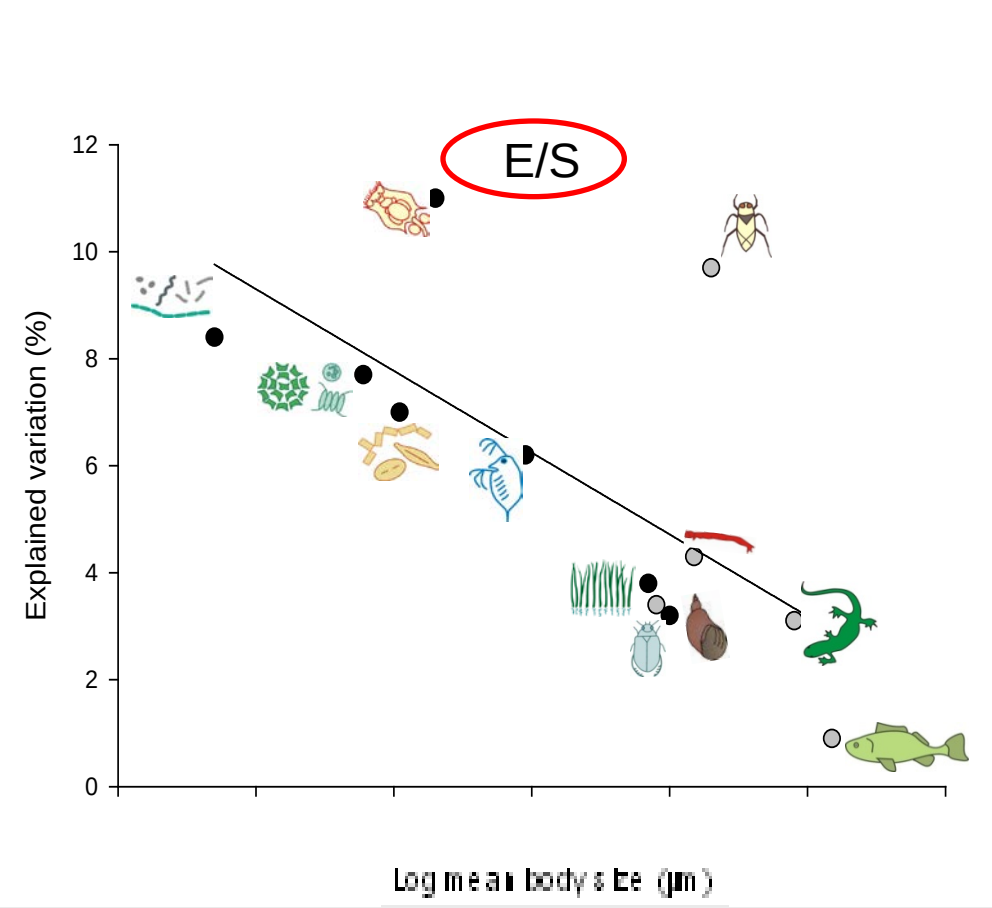
