

Combining species traits to causally link species and their habitat: An alternative to multivariate trait analyses

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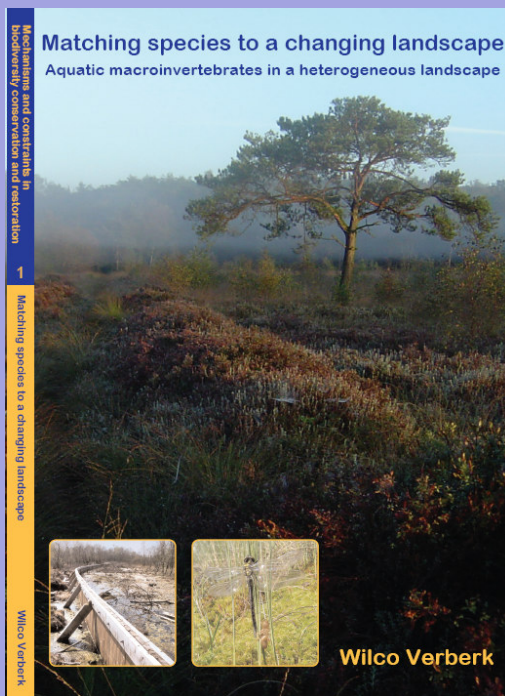
Goal: to explain patterns in species occurrences

Relationships between species habitat use and environmental conditions

Verberk W.C.E.P. (2008) Matching species to a changing landscape – Aquatic macroinvertebrates in a heterogeneous landscape. PhD thesis, Radboud University Nijmegen.

Verberk WCEP, Siepel H & Esselink H (2008) Life-history strategies in freshwater macroinvertebrates. *Freshwater Biology* 53: 1722-1738.

Verberk WCEP, Siepel H & Esselink H (2008) Applying life-history strategies for freshwater macroinvertebrates to lentic waters. *Freshwater Biology* 53: 1739-1753.



http://webdoc.ubn.ru.nl/mono/v/verberk_w/matcsptoa.pdf
wilco@aquaticecology.nl

Goal: to explain patterns in species occurrences

Relationships between species habitat use and environmental conditions

Descriptive :

