SUBMERGED AQUATIC PLANTS AS INDICATORS OF ENVIRONMENTAL STRESS IN CHALK STREAMS

Alexander J. W. Poynter¹
Lesley C. Batty¹, Mark E. Ledger¹, Shirley Medgett²

¹Water Sciences Research Group, University of Birmingham
²Environment Agency, Solent and South Downs Area
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• Further work
• Defined as “One or a few species that reflect the community” (Krebs, 2009)

• Presence and changes to indicators reflect changes in overall community

• Selection criteria:
  – Well known species – Taxonomy, biology, natural history
  – Easy to survey
  – Specialists
  – Close association to taxa within community

• Incredibly useful for monitoring the health of communities and habitats

• Macroinvertebrates most often used in lotic systems
ENVIRONMENTAL STRESS

• Natural or anthropogenic pressures on the environment
• Leads to degradation
• Examples of pressures in chalk streams:
  – Low flows – natural (e.g. droughts) or human (e.g. over-abstraction)
  – Nutrient enrichment
  – Increased sediment input
• ‘Chalk stream malaise’

Photographs from Glasspool, 2007
AQUATIC MACROPHYTES AS INDICATORS

• Useful as indicators:
  – Sensitive to environmental changes
  – Can be easy to identify and survey
  – Important roles in community
  – Keystone species – e.g. *Ranunculus* spp. (Water crowfoot)

• Difficulties in using as indicators:
  – Taxonomic clarification needed
  – Large differences in surveyor ability/judgement
  – Many responses to stress still not proven, even in key species
  – Abundant confounding variables, particularly in chalk streams
PhD project entitled:

“Impacts of environmental stressors on the River Itchen *Ranunculus* community”

- Joint ecological study between University of Birmingham and Environment Agency
- Focus on submerged plant community
- Knowledge is needed in order to advise flow regulations and aid management and conservation:
  - Changes in environmental conditions and responses in the plant community
  - Keystone species responses to changes in flow and nutrients

**Project Aim**

To improve the understanding of the macrophyte-environment dynamic in the River Itchen *Ranunculus* community
Research is comprised of three distinct stages:

1. **Community assessment** – Spatiotemporal analysis of past macrophyte, water quality and flow data
2. **Experimental studies** – Utilising experimental channels (mesocosms) and transplant studies to test plant stress responses
3. **Environmental metabolomics** – Testing stress responses of plants by integrating cutting edge metabolite profiling studies into experimental studies
Community assessment

Plant community assessment using:

- 6 years of macrophyte survey data
- Corresponding water quality and flow data
Results so far:

- Multivariate analysis defines overall trends
- Identification of key taxa by abundance: *Ranunculus spp.*, *Berula erecta*, *Callitriche spp.*, *Cladophora agg.*
- Focus on key species for correlation and regression analyses
- Patterns with flow, phosphate and shade established
- Competitive interactions between key macrophyte taxa
EXPERIMENTAL WORK

- Autecological study of *Ranunculus penicillatus* ssp. *pseudofluitans*.
- Made up of two phases:
  - Experimental channels
  - Clonal transplants
- Aim: To develop an understanding of the responses of *R. pseudofluitans* to environmental stress, with particular focus on the effects of:
  - Flow conditions on the growth of *R. pseudofluitans*
  - Nutrient enrichment on the growth of *R. pseudofluitans*
  - Suspended sediments on the growth of *R. pseudofluitans*
Low flow
- Spindly stemmed, long internodes
- Short leaved, ≤ internode
- Very minor rooting system
- Little branching
- Weak stems

High flow
- Short stemmed, short internodes
- Long leaved, ≥ internode (sometimes 2x as long)
- Extensive root system
- Widely multi-branched
- Stronger stems
ENVIRONMENTAL METABOLOMICS

- Coinciding with survey and channel studies
- Assessing the metabolite responses of *R. pseudofluitans* to changes in flow, nutrients and suspended sediments
- Potential use as a sub-lethal indicator
- First metabolomic study on aquatic macrophytes
Results from suitability study show that:

- Metabolic profiles for all samples have reasonably high variation (Relative Standard Deviation; RSD)
- RSDs for each sample, when analysed by Principal Components Analysis (PCA), show large amounts of scattering, with no particular clusters or groups
- The RSD scores, whilst indicating high natural variation and scatter amongst all samples, were acceptable (particularly for wild samples), and will likely be overridden by the effects of environmental stress in any case
FURTHER WORK

Outstanding questions:

• Improvements in survey techniques?
  – Utilise aerial mapping as a potential macrophyte survey method

• Responses of other chalk stream macrophytes?
  – Expand experimental work to cover other key taxa

• How to combat confounding variables?
  – Develop a method to quantify the effects of confounding variables, e.g. swan grazing, cutting

Other work:

• Clarification of status, distribution, taxonomy and genetics

• Nutrient and competition dynamics

• Regrowth, colonisation and fragmentation potential

• Future implications of climate change
THANK YOU FOR LISTENING!

Any questions?

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