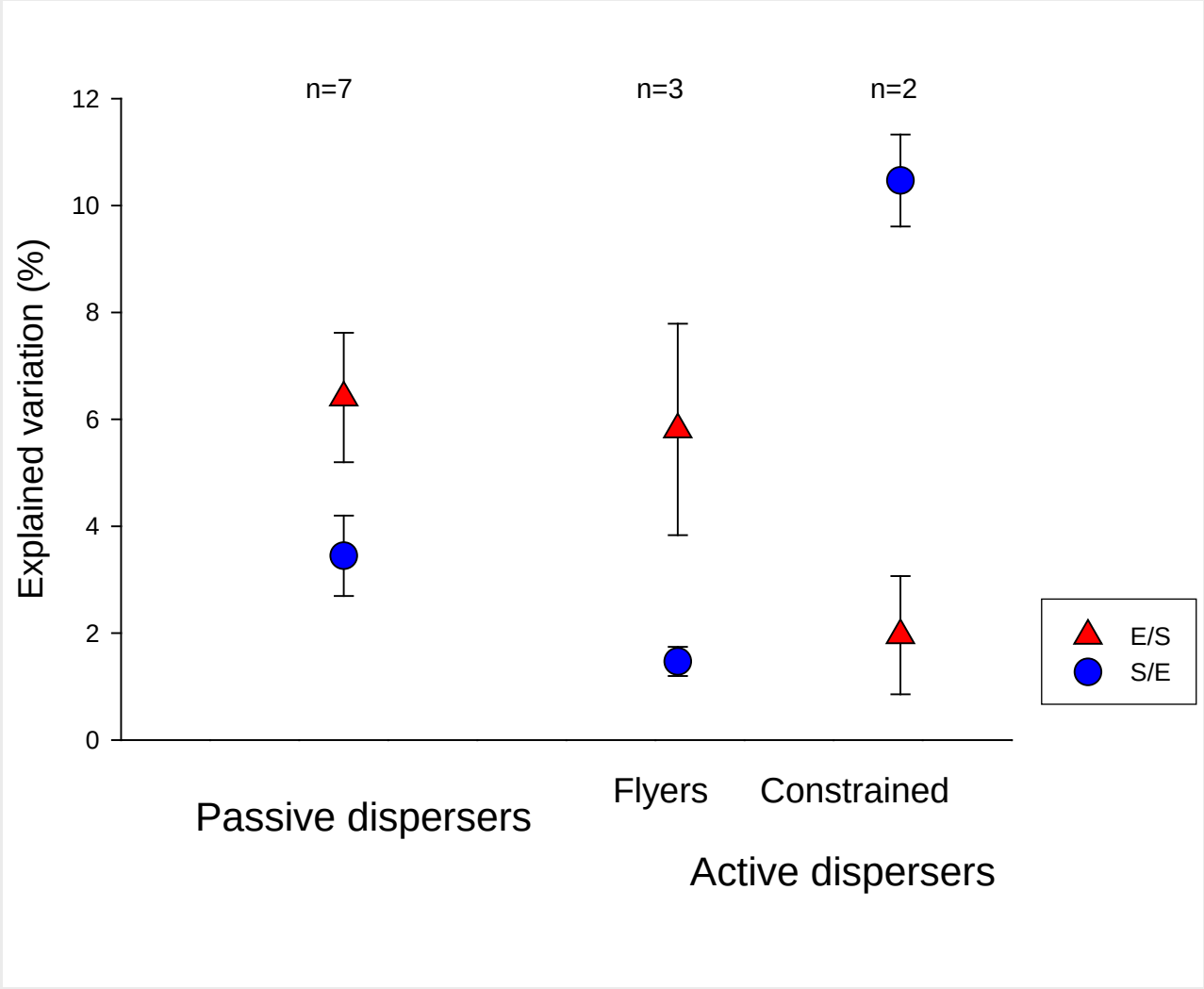




