How to handle biodiversity for nature managers and policy-makers?

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Communication and understanding

- For communication aggregated terms serve best
  - ‘the number of species has declined’
  - ‘the diversity-index is 10% lower’
- For understanding we will have to consider species characteristics
  - ‘species A suffers from food shortage; the peak of insects shifted due to climate change’
  - ‘species B increases because of longer and warmer summers’

Communication and understanding

	Species approach	Community approach
Aggregation	-	+++
Causality	+++	-

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The best of two worlds: life-history tactics

	Species approach	Life-history tactic approach	Community approach
Aggregation	-	++	+++
Causality	+++	++	-

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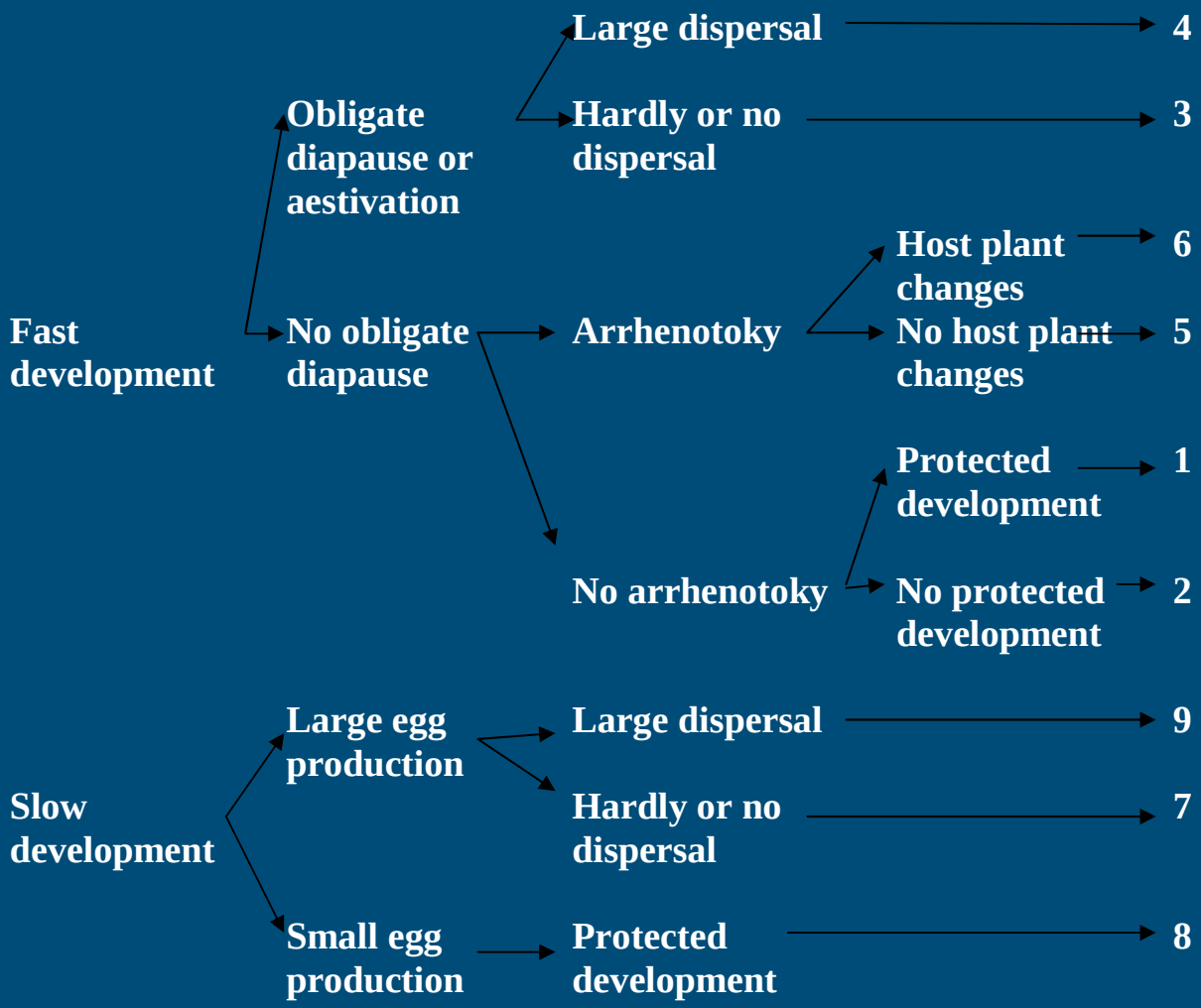
Why life-history tactics?

- Life-history tactics are defined as a set of co-adapted traits designed, by natural selection, to solve particular ecological problems. A complex adaptation.
- So, different species experiencing a similar environment may have comparable life-history tactics
- In short, we may handle the overwhelming diversity of life in a more comprehensive manner

