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Metrics of structural change as indicators of chironomid community stability in high latitude lakes

Roseanna J. Mayfield [a,*], Peter G. Langdon [a], C. Patrick Doncaster [b], John A. Dearing [a], Rong Wang [c], Larisa B. Nazarova [d,e,f], Andrew S. Medeiros [g], Stephen J. Brooks [h]

[a] Geography and Environmental Sciences, University of Southampton, Southampton, SO17 1BJ, UK
[b] Biological Sciences, Institute for Life Sciences, University of Southampton, Southampton, SO17 1BJ, UK
[c] State Key Laboratory of Lake Science and Environment, Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, Nanjing, 210008, China
[d] Potsdam University, Institute of Earth and Environmental Science, Am Neuen Palais 10, 14469, Potsdam, Germany
[e] Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Research Unit Potsdam, Telegrafenberg A43, 14473, Potsdam, Germany
[f] Kazan Federal University, Kazan Federal University, Kremlyovskaya str., 18, 420018, Kazan, Russia
[g] School for Resource and Environmental Studies, Dalhousie University, Halifax, Canada
[h] Department of Life Sciences, The Natural History Museum, London, SW7 5BD, UK

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A B S T R A C T

Understanding the effects of climate change on ecosystem structure and stability is challenging, especially in high latitude regions that are predicted to experience the largest increases in ambient temperature. Global warming is likely to be a key driver of ecosystem change in freshwater lakes. Increased temperature can positively or negatively affect lake community composition through the loss of cold-adapted taxa and the arrival of temperate or eurytopic taxa. Here, we analyse the likely effects of temperature-induced changes in taxonomic richness and compositional turnover of environmentally-sensitive chironomids (Diptera: Chironomidae) across three regions - northern North America, Norway, and Russia - using existing datasets. Structural parameters (beta diversity, compositional disorder, and network skewness) were applied to model-simulated and empirical chironomid datasets across a large spatial temperature gradient. The analyses of empirical datasets showed changes in community structure across temperature gradients, suggesting varying states of ecosystem stability or instability. The comparison with null models enabled assessment as to whether these stresses agreed with expected patterns due to covarying summer temperature conditions or whether they deviated from expectations suggesting additional stress on the ecosystems. For all three regions, lakes in the mid-temperature range showed most evidence of relative ecosystem stability, with greater beta diversity, compositional disorder, and skewness, unanticipated by the modelled simulations. This is most likely due to more diverse habitats across the ecotone boundaries and additional factors that can influence ecosystem structures. Thus, we show that structural changes typical for ecosystem stability can be detected through changes in community structure across temperature gradients. This is important for understanding how lakes may change under current and future climate change.

Author contributions

R. J. Mayfield, P. G. Langdon, C. P. Doncaster, and J. A. Dearing discussed the research conceptualization and outcomes. C. P. Doncaster provided the original R code for the compositional disorder calculations and incidence matrix simulation R code used to create the theoretical data. R. Wang provided the original MATLAB network skewness code. R. J. Mayfield adapted the above codes, created the hypothetical datasets and ran all analyses on the

* Corresponding author.
E-mail addresses: R.Mayfield@soton.ac.uk (R.J. Mayfield), P.G.Langdon@soton.ac.uk (P.G. Langdon), cpd@soton.ac.uk (C.P. Doncaster), J.Dearing@soton.ac.uk (J.A. Dearing), rwang@niglas.ac.cn (R. Wang), nazarova_larisa@mail.ru (L.B. Nazarova), andrew.medeiros@dal.ca (A.S. Medeiros), S.Brooks@nhm.ac.uk (S.J. Brooks).

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