Many Species

Many Sites

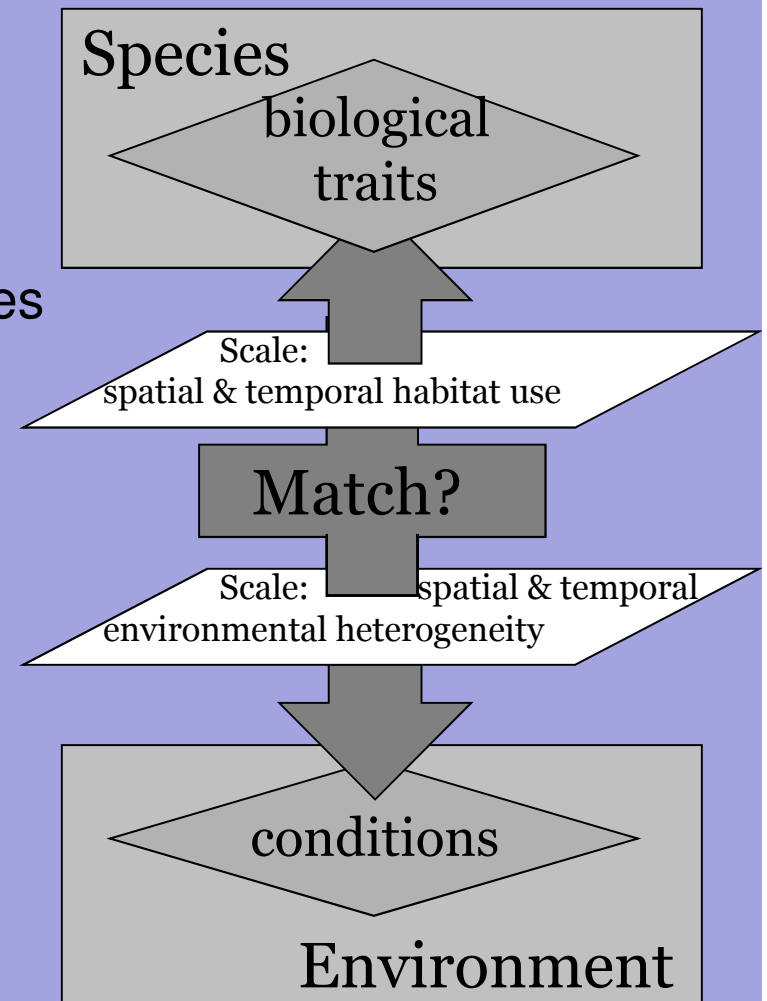
Many Environmental conditions

} Multivariates

Explanatory:

Causal mechanisms → biological traits

Included in multivariates



Previous analyses incorporating

species traits

Difficulties:

