# A note on the diet of narwhals (*Monodon monoceros*) in Inglefield Bredning (NW Greenland)

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The contents of 35 narwhal (*Monodon monoceros*) stomachs were obtained from the Inuit hunt in Inglefield Bredning (NW Greenland) in the open-water seasons of 1984 and 1985. Questions concerning narwhal feeding habits were addressed by relating lengths of otoliths and invertebrate remains to the known lengths and weights of fishes and invertebrate species prior to digestion, and by assessing the number and volume of each prey species represented by the stomach contents. The 48 kg (wet weight) of stomach contents examined consisted of 64% arctic cod (*Arctogadus glacialis*), 15% polar cod (*Boreogadus saida*), 19% unidentified gadids and 2% invertebrates.

Key words:
Narwhal, *Monodon monoceros*, feeding habits, Greenland.

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## Introduction

The narwhal (*Monodon monoceros*) is profoundly important to Inuit in the municipality of Avanersuaq (NW Greenland), especially to those people living in settlements along Inglefield Bredning. Narwhals congregate in this fjord, especially near its eastern end, during the open-water season from July through September (Born *et al.* 1994). Hunters in Avanersuaq catch an estimated 150–200 narwhals per year, and this represents more than 10% of the annual harvest of edible hunting products in the municipality (Born 1987, Heide-Jørgensen 1994).

Despite its importance to Inuit communities the narwhal's feeding habits have not been assessed quantitatively in Greenland. Vibe (1950) described some of the major prey items of narwhals in Avanersuaq. Meldgaard & Kapel (1981) examined the stomach contents of one narwhal caught in Melville Bugt. Dietz *et al.* (1994) summarized information on narwhal feeding in East Greenland waters. Finley & Gibb (1982) presented quantitative descriptions of narwhal feeding during June-September in and near Pond Inlet, eastern Canadian Arctic.

We used narwhals taken by Inuit in Inglefield Bredning to study narwhal feeding during the brief open-water seasons of 1984 and 1985.

## Materials and methods

### Standard material

Otoliths and fish measurements used in this study were obtained from trawl surveys by r/v *Adolf Jensen* in Inglefield Bredning (77°30'N, 70°00'W) and Melville Bugt (76°00'N, 62°00'W) during August 1987. The lengths and weights of the fish were measured before their otoliths were removed in the laboratory. Lengths of otoliths were measured with a micrometer.

### Stomach samples

Stomach contents or whole stomachs (usually with data on length and sex of the whale) were collected by biologists or hunters from 35 narwhals (6 in 1984, 29 in 1985) killed between 23 July and 8 September in the open-water hunt in Inglefield Bredning. Samples were kept frozen until examination in the laboratory.

Sagittal otoliths, cephalopod beaks and skeletal parts of invertebrates were retrieved by washing and sieving the thawed stomach samples through fine-mesh (0.45

Table 1. Standard equations for fish length and weight on otolith length.

| Species | Otolith length vs. fish length | Otolith length vs. fish weight |
|---|---|---|
| Arctic cod<br>*Arctogadus glacialis*<br>Melville Bugt | $FL = -52.19 + 31.81*OL$<br>$R^2 = 0.97$, $N = 178$<br>range: 2.5–8 mm | $FW = 0.0089454*OL^{4.2543}$<br>$R^2 = 0.96$, $N = 178$<br>range: 2.5–8 mm |
| Polar cod<br>*Boreogadus saida*<br>Inglefield Bredning | $FL = 5.46 + 23.75*OL$<br>$R^2 = 0.91$, $N = 184$<br>range: 5.5–12 mm | $FW = 0.1475*OL^{2.7320}$<br>$R^2 = 0.90$, $N = 192$<br>range: 5.5–12 mm |

mm) netting. When possible, otoliths were identified to species and their lengths measured under a dissecting microscope or with a micrometer. These measurements were used to calculate fish weights and lengths, following Härkönen (1986). Weight was calculated in order to determine the proportional contribution (by wet weight) of each identified species. As teleost fishes contain two sagittal otoliths, the number of otoliths was divided by two.

Otoliths shorter than 5 mm generally could not be identified to species. As almost all of those that could be identified were from polar cod (*Boreogadus saida*), we used the standard equations for polar cod (Table 1) for all otoliths less than 5 mm long. The few otoliths of Liparidae could not be identified to species and were not used to estimate fish weight or length.

Most otoliths had been affected by gastric juices and had thus been shortened. However we assumed that otoliths from all species had been reduced in size by the same fraction and therefore