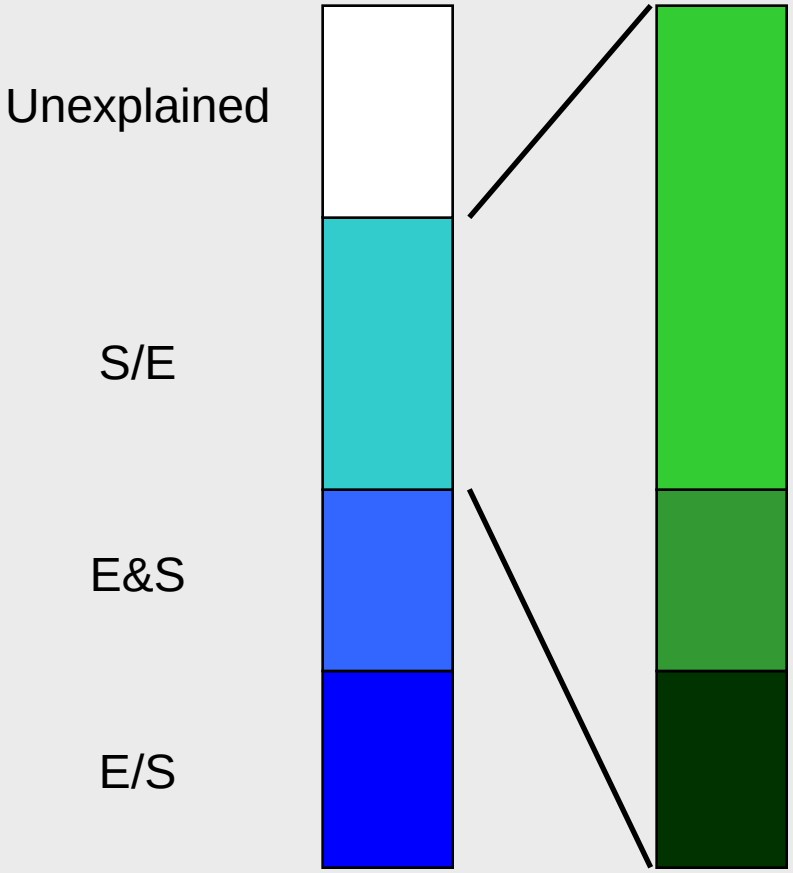
Metacommunity structure and dispersal mode