Relationships among traits

Averaging out

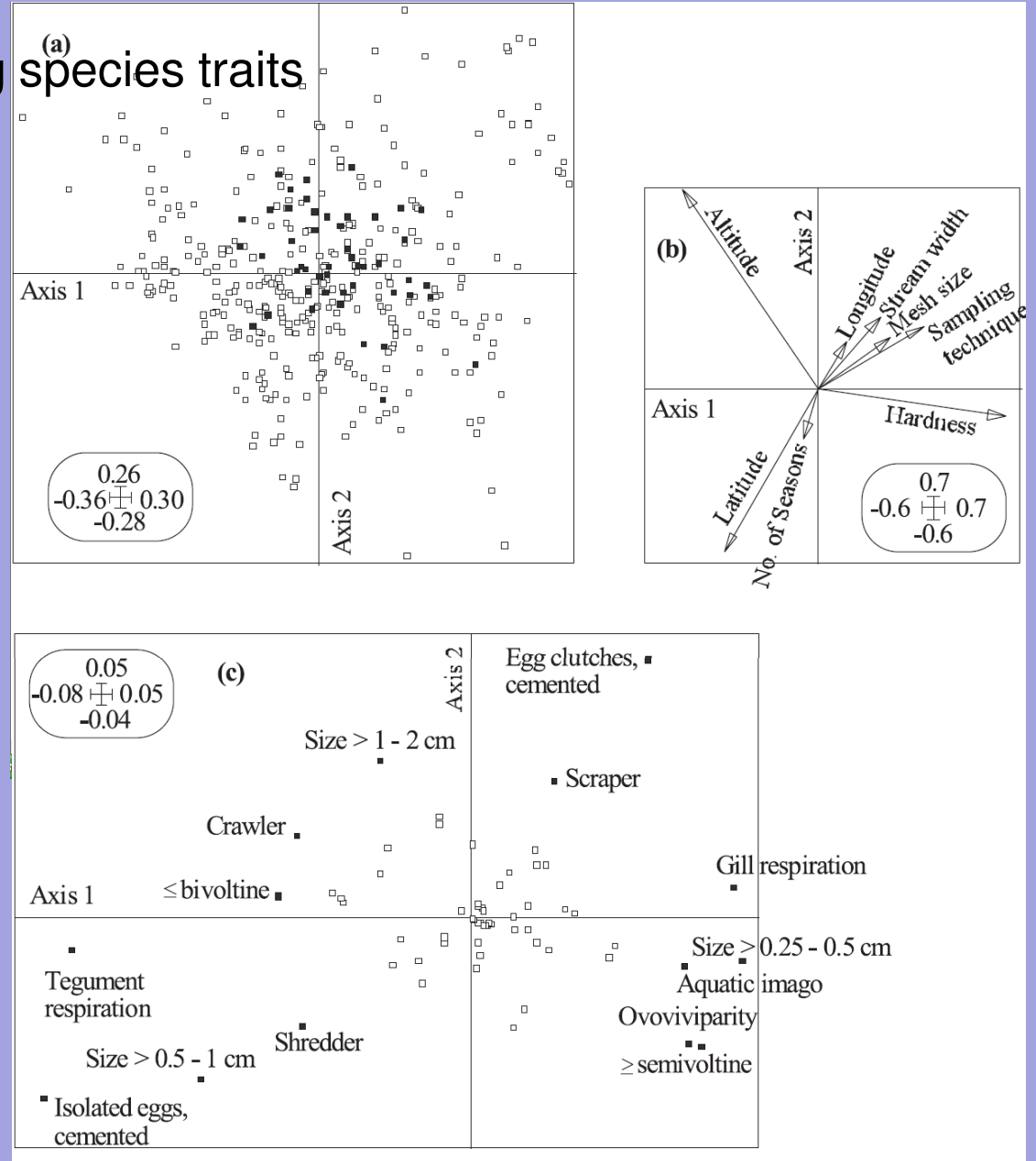
Alternative suites

A posteriori

Ad hoc explanations

Predictions performed poorly

Explanation for patterns
in species occurrence?



