CONTEXTUALISING STATISTICALLY SIGNIFICANT DIFFERENCES OBSERVED IN MESOCOSM STUDIES USING HISTORICAL CONTROL DATA

CAMBRIDGE ENVIRONMENTAL ASSESSMENTS

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Background

Mesocosms are used as part of the higher tier aquatic risk assessment for plant protection products (PPPs) in the EU registration process. When setting up mesocosm studies, care should be taken to standardise communities present in each replicate to reduce variability and maximise statistical power. However, being dynamic and complex systems, variability can often still occur between replicates, which can affect the reliability and interpretation of the results.

Cambridge Environmental Assessments (CEA) have a wealth of control data from historical mesocosm studies, with samples collected in spring, summer and autumn, thus capturing the variability in population and community dynamics over multiple years and seasons.

Here we present our review of this historical control data, and how this provides a baseline to aid interpretation of results from individual studies.

Aims and Methods

- *To understand seasonal community dynamics in mesocosms at the Cambridge Environmental Assessments facility, Boxworth, Cambridge, UK.*
- *To better predict community structures under certain environmental conditions throughout the sampling period of a study.*
- *To aid filtering of statistically significant differences that can arise due to natural variability rather than biologically relevant effects.*

Historical control data were collated and analysed from:

11 mesocosm studies → **46** replicates → **2010** to **2017** → **18** zooplankton taxa → **8** environmental variables

- Analyses were conducted using R 3.4.4 and Canoco 5. Initial unconstrained analysis of abundance (log10 transformation) with supplementary variables indicated an effect of year as well as season, corresponding to changes in water qualities.
- Subsequent constrained analyses to test the influence of environmental variables on community structure are presented below:

Results and Discussion

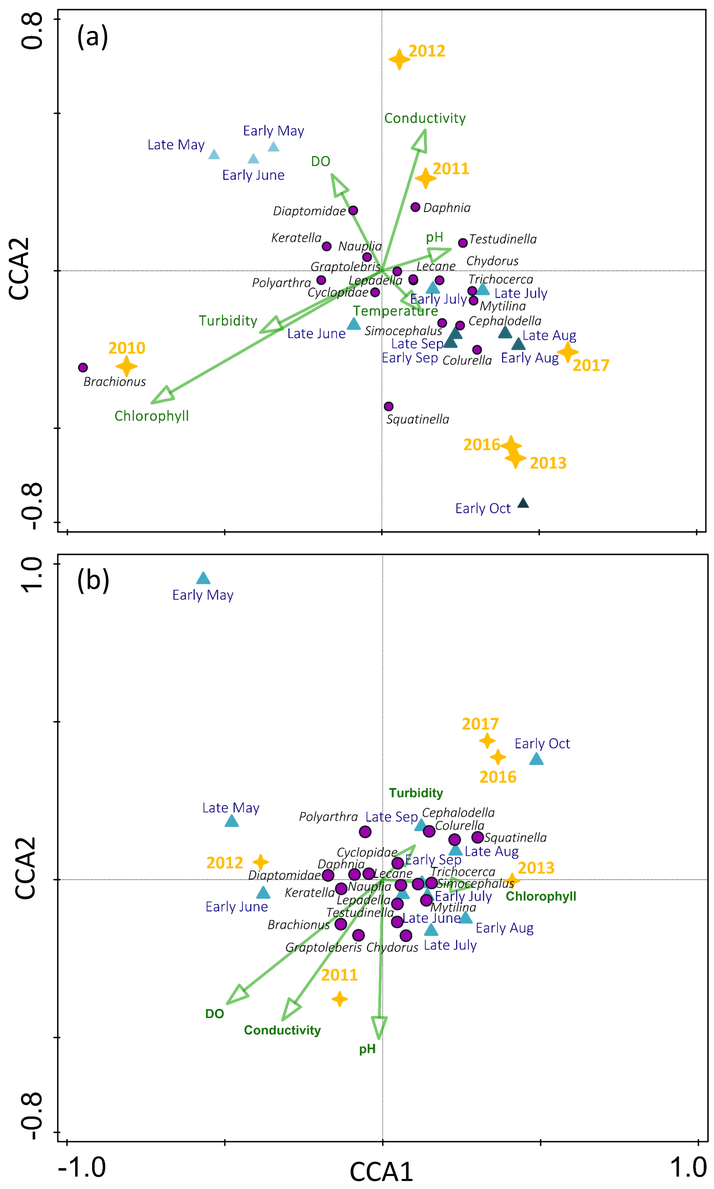

***Figure 1**. Canonical Correspondence Analysis (CCA) of historical data with (a) all studies included and (b) anomalous 2010 data removed due to high chlorophyll/Brachionus.*
(a) Explained variation = 32.17%, P=0.0001, pseudo-F=4.9, P(adj) < 0.05 for individual variables, (b) Explained variation = 24.3%, P=0.0001, pseudo-F = 2.7, P(adj) < 0.05 for individual variables except temperature.

General overview

- As realistic systems, mesocosms are intrinsically variable.
- Environmental variables had a significant impact on community structure (Fig 1).
- Seasonal patterns for zooplankton can be identified from our historical data (Fig 2).
- High chlorophyll correlates to increases in *Brachionus* abundance (Fig 1-3). Multivariate analyses outputs indicate these patterns are isolated to earlier months.
- Following removal of anomalous data (2010), the influence of chlorophyll significantly decreased (Fig 1), however the seasonal pattern remains consistent for both biotic and abiotic factors.