Variation partitioning on RDA-models: environment versus space

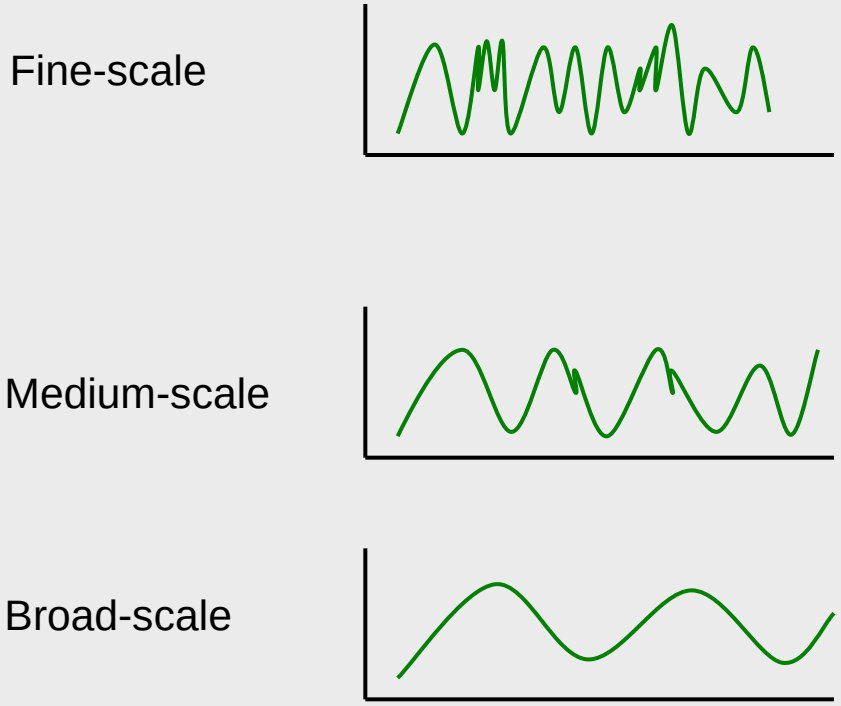


Metacommunity structure and dispersal mode

Detection of influential spatial scales



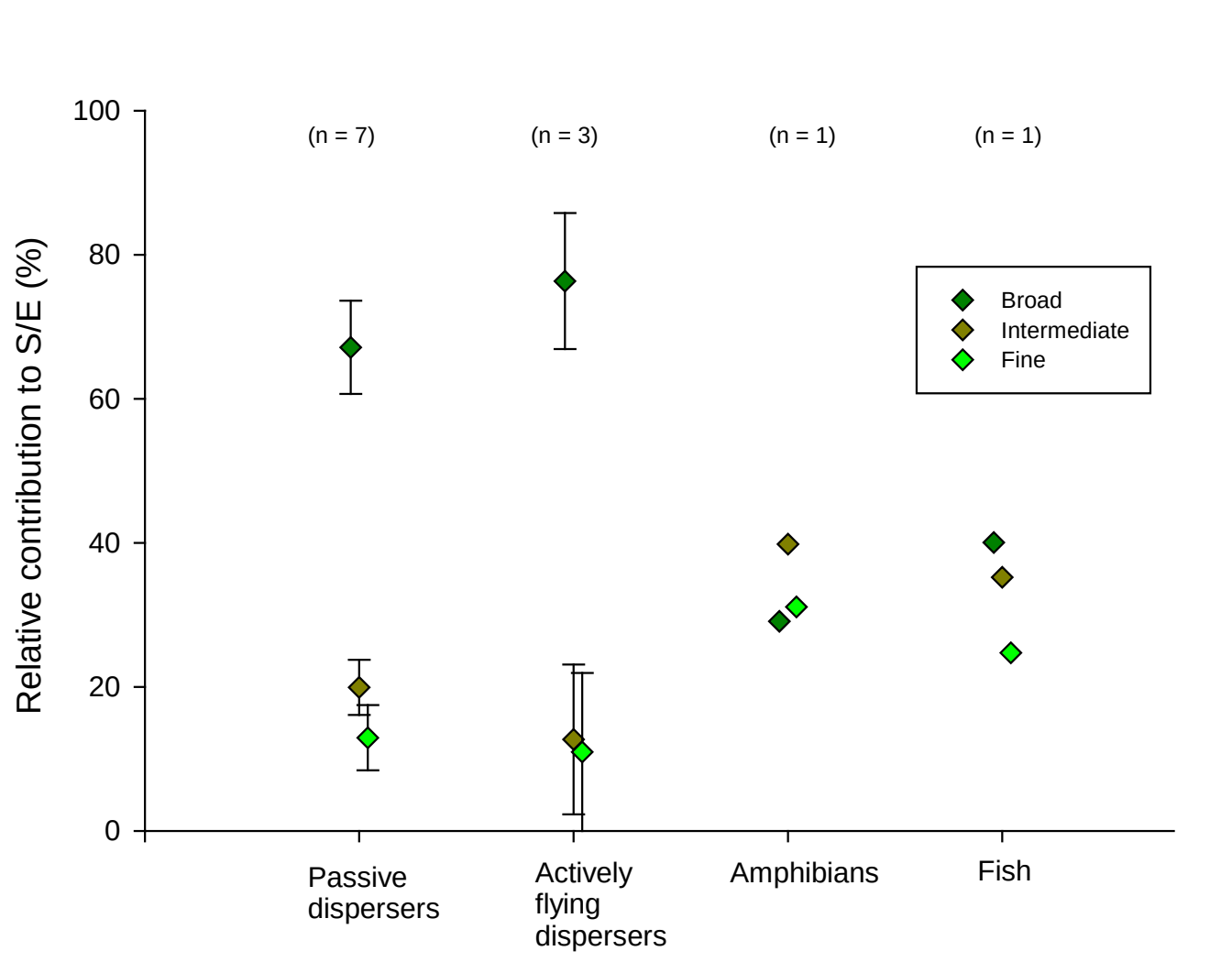
Result of
variation partitioning



construction of spatial model through
construction of Moran Eigenvector Maps
(MEM-analysis)

Metacommunity structure, body size and dispersal mode

Detection of influential spatial scales



Conclusions:

We observed strong and consistent relationships between key traits of organism groups and the structure of their metacommunities.