Statzner *et al.*, 2004 *Ecography* 27: 470-488.

Dealing with these difficulties

Start from species traits

Define functionally equivalent groups *a priori* based on trait combinations

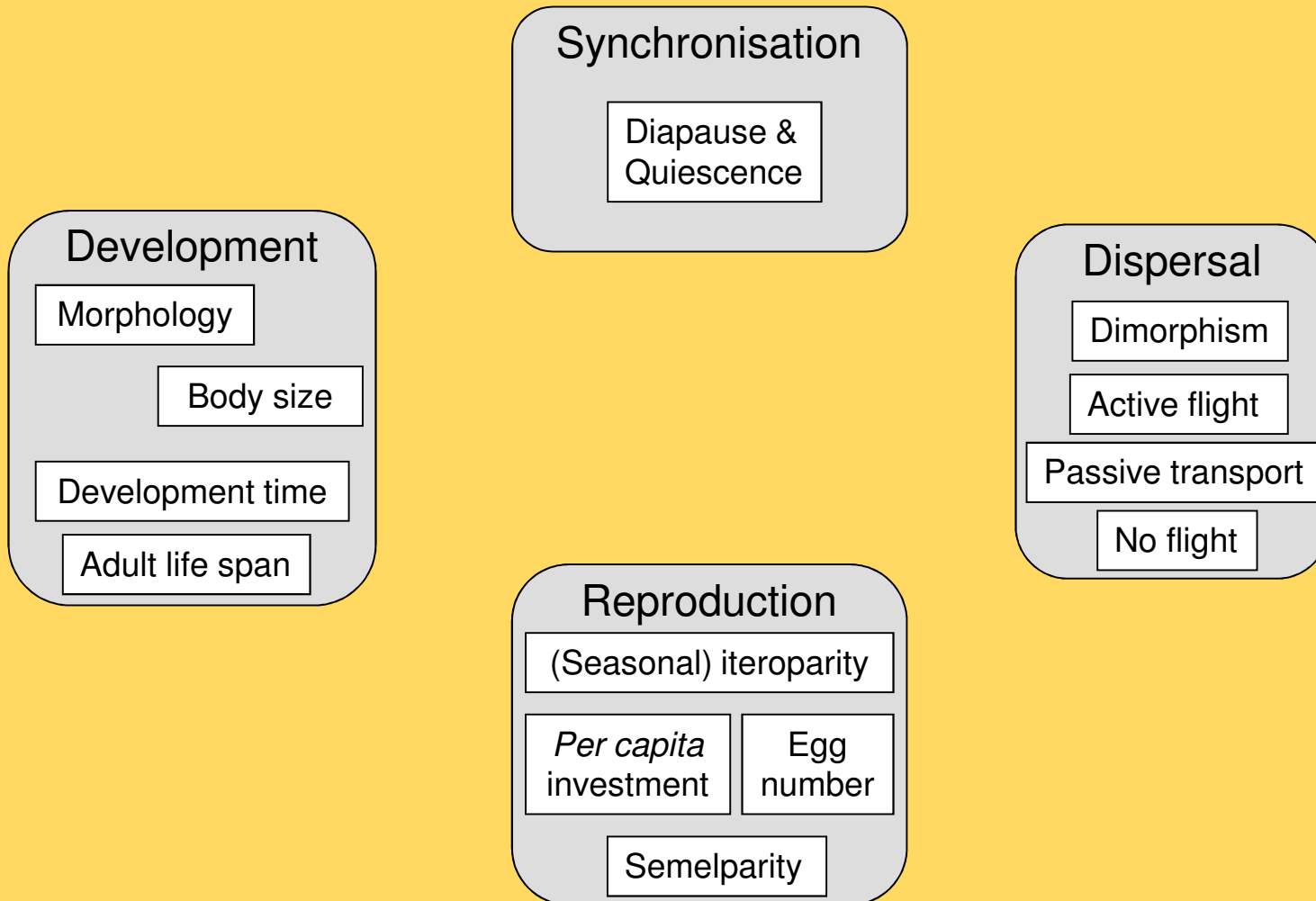
Life-history strategies:

“sets of co-evolved traits which enable a species to deal with a range of ecological problems.”

Stearns (1976) Life-history tactics: A review of the ideas. Quarterly Review of Biology 51: 3-47.

Test theoretically defined groups with empirical data.

Life-history strategies in aquatic macroinvertebrates

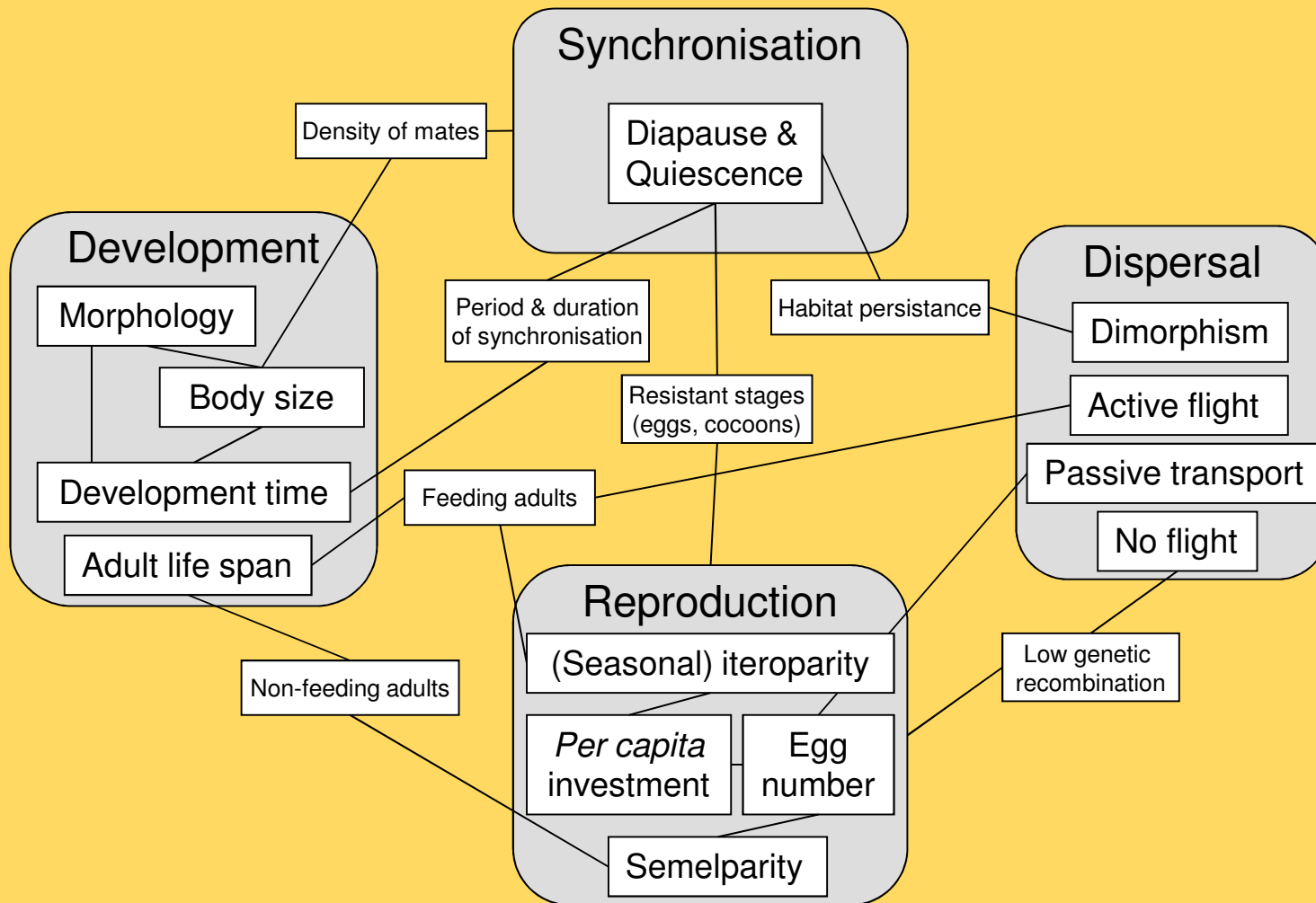


Life-history strategies in aquatic macroinvertebrates

Consider multiple traits acting in concert

- Relationships among traits (trade-offs and spin-offs)
- Investment in traits

Life-history strategies in aquatic macroinvertebrates



Life-history strategies in aquatic macroinvertebrates

Trade-off

Investments in one trait → less resources for another trait.

Growth and development

Egg size and egg number

...



Life-history strategies in aquatic macroinvertebrates

Trade-off

Investments in one trait → less resources for another trait.

Growth and development

Egg size and egg number

...

Spinn-off

Investments in one trait → increases benefits or lowers costs for another trait.

Few eggs and brood care

Gills in damselflies for respiration and locomotion

...



Life-history strategies in aquatic macroinvertebrates

Consider multiple traits acting in concert

- Relationships among traits (trade-offs and spin-offs)
- Investment in traits

Function of traits and combinations of traits

- In light of other traits of a species
- Relative differences (similar body plan)
- Alternative suites (different body plan)

Life-history strategies in aquatic macroinvertebrates

Different traits combinations may be functionally similar

Egg protection:

- endophytical oviposition
- gelatinous matrix
- brood care
- ovoviviparous



Life-history strategies in aquatic macroinvertebrates

Considering multiple traits acting in concert

Function of traits and combinations of traits

13 life-history tactics





Applying life-history strategies to field data

45 waters sampled

- spring (april-may)
- autumn (september-november)

Invertebrate groups identified:

Scientific name	Common name
Tricladia	Flatworms
Hirudinea	Leeches
Coleoptera	Beetles
Hemiptera	True bugs
Odonata	Dragonflies & Damselflies
Trichoptera	Caddisflies
Chaoboridae	Phantom midges
Chironomidae	Nonbiting midges
Dixidae	Meniscus flies
Rest (e.g. <i>Asellus aquaticus</i> , <i>Argyroneta aquatica</i>)	Waterspider, Aquatic sowbug

>94,000 individuals

238 taxa

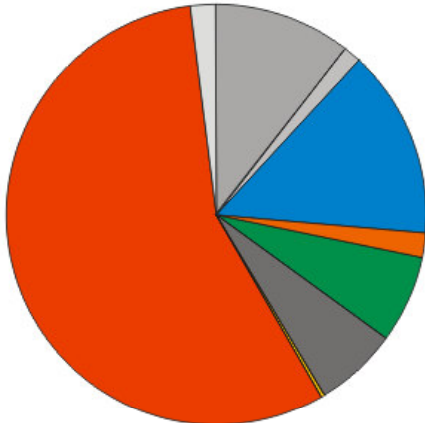
Applying life-history strategies to field data

