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Trophic Relationships at High Arctic Ice Edges

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ABSTRACT. At ice edges in the Canadian High Arctic, seabirds and marine mammals eat arctic cod (*Boreogadus saida*) and, to a lesser extent, zooplankton (calanoid copepods and *Parathemisto*) and ice-associated amphipods. Cod eat ice-associated amphipods, other ice-associated taxa (harpacticoid and cyclopoid copepods), and zooplankton. Calanoid copepods, *Parathemisto*, and the ice-associated amphipods studied (*Onisimus glacialis, Apherusa glacialis, Gammarus wilkitzkii*) all eat primarily diatom algae characteristic of the under-ice flora. From this information, a food web at the ice edge is constructed.

Key words: trophic relationships, arctic, ice edges, seabirds, marine mammals, cod, epontic community, zooplankton

RÉSUMÉ. En bordure des glaces dans l'Arctique polaire canadien, les oiseaux de mer et les mammifères marins se nourissent de morue arctiques (*Boreogadus saida*) et, quoique dans une moindre mesure, de zooplanctons (copépodes calanoides et *Parathemisto*) et d'amphipodes associés à la glace. La morue se nourrit d'amphipodes ainsi que d'autres taxons (copépodes harpacticoides et cyclopes) tous associés à la glace, et de zooplancton. Les copépodes calanoides *Parathemisto*, et les amphipodes associés à la glace qui ont été étudiés (*Onisimus glacialis, Apherusa glacialis, Gammarus wilkitzkü*) tirent tous leur substance principale d'une algue diatomée commune à la flore trouvée sous la glace. A partir de cette information, une chaine alimentaire est donc construite pour la bordure des glaces.

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INTRODUCTION

The undersurface of arctic sea ice supports a diverse assemblage and high concentration of microalgae comprised primarily of diatoms (Alexander, 1974; Horner, 1976, 1977; Dunbar and Acreman, 1980). Various invertebrates including meiofauna (nematodes, polychaetes, and harpacticoid and cyclopoid copepods) and macrofauna (primarily gammarid amphipods) live on, or just within, the under-ice surface (e.g., Horner and Alexander, 1972; Golikov and Averincev, 1977). A trophic link between this epontic flora and fauna has been postulated frequently (Apollonio, 1961; English, 1961; Alexander, 1974; Horner, 1977), but quantitative data have been lacking.

A small gadoid fish, the arctic cod (*Boreogadus saida*), is also thought to occur close to the undersurface of sea ice (Andriashev, 1970; Wilimovsky in McRoy and Goering, 1974; McAllister, 1975; Golikov and Averincev, 1977). As Horner (1976) noted, there are many unpublished observations of cod in close association with blocks of ice overturned by icebreakers. The diet of those specific *Boreogadus saida* occurring near the ice undersurface has not been studied previously, but this small cod is a major component of the diets of many arctic seabirds and marine mammals (Belopol'skii, 1957; Davis *et al.*, 1980).

During late spring and early summer, many seabirds and marine mammals congregate at the edges of landfast ice in the Canadian High Arctic (Bradstreet, 1979; Finley *et al.*, 1980; McLaren, 1982). Bradstreet (1980) showed that two alcids occurring at the edges of landfast ice in the Barrow Strait area fed heavily on arctic cod, the pelagic amphipod *Parathemisto*, and (to a lesser degree) ice-associated amphipods. It seems possible, therefore, that birds and marine mammals congregate at ice edges because feeding opportunities are improved there.

This study was conducted concurrently with those of Bradstreet (1982), who studied the occurrence, distribution, and behavior of seabirds, marine mammals, and arctic cod near the landfast ice edge across the mouth of Pond Inlet in 1979; and Cross (1982), who provided information on under-ice flora and fauna. Here, we integrate the results of these two studies and provide new information on the diets of various vertebrates and invertebrates. This and other information allows us to elucidate important trophic pathways occurring at the edges of landfast ice.

METHODS

Collection Methods

Birds. Biologists and Inuit hunters shot actively-feeding birds along the offshore landfast ice edge across Pond Inlet in 1978 (murres [*Uria lomvia*], $n = 63$) and 1979 (murres, $n = 52$; fulmars [*Fulmarus glacialis*], $n = 31$). During dissections (within 12 h of collection) the oesophagus, proventriculus, and gizzard were slit along their combined length and all food items were flushed into storage vials with 10% neutral formalin.

Mammals. Four ringed seal (*Phoca hispida*) stomachs were obtained from Inuit hunters at the ice edge. We also collected feces at 13 holes where ringed seals were seen hauled out on the landfast ice <2 km from the edge. Stomachs of narwhals (*Monodon monoceros*) taken by Inuit at the ice edge were available in 1977 ($n = 25$) and 1979 ($n = 10$). Stomachs and feces were frozen or preserved in formalin, respectively, for later analysis.

Arctic cod. The stomachs of 46 arctic cod collected from the undersurface of offshore landfast ice <2 km from the ice edge and 27 cod from inshore ice cracks near Bylot Island (Bradstreet, 1982) were selected for food habits studies. Fish were frozen in the field for later study. We selected cod representative of the length range within a given year class, and only stomachs that contained food were analyzed.

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