+ passive dispersers: dispersal limitation increases with body size
  increasing strength of spatial patterns
  decreasing spatial scale at which patterns are manifested

+ active dispersers:

  - flying insects tend to be less dispersal limited than passive dispersers of similar body size

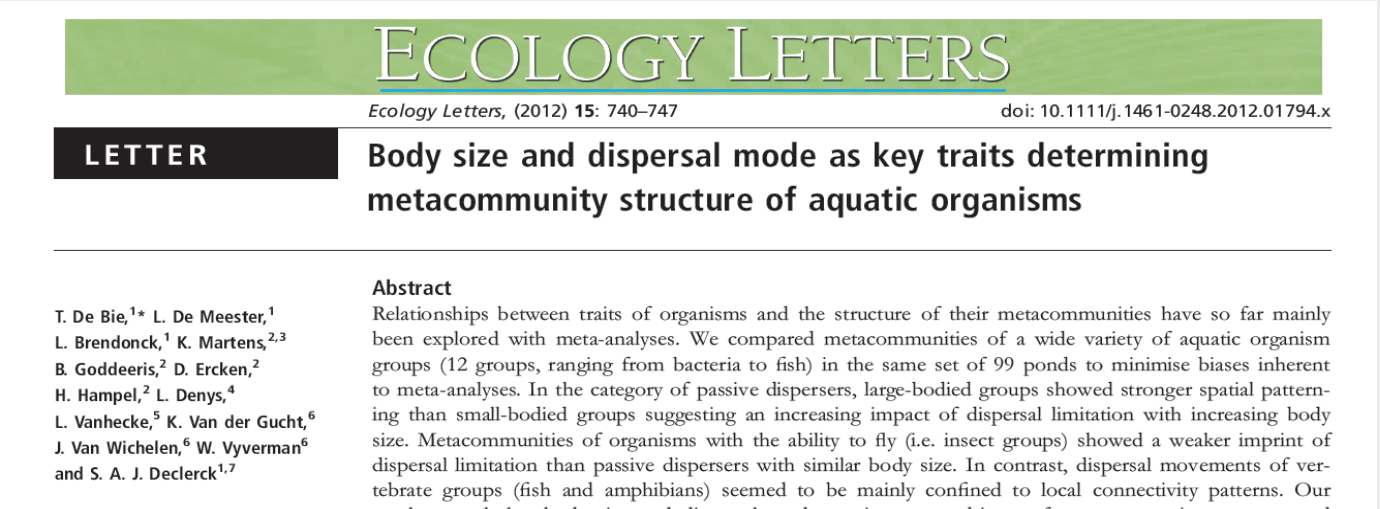
  - amphibians and fish: small-scale spatial patterns suggest strong reliance on local connectivity patterns

Conclusions:

With increasing spatial scale, beta diversity tends to shift from being environmentally controlled to being dispersal-controlled

Our results show that the scale at which this shift occurs depends on organism traits, such as body size and dispersal mode

Incorporation of traits can therefore
-provide a more predictive framework for metacommunity ecology
-help steer management decisions
(e.g., identification of groups vulnerable to dispersal limitation)



ECOLOGY LETTERS

Ecology Letters, (2012) **15**: 740–747 doi: 10.1111/j.1461-0248.2012.01794.x

LETTER

Body size and dispersal mode as key traits determining metacommunity structure of aquatic organisms

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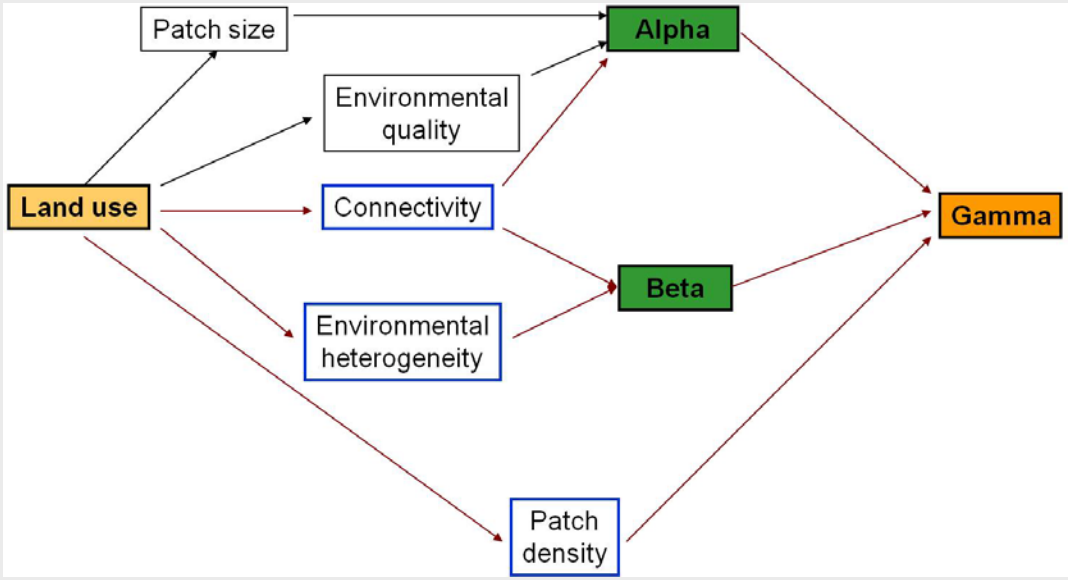
Abstract