Functional classification spanning different systematic groups

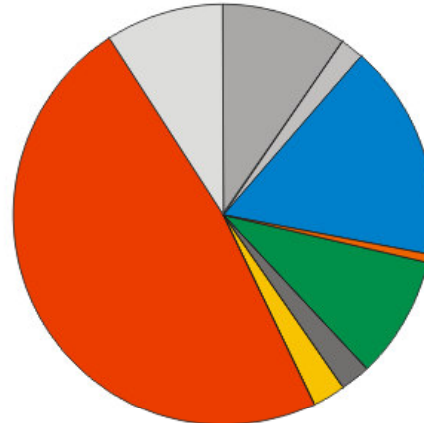
Systematic group	Total	Life-history strategy												
		D1	D2	D3	S1	S2	S3	S4	R1	R2	R3	R4	T1	T2
Arachnida	1 (1)												1	
Coleoptera	86 (7)	22			2	8	22		19				12	1
Crustacea	1 (1)											1		
Diptera	64 (6)	15		9	13	6			2				19	
Ephemeroptera	1 (1)		1											
Hemiptera	20 (4)	6		3					7				4	
Hirudinea	6 (3)							2		2	2			
Megaloptera	1 (1)												1	
Odonata	15 (4)		3		2	4							6	
Oligochaeta	23 (3)							9				8		6
Plecoptera	1 (1)												1	
Trichoptera	15 (4)	1			2	7							5	
Tricladida	4 (2)							2		2				
Total	238 (13)	44	4	12	19	25	22	13	28	4	3	8	49	7

Bog pools (n=18)

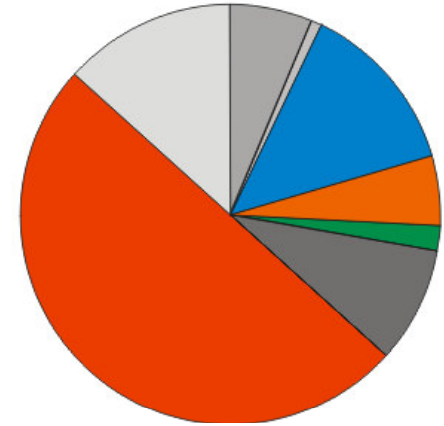
large bog pools (6)



small bog pools (6)



small, shaded bog puddles (6)



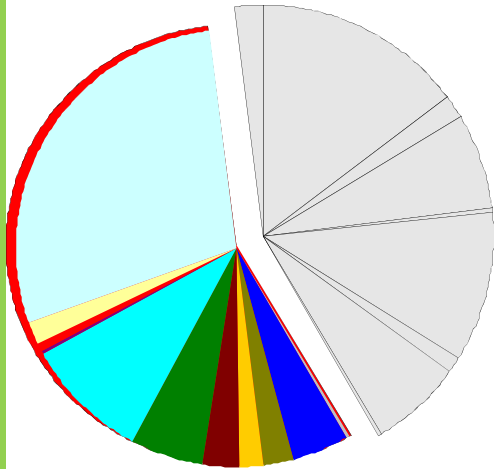
High investments in physiological tolerance, constraining other investments



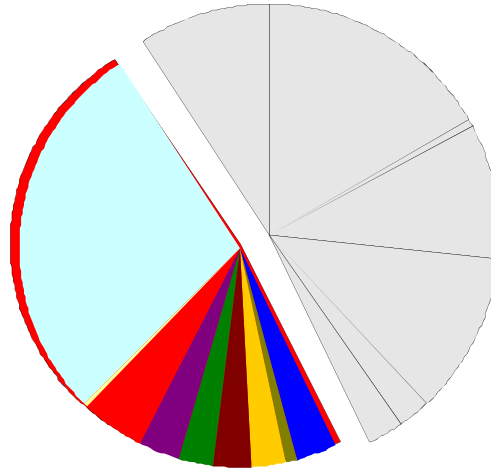
Habitat suitability as a key aspect

Bog pools (n=18)