An example with pest insects on trees



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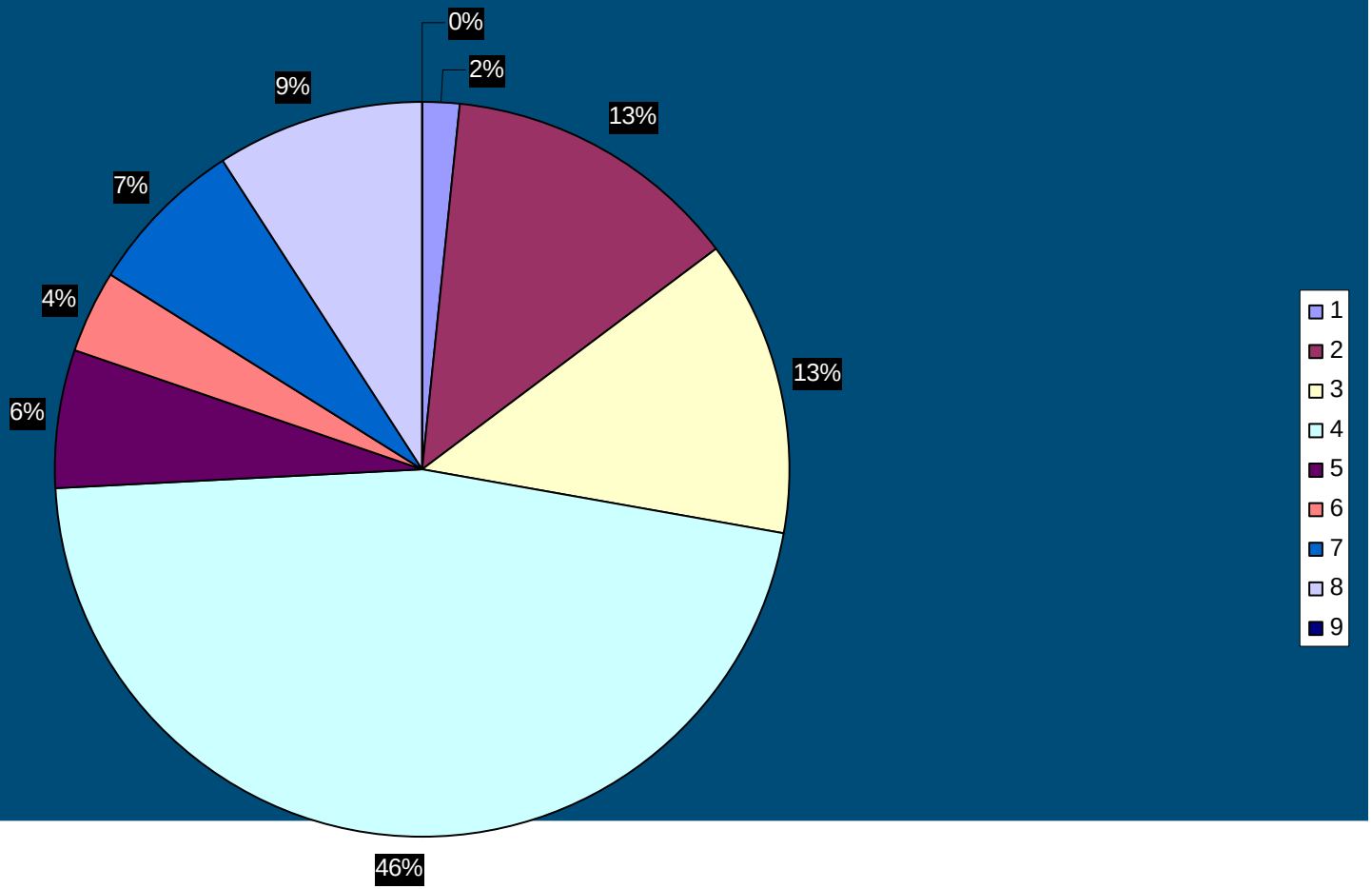
Life-history tactics of pest insects on trees

1st period 1946-1960



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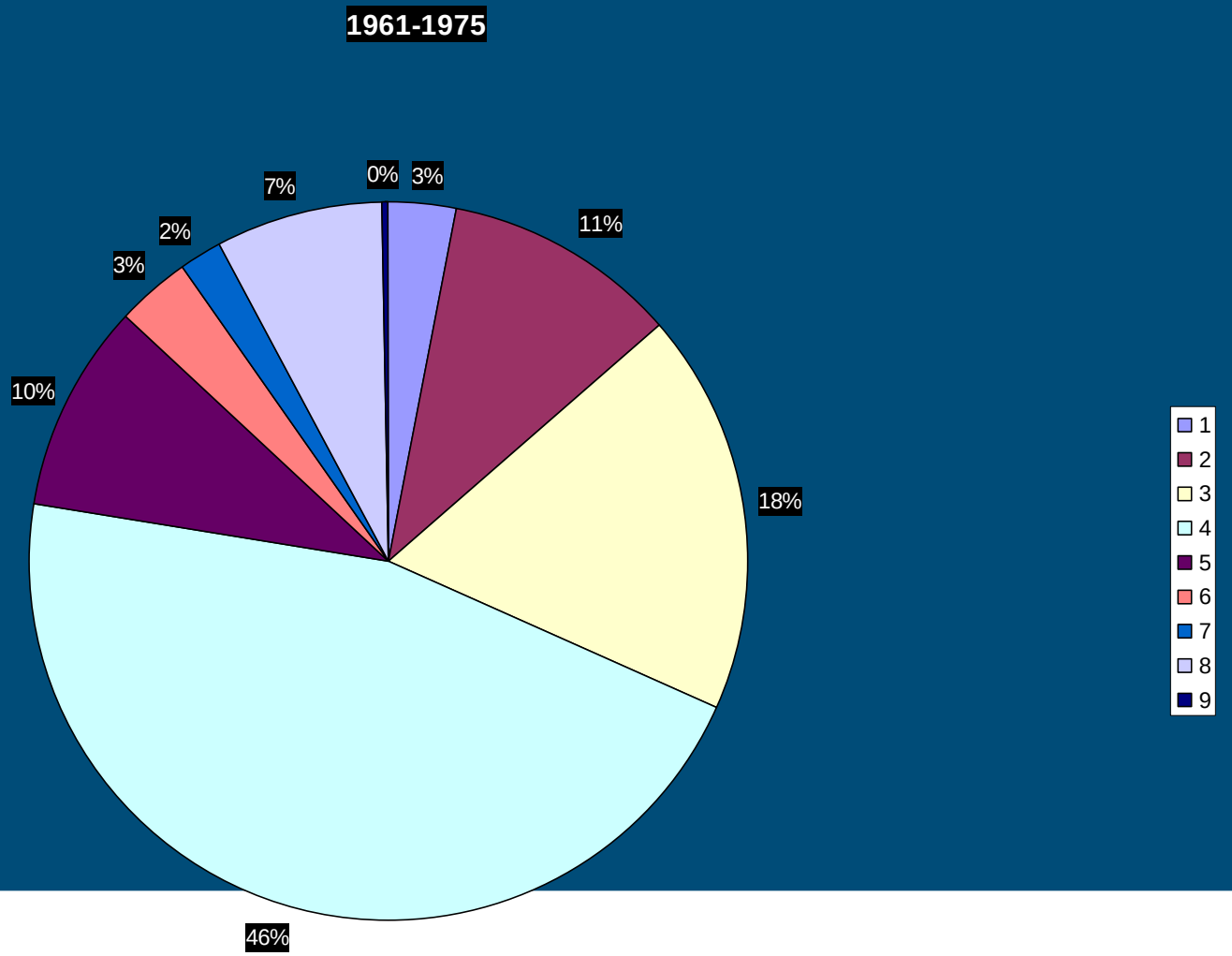
Life-history tactics of pest insects on trees

