Disentangling the Drivers of Insect Armageddon

Determining the Impact of Anthropogenic Disturbances on Midge Diversity in the UK

Aspen Watts
awatts02@student.bbk.ac.uk
Department of Geography, Birkbeck University of London

Introduction

Insects and other invertebrates play key roles in ecosystems, providing pollination, herbivory, detritivory, nutrient cycling, and acting as integral parts of the food web. Any loss or change to insect communities will have effects across all levels of an ecosystem.

Anthropogenic activities are causing a profound decline in insect species, described as Insect Armageddon (Hallmann et al., 2017). This is especially true of freshwater environments, which contain a high proportion of invertebrate species, and are both influenced by and influence wider areas due to the nature of their water catchments.

Unfortunately, many anthropogenic activities and drivers of environmental change occur simultaneously in a given freshwater environment (Dudgeon, 2019). For example, there may be industrial activity creating chemical pollution, introduction of invasive alien species by shipping or tourism, and a change in nutrient inputs through the alteration of surrounding land from forest to farmland.

The concurrence of these drivers make the individual impacts of a specific cause difficult to separate, as most modern surveys of freshwater insects are unlikely to cover more than a decade at the very most, by which time most contemporary drivers will already have had impacts.

There is a need for longer term baselines/data to inform modern restoration and conservation efforts (Porinchu & MacDonald, 2003).

Case Study – The Loe, Cornwall

Figure 1: The Loe (dark blue) and its catchment (red). (UK CEH, 2023)

- Site of Special Scientific Interest
- National Trust
- History of varied land-use/anthropogenic influences
  - Tin and copper mining in the early 20th Century
  - Primarily agriculture post-1938, with an Increasing scale and output 1950-present
  - Any modern ecological surveys will be influenced by these changes in land-use
- Hypothesis of a loss of species diversity, and decrease in insect biomass
  - Expectation of some recovery since the end of the mining industry

Methods

- Longer-term data can be collected from paleo-ecological datasets, such as **Chironomid (non-biting midge)** remains (Porinchu & MacDonald, 2003).
  - Chironomids are abundant in lake ecosystems and are sensitive to environmental change.
  - Key components of ecosystem – up to 50% of species (Serra et al., 2016).
  - Their larvae grow in the lakebed, shedding their exoskeletons as they develop.
  - The headcapsules in particular preserve well, and can be identified to species morphotype.
  - Communities are preserved in sediment as a snapshot of which species were present.

Figure 2: The preserved headcapsule of *Sergentia coracina*.

- Sediment is collected in cores.
  - Depth/age is calculated from radiometric dating and volcanic ash.
  - Samples are taken at appropriate intervals (4cm in this case), and chemically treated and filtered to remove dirt and debris.
  - Chironomid headcapsules are collected and identified/counted.

Results

Analysis of the core sediment record immediately showed changes in the species composition, aligned with known historical landmark events:

- Overall richness (number of species), and sample density (approximate abundance of individuals) dropped as the mining intensified.
- A further decrease in richness was observed during an intense pollution event (80cm).
- Species richness and abundance began to increase after the closing of the mines in 1938.
- Subsequent decline observed more recently, following more intensive farming practices.
- Even within "recovery" the composition is very altered.

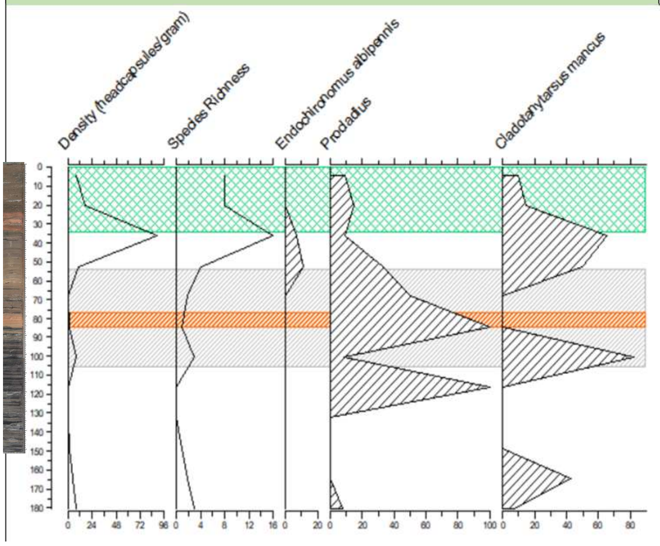

Figure 3: Density and species richness of all Chironomid headcapsules recovered from the Loe samples, alongside the percentage abundance of *Endochironomous albipennis*, *Procladius*, and *Cladotanytarsus mancus*. Periods of intensive mining (grey) and agriculture (green) are marked.

Key Species

- *Endochironomus albipennis*
  - Associated with macrophytes
  - Mesotrophic and eutrophic lakes (high nutrient)
- *Procladius*
  - Often dominates when other taxa cannot tolerate conditions
  - Peak during mining (close to 100%)
- *Cladotanytarsus mancus*
  - High proportion of community after mining
  - Productive lakes

Conclusions

Changes in population over time were successfully plotted, with a starting point far earlier than would be possible with "living" data.

The results showed that despite signs of recovery from the historical mining in the region, there are further impacts on local insect populations, likely due to the agricultural practices in use.

Further data collection and analysis for this site will be carried out to improve the clarity of the information to then inform restoration and conservation efforts.

Acknowledgements: Dr Hellion Bennion, UCL; Dr Stefan Engels, Birkbeck; Dr Celia Martin-Puertas, RHUL;

References:
Hallmann, C. A., Sorg, M., Jongejans, E., Siepel, H., Hofland, N., Schwan, H., Stenmans, W., Müller, A., Sumser, H., Hörren, T., Goulson, D., & de Kroon, H. (2017). More than 75 percent decline over 27 years in total flying insect biomass in protected areas. *PLoS ONE*, *12*(10). https://doi.org/10.1371/JOURNAL.PONE.0185809
Serra, S. R. Q., Cobo, F., Graça, M. A. S., Dolédec, S., & Feio, M. J. (2016). Synthesising the trait information of European Chironomidae (Insecta: Diptera): Towards a new database. *Ecological Indicators*, *61*, 282–292. https://doi.org/10.1016/J.ECOLIND.2015.09.028
Dudgeon, D. (2019). Multiple threats imperil freshwater biodiversity in the Anthropocene. *Current Biology*, *29*(19), R960–R967. https://doi.org/10.1016/J.CUB.2019.08.002
Porinchu, D. F., & Macdonald, G. M. (2003). The use and application of freshwater midges (Chironomidae: Insecta: Diptera) in geographical research. *Progress in Physical Geography*, *27*, 378–422. https://doi.org/10.1191/0309133303pp388ra
eip.ceh.ac.uk. (n.d.). *Details about a UK lake*. [online] Available at: https://eip.ceh.ac.uk/apps/lakes/detail.html#wbid=46556 [Accessed 16 Feb. 2023].