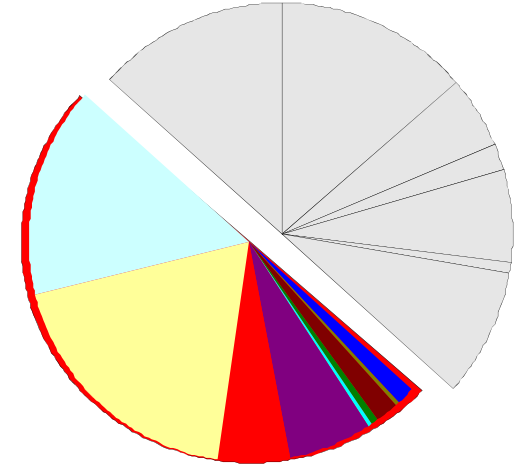
large bog pools (6)



small bog pools (6)



small, shaded
bog puddles (6)



Habitat suitability as a key aspect
Differences in abundance aggregated

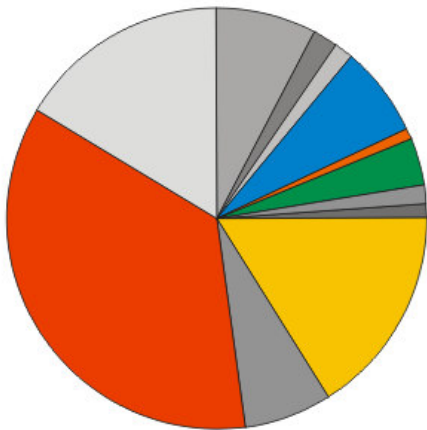
High investments in physiological tolerance, constraining other investments

Long larval development with synchronised emergence of short-lived adults

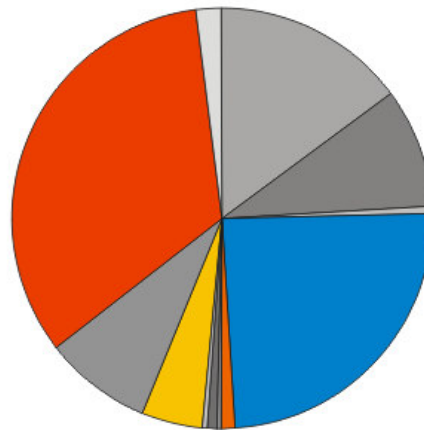
High per capita investment and several successive reproduction events

Mesotrophic waters (n=14)

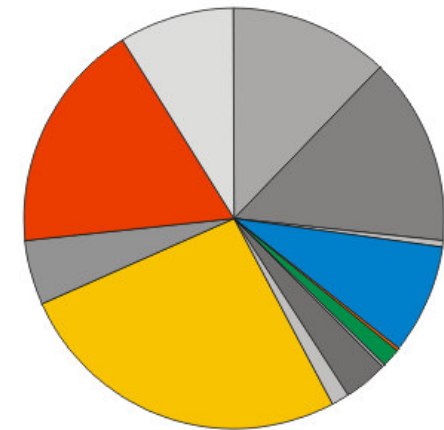
shallow mesotrophic puddles (4)



mesotrophic pools (5)



strongly buffered mesotrophic pools (5)



Predictability and stability as a key aspect

Summary

Life-history strategies (Verberk et al., 2008a. *Freshwater Biology*, 53: 1722-1738.)

- Multiple traits and functional implications
- Integrated response

Application (Verberk et al., 2008b. *Freshwater Biology*, 53: 1739-1753.)

- Causality
- Aggregation
- Insight from species perspective

Also successfully applied to:

- Density distribution relationships
- Evaluation of restoration measures