2nd period 1961-1975



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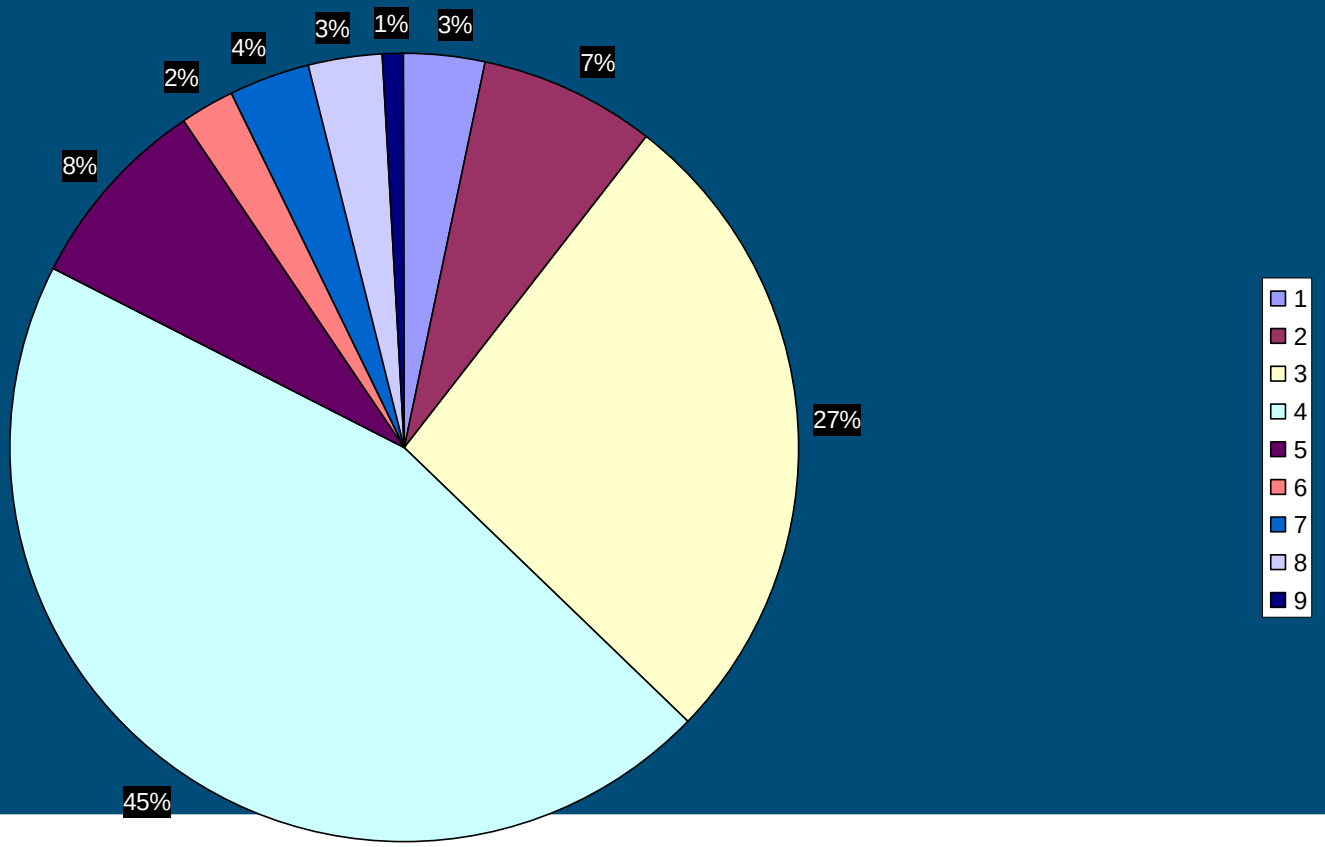
Life-history tactics of pest insects on trees