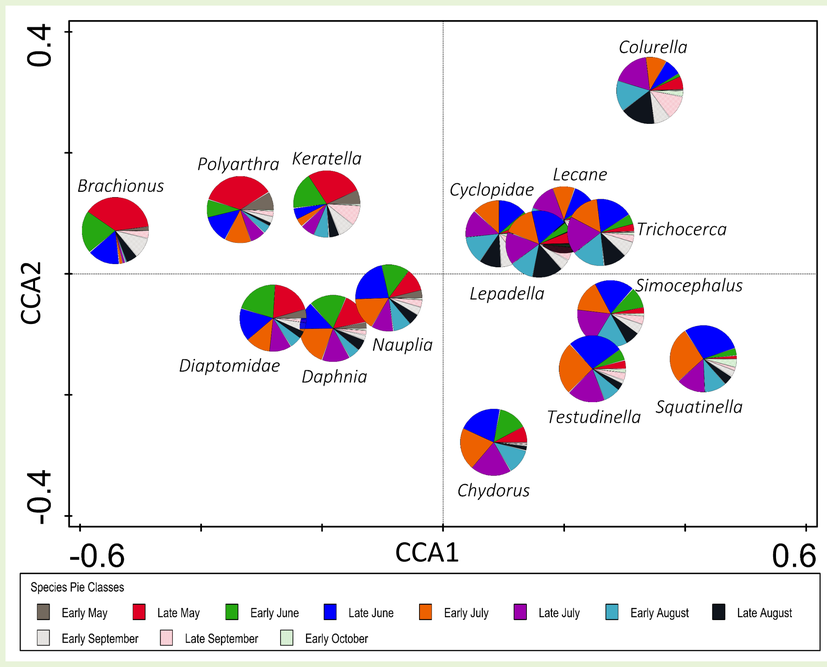

***Figure 2**. Pie symbol diagram showing seasonal distribution of species from 2010-2017*
Seasonal distribution corresponds to CCA1, where negative values coincide with earlier months constrained against season.
Explained variation = 8.01%, P=0.0001, pseudo-F=3.3

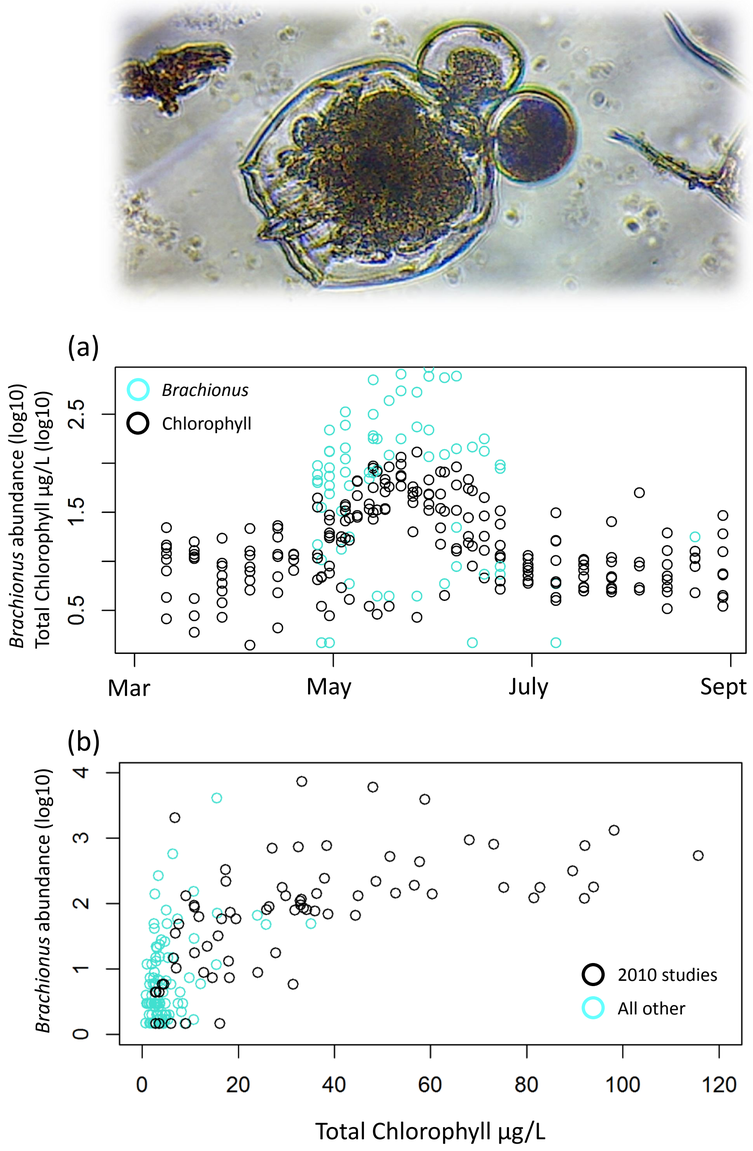

***Figure 3**. Contextualisation of boom-and-bust species in mesocosms.*
(a) Two studies were carried out in 2010, which showed a high chlorophyll peak, causing high *Brachionus* abundance early in the sampling season.
(b) Using background data from subsequent years, these results can be confirmed as outliers at our mesocosm facility.

CONCLUSIONS AND NEXT STEPS

- These results show how historical data can help contextualise results from current mesocosm studies
- This allows an assessment of biological relevance and thus the appropriateness of influencing the regulatory acceptable concentration (RAC)
- Analyses of zooplankton community structures in mesocosms form a basis from which CEA will continue to build upon, including other taxonomic groups
- Further research is required to determine statistically inherent variability between ponds to improve statistical power and increase reliability of endpoints