Landscape effects of climate, agriculture, and urbanization on benthic invertebrate communities of Canadian prairie lakes

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ABSTRACT: Paleoecological analyses of fossil chironomid assemblages from eight lakes of the Qu[]Appelle Valley, Saskatchewan, Canada, were used to quantify the relative influence of climate, resource use, and urbanization on benthic invertebrate communities 1850-1995. Fossil analyses inferred that Qu[]Appelle lakes are naturally productive but that invertebrate communities were altered by agriculture and urbanization. In western lakes, rates of community change (chord distance per 5 yr) were low and nonsignificant ($P < 0.05$) prior to European settlement, but increased twofold after ~1930-1940. In contrast, uniformly significant rates of community change were recorded in eastern downstream lakes only after the 1960s. In both cases, high rates of change corresponded to alterations in the balance between deep-water (Chironomus) and littoral species (*Cladotanytarsus mancus* group, *Tanytarsus* s.lat. [s.l.]). Comparison of historical and fossil time series (~1920-1993) using variance partitioning analysis (VPA) explained up to 86.6% of past variations in chironomid community composition. Unexpectedly, climate (winter temperature) explained a significant (P , 0.05) and substantial (mean ± SD, n =5 8; 24.8 ± 21.9%) amount of community variance at all sites except Round Lake. In contrast, land-use practices exhibited significant but less substantial (6.7 ± 6.1%, n = 8) impacts on zoobenthos of five lakes, whereas significant urban impacts (3.6 ± 7.5%, n = 8) were recorded only at two sites. Similarly, redundancy analysis showed that minimum winter or spring temperature significantly influenced the relative abundance of littoral taxa in seven lakes. Such strong effects of climate on benthic invertebrate communities contrast its weak effects on phytoplankton in these lakes and suggest that future environmental change may be expressed differentially among habitats.

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