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Late Quaternary marine records from High Arctic Canada: problems, solutions, and multiproxy perspectives

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The Canadian Arctic Archipelago (= CAA) constitutes a significant geographic region within the Arctic Ocean Basin, influencing its oceanography, biology, ecology, and climate. Yet comparatively little is known about the long-term (post-Late Wisconsinan) environmental history of the marine channels of this region (the "Northwest Passage" = NWP). New marine data emerging from the central CAA extending back to regional deglaciation highlight the potential of multiproxy approaches in high-latitude settings.

Five long (piston and trigger-weight) cores in an east-west transect through the NWP, investigated for sedimentological characteristics, microfossils (dinocysts, non-pollen palynomorphs, benthic and planktonic foraminifera, ostracods), and stable isotope ratios, show a dynamic late Quaternary environmental history. Our data suggest grounded glacial ice, rapid deglaciation, and a characteristic progression from ice-proximal to ice-distal conditions. Despite chronological complexities (scarcity of dateable materials, Portlandia Effect), age model extrapolations place deglaciation at ∼11.0-10.3 cal ka BP (location dependent). Noticeable biological activity is marked by the appearance of planktonic foraminifera (Neogloboquadrina pachyderma) at ∼10.0 cal ka BP. This signals the penetration of (Atlantic-derived) Arctic Intermediate Water (AIW) into the central NWP following deglaciation, likely facilitated by higher sea-levels permitting increased flow across inter-channel sills. Subsequent (∼9.0-7.0 cal ka BP) ameliorated conditions (open-water season greater than present) marked by substantial diversification and abundance across all microfossil groups may correspond to a previously postulated "Holocene Thermal Optimum". After ∼7.0 cal ka BP increased sea-ice and modern microfossil assemblages imply conditions similar to modern, likely due to the exclusion of AIW due to glacioisostatic shallowing combined with climate cooling.

Remaining micropalaeontological challenges in the CAA include:

i) low diversity communities (e.g. dinocysts) dominated by generalist taxa capable of withstanding large fluctuations in physical parameters

ii) apparent disappearance of foraminiferal tests after ∼6 cal ka BP, due to dissolution, switch from calcareous to more fragile agglutinated groups and/or increased importance of smaller (45-63 μm) taxa

iii) cryptic palaeoenvironmental preferences of non-pollen palynomorphs such as acritarchs

iv) implied non-analogous early to mid-Holocene environmental conditions, limiting the utility of modern analogue based transfer functions

A multiproxy micropalaeontological approach, coupled with sedimentological and biogeochemical data, may best overcome such challenges in the CAA. Additionally, particular attention needs to be directed towards standardized radiocarbon dating and calibration. Emerging marine records should be assessed in tandem with the wealth of geomorphological and geological terrestrial data, given the exceptional linkage between marine and terrestrial environments in this archipelago. Collectively, such approach would lead to an integrated understanding of long-term environmental and climatic histories in this climatically-sensitive region.