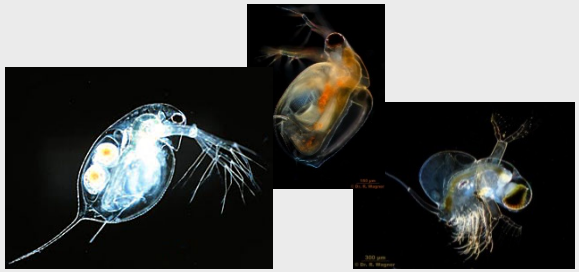
Relationships between traits of organisms and the structure of their metacommunities have so far mainly been explored with meta-analyses. We compared metacommunities of a wide variety of aquatic organism groups (12 groups, ranging from bacteria to fish) in the same set of 99 ponds to minimise biases inherent to meta-analyses. In the category of passive dispersers, large-bodied groups showed stronger spatial patterning than small-bodied groups suggesting an increasing impact of dispersal limitation with increasing body size. Metacommunities of organisms with the ability to fly (i.e. insect groups) showed a weaker imprint of dispersal limitation than passive dispersers with similar body size. In contrast, dispersal movements of vertebrate groups (fish and amphibians) seemed to be mainly confined to local connectivity patterns. Our

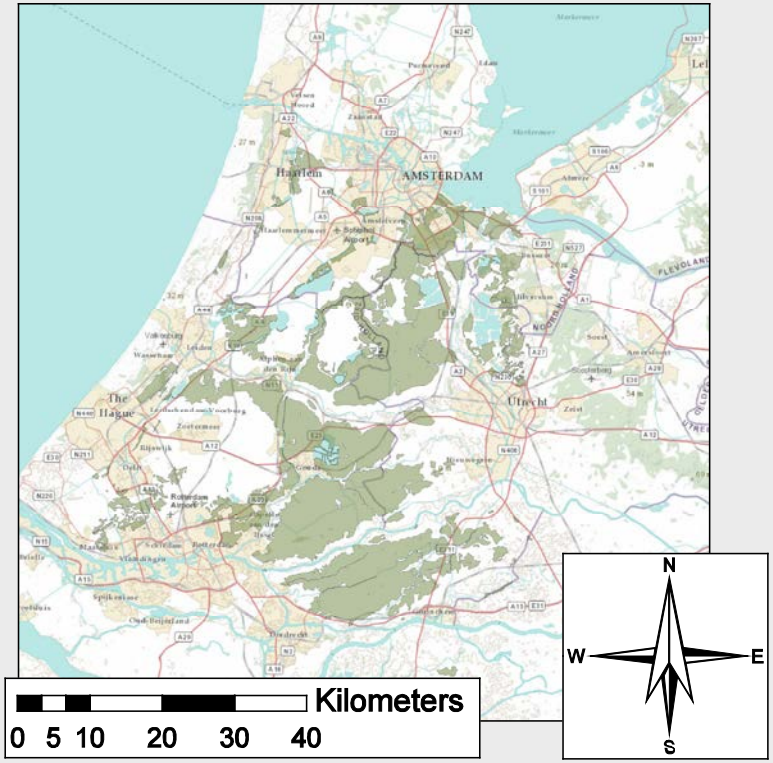
Metacommunities of macrophytes and zooplankton in ditch systems of The Netherlands