3rd period 1976-1991 1976-1990



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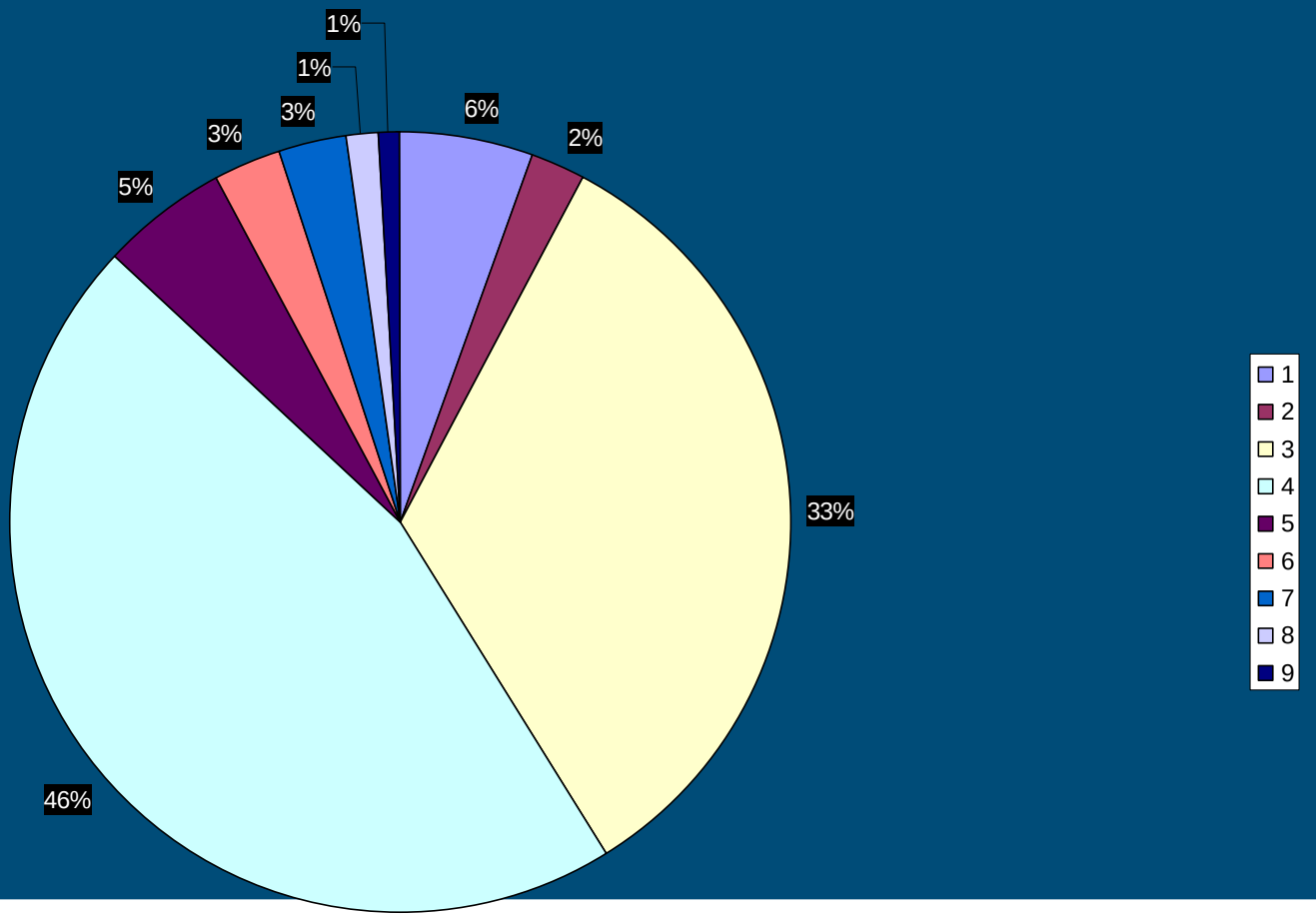
Life-history tactics of pest insects on trees

4th period 1991-1999



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Some hypotheses from the changes seen:

- Tactics having a long development stage, hardly any dispersal and a protected juvenile stage decline
- A tactic showing synchronisation in development and good dispersal is remarkably constant
- A tactic showing the same synchronisation but without good dispersal is increasing

How does this work?

- Selection of traits: which are relevant
- Traits should have an investment, so trade-offs must be present and traceable
- Environmental main frames may help in distinguishing relevant traits

Habitat templet of Southwood 1977

HERE AND NOW	ELSEWHERE AND NOW
HERE AND LATER	ELSEWHERE AND LATER

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Scheme of Stearns 1976

- Period cyclic, fixed and >> life time
- Period cyclic, fixed and ≤ life-time
  - start and conditions predictable
  - start predictable within limits
  - start predictable, conditions during cycle unpredictable
  - as 3rd but later conditions may improve
- Period not cyclic, distributed randomly over time

What kind of traits are relevant?

