# Permeability of the pond landscape of northwest England: The Odonata perspective

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Fig.1 – Cheshire, England

## Objectives

**To quantify species-specific permeability of the landscape and investigate causes of variation between species of Odonata**

484 Cheshire ponds (region marked on Fig. 1) were surveyed during EU Pond *LIFE* Project (1995-1999). Botanical, macroinvertebrate and water chemistry data were recorded. These data showed that species varied widely in their occupancy of the ponds, (Fig. 2) despite connectivity being exceptionally high. We analyse this dataset using ordination methods and other statistics to investigate the factors that influence odonate diversity in English ponds.

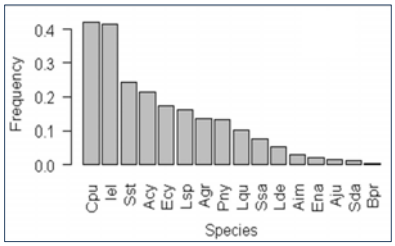



Fig.2 – Frequency of species occurrence in 484 Cheshire ponds

## Ordination Methods

The vegan package in R was employed to generate models to describe odonate communities based on (i) plant communities, (ii) pond characteristics and (iii) water chemistry. These were compared to null models to assess goodness of fit using Akaike's information criterion (AIC).

Table 1 – Multivariate models and goodness of fit (AIC)

| Response | Environment | Ponds | AIC | ΔAIC vs. null |
|---|---|---|---|---|
| Odonata community | Plant | 293 | 1447 | 71 |
| Odonata community | Pond | 260 | 1457 | 16 |
| Odonata community | Chemistry | 53 | 263.9 | 5.9 |
| | | | | |
| Plant community | Chemistry | 72 | 548.7 | 1.0 |

Ordination methods showed that all models of odonate communities had at least moderate support. However, the variation in odonate communities was best explained by the plant communities. This was shown not to be an indirect effect of water chemistry, as water chemistry does not significantly explain plant communities.

## Chemical Tolerance

● = All ponds
— = Ponds containing *Enallagma cyathigerum*

Proportions of total range of 10 chemical variables summed for each species
→ score out of 10

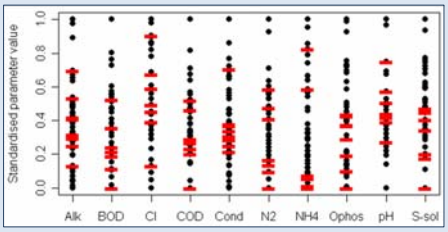
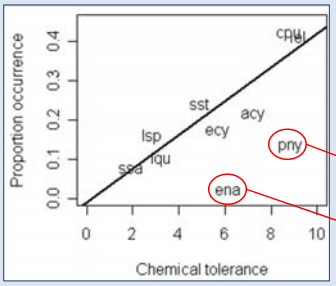



Fig.3 – Water chemistry values and the subset of values at which a species was found




Chemical tolerance correlates with proportion of ponds occupied (r=0.60, p=0.003).

Outliers:
- pny = *Pyrrhosoma nymphula*, a bog-dwelling species whose habitat is under-represented in the surveys.
- ena = *Erythromma najas*, which is strongly associated with particular floating plants.

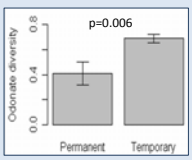
Fig.4 – Chemical tolerance of each species against proportion occurrence in the pondscape

A strong fit with chemical tolerance confirms the intuitive assumption that species with the broadest tolerance to chemical conditions can persist in the greatest proportion of ponds.

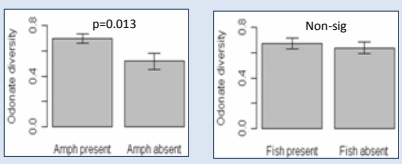
## Other Hypotheses

Odonate communities are shaped by:

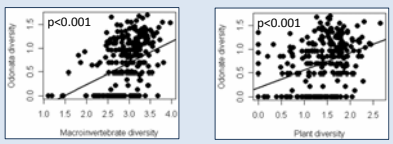
- **Water permanence**
The intermediate disturbance hypothesis has been put forward as a cause of increased diversity by arresting succession. Also, Odonata are swift colonisers, benefiting from frequent disturbance.




- **Predation**
Competition from vertebrate predators reduces the available prey and predation on larvae is a major source of mortality.




- **Plant/prey diversity**
Odonata are associated with habitats with a high degree of plant architectural complexity. Increased prey Diversity reduces competition Between different odonate species.




## Conclusions

Extensive variation in habitat suitability between species results in reduced landscape permeability. This will have consequences for understanding metapopulation ecology and distributional changes.

Variation is likely caused by chemical tolerance limits, including COD and BOD which are directly linked to agricultural pollution.

Odonate communities are explained by plant communities, though temporary and amphibian-inhabited pools exhibited greater odonate diversity.

The varied nature of individual ponds highlights the need to conserve the pond landscape as a whole to ensure ecological integrity.

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