NWO ‘Biodiversiteit werkt’-project



Sven Teurlincx

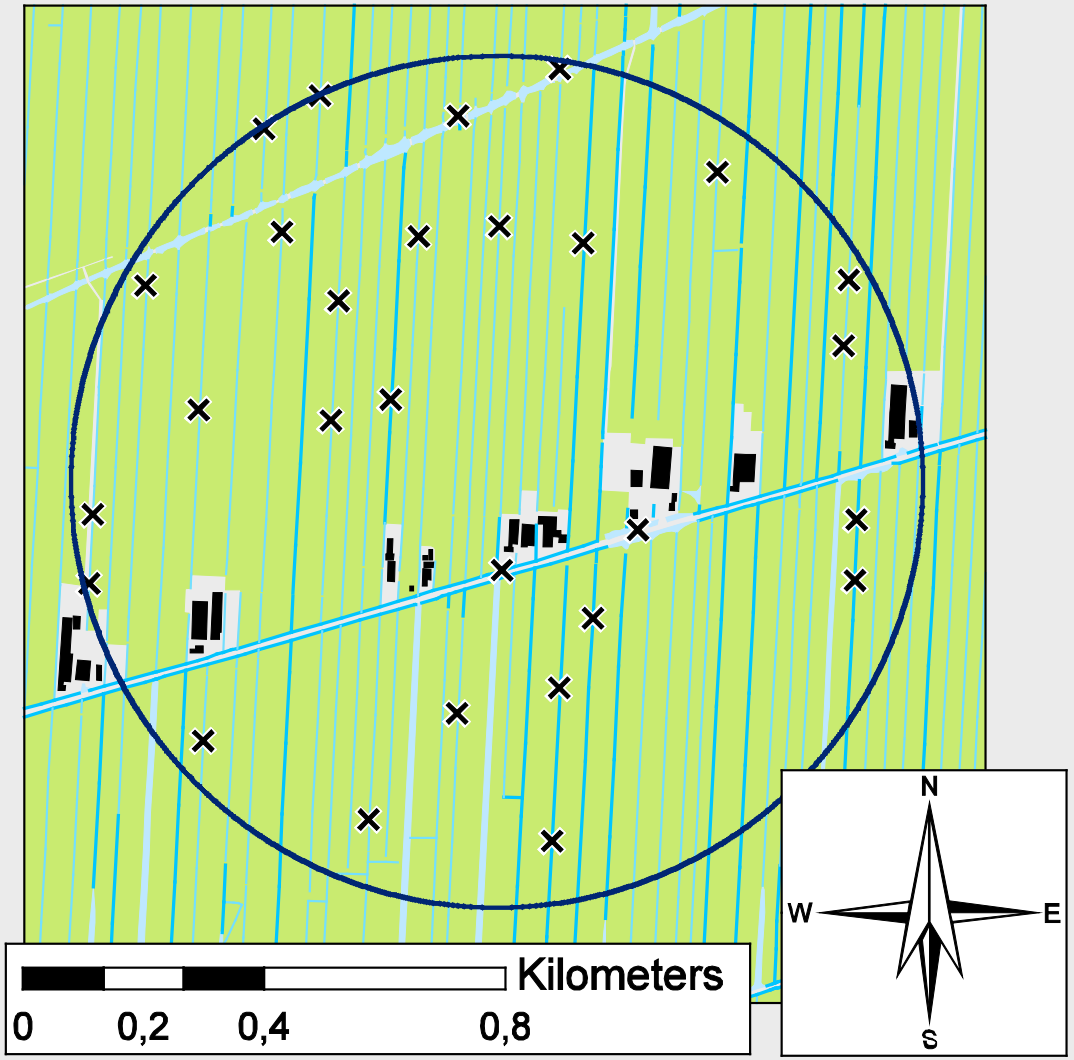




Study of link between spatial community patterning and dispersal traits in macrophytes

Sven Teurlincx

Dr. Merel Soons



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