- Traits to ensure the next generation: reproduction
- Traits to ensure the best timing: synchronisation
- Traits to ensure development
- Traits to ensure dispersal

Now first some book-keeping

- Considering that traits should show some kind of trade-offs, it means that energy and nutrients are carefully invested
- So, life-history traits are on the spending of energy and nutrients
- Feeding guilds are on the income
- Of course, these are related, but don’t mesh up!

Possible trade-offs in reproduction, ..

- Egg-size versus number of eggs
- Careful oviposition versus number of eggs
  - iteroparity versus semelparity
- Brood care versus number of eggs or batches
- Individual life-time versus reproductive investment
- Dispersal versus reproductive investment (oogenesis-flight syndrome)
- etc.

in synchronisation, ...

- Diapause versus alternative host plants
- aestivation versus continuous generations
- overwintering as an adult or as eggs?
- … or in various larval stages?

in development, ….

- Stay small and grow fast or grow big and take time (and risks)
- Invest in special tools (extra hairs, big size organs, time to learn, etc.)

and in dispersal

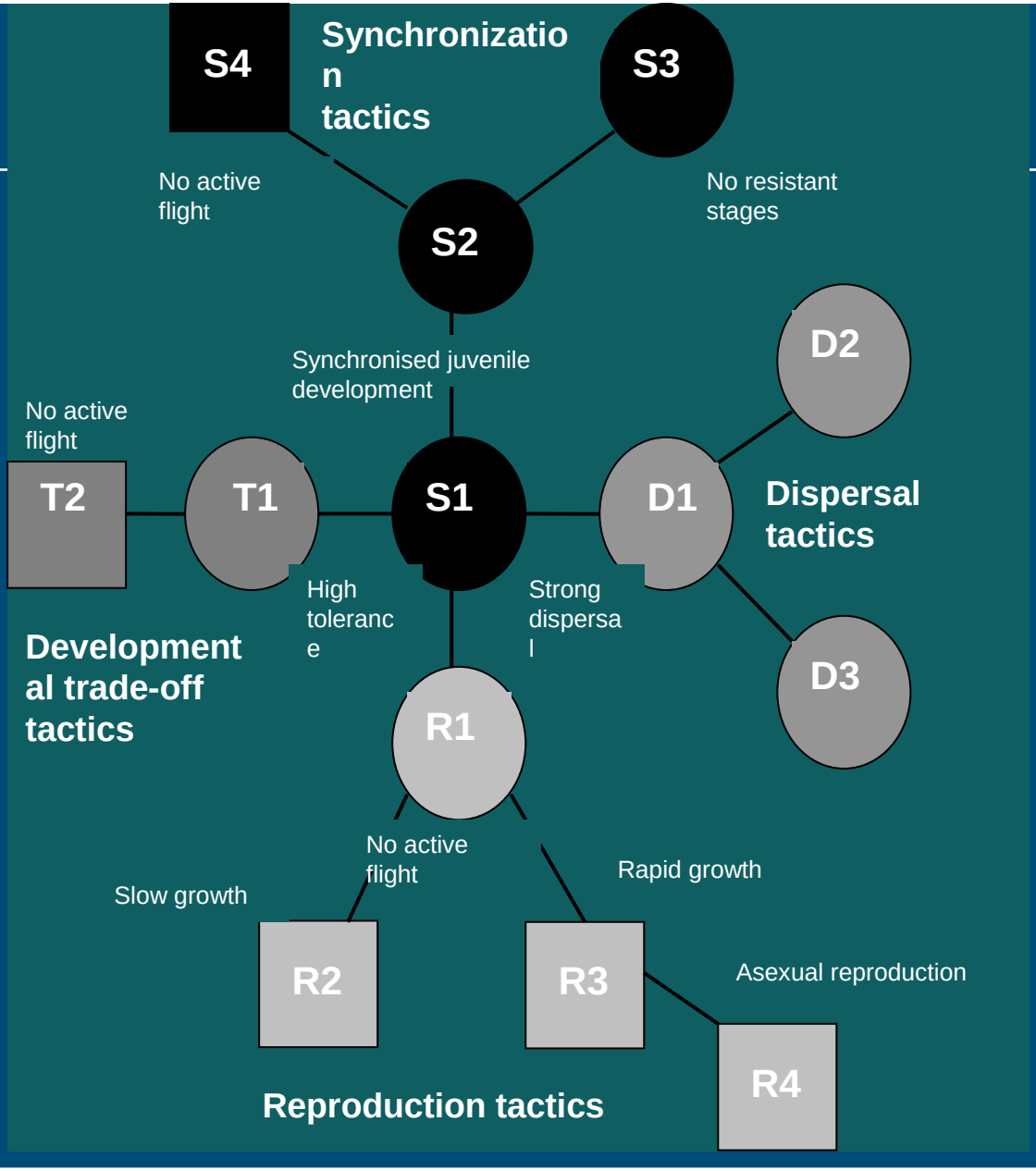
- Invest in wings
- …. in flight muscles
- in organs for phoresy
- in organs to be blown away, or carried with streams
- in organs to be collected (mostly seeds in plants)
- Migrating birds: return in one flight, or step by step?

Bet-hedging

- Run with the hare and hunt with the hounds
  - as part of a response, initiated by different environmental conditions
  - as part of different genetic strains, occurring in a balance in the population

Example from aquatic macro-invertebrates

- 1. Reproduction tactics (R 1 – 4)
- 2. Developmental trade-off tactics (T1, T2)
- 3. Synchronisation tactics (S 1 – 3)
- 2. Dispersal tactics (D 1 – 3)



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Some of the tactics and species (1)

- S1: long development, synchronised emergence, short adult lifespan
  - species: *Beraeodes minutes* (Trichoptera), *Procladius choreus* (Diptera)
- D1: short development, strong dispersal, long-living adults, iteroparity
  - species: *Hydroglyphus pusillus* (Coleoptera), *Hesperocorixa sahlbergi* (Heteroptera), *Anopheles atroparves* (Diptera)

Some of the tactics and species (2)

- T1: high tolerance, physiological and morphological adaptations constrain reproduction etc.
  - species: *Ceriagrion tenellum* (Odonata), *Peltodytes caesus* (Coleoptera), *Chaoborus pallidus* (Diptera)
- R3: sequential reproduction, parental care
  - species: *Asellus aquaticus* (Isopoda), *Helobdella stagnalis* (Hirundinea)

Conclusions so far ….

- Relevant traits show trade-offs and thus specific investments
- Species can be grouped into life-history tactics using these traits
- Life-history tactics are independent of systematic groups (defined ecologically)

… but is it meaningful?

- Can we use the tactics to show changes in the environment that became understandable using this tool?

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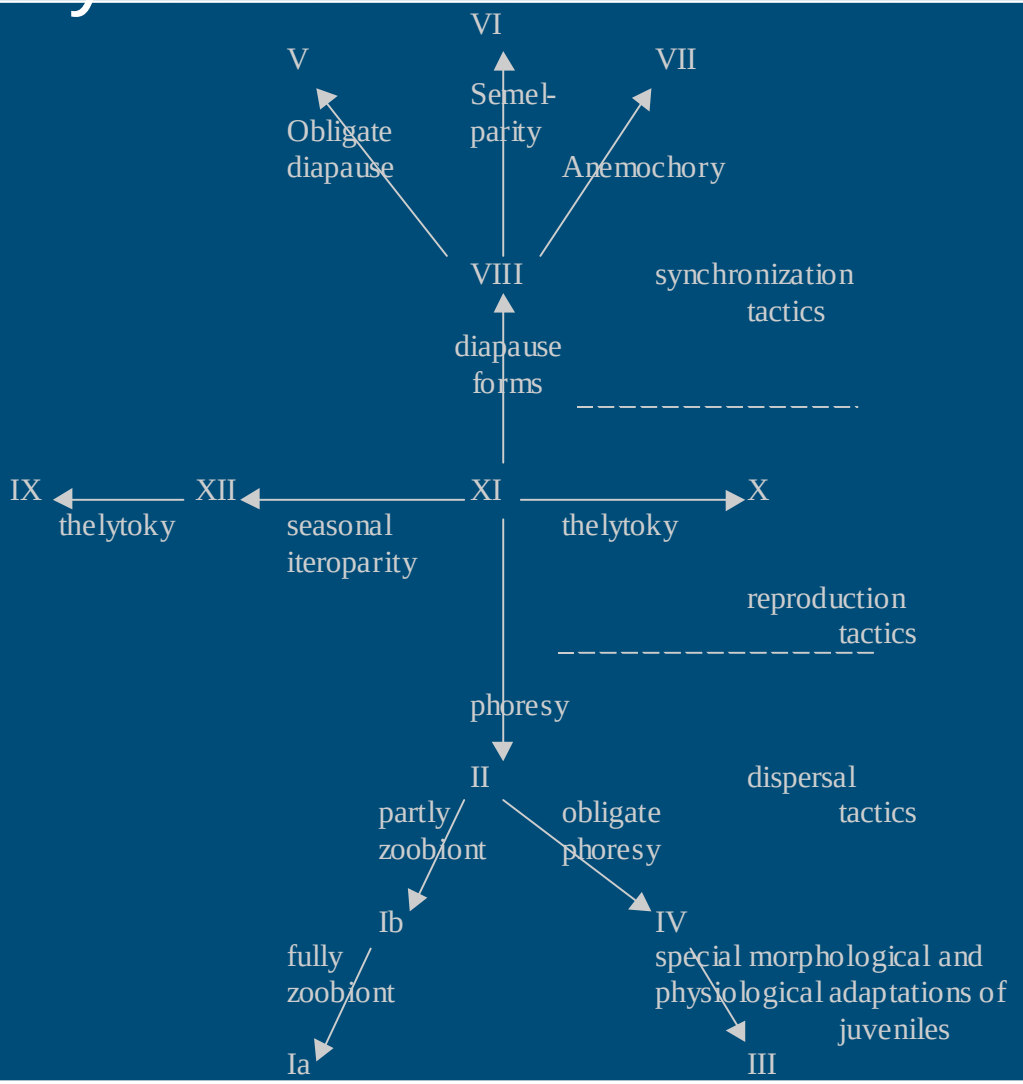
Life-history tactics in soil micro-arthropods



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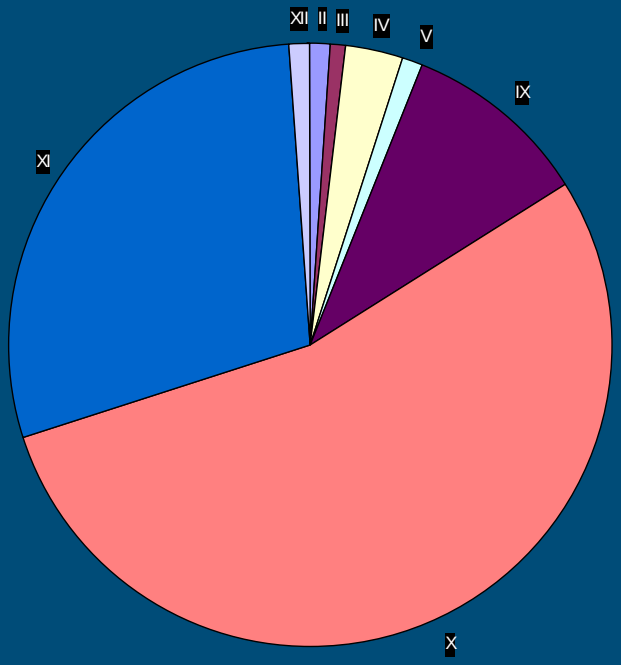
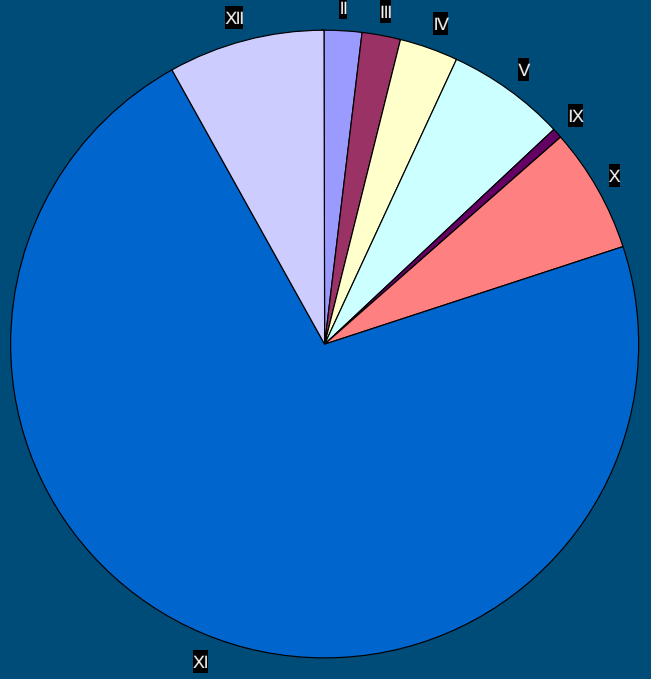
From undisturbed forest soil to low-input grassland, ...





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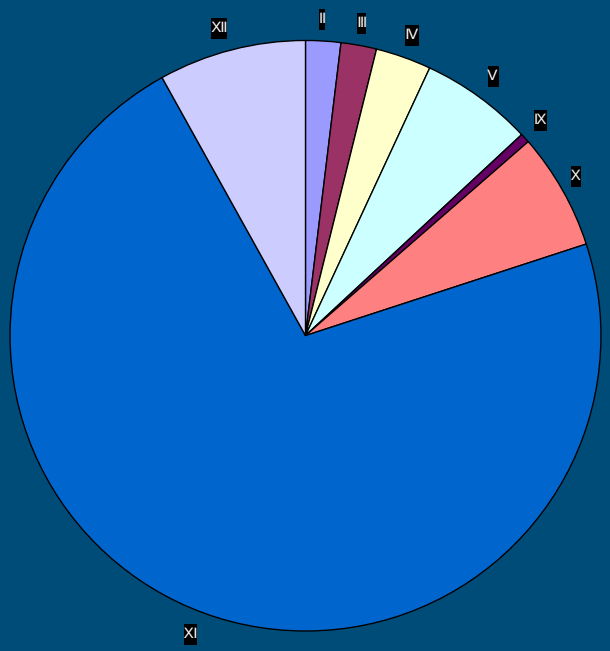
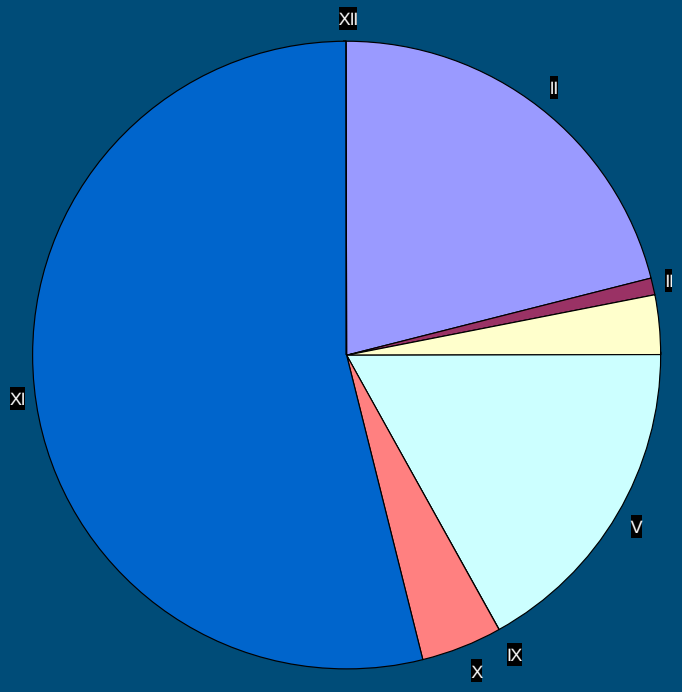
from low-input to high-input grassland, ...





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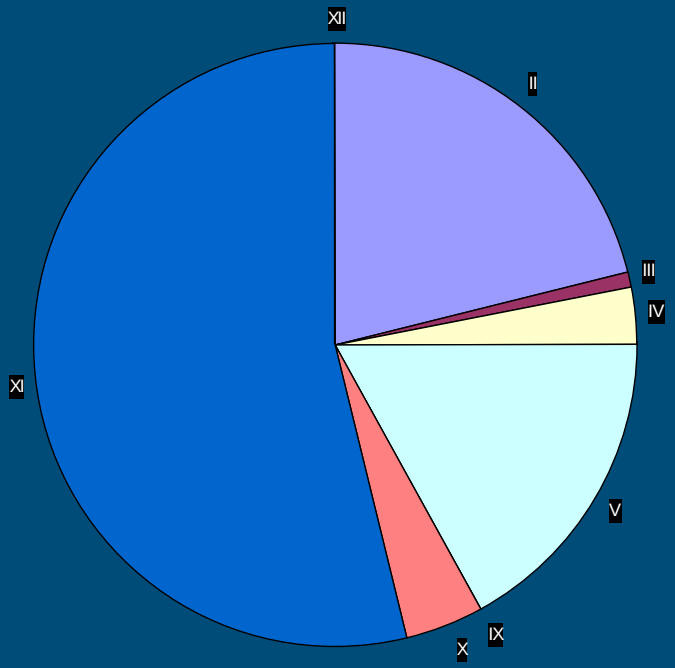
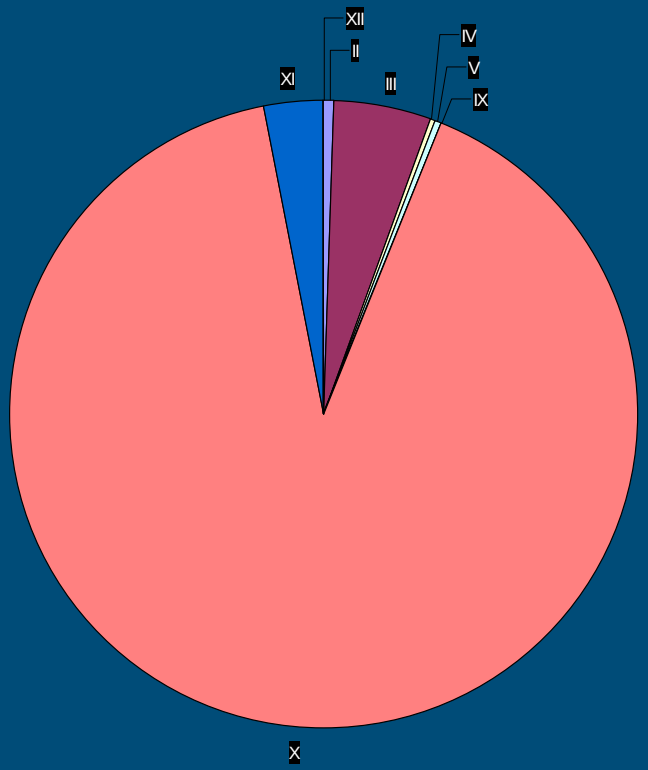
and the application of persistent pesticides.





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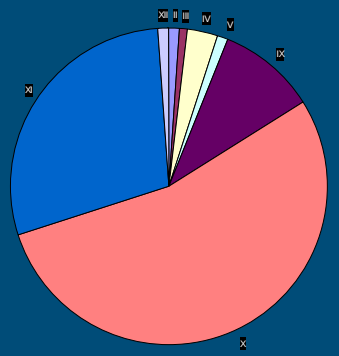
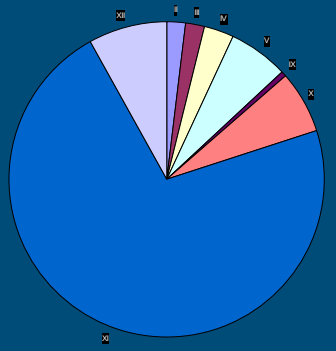
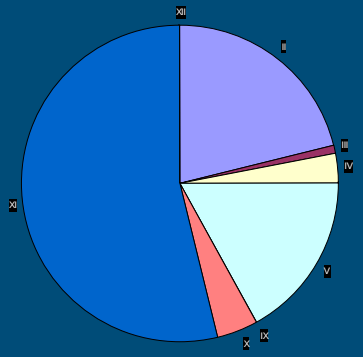
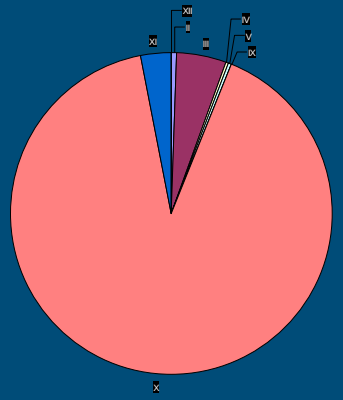
And all changes in one picture









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Conclusions from the microarthropods

- Thelytokous reproduction tactics decrease with higher dynamics
- But, the use of DDT overshadows all other dynamics and is experienced as a dominant and constant factor
- Tactics with higher dispersal capacities increase from forest to grassland and intensively used grassland

Conclusions in general

- The use of life-history tactics serves good testable hypotheses
- It overcomes the confusion of having many ecologically similar species (they are grouped now instead of separated due to different names)
- It enables the comparison over systematic groups
- Meaningful changes in the environment can be demonstrated and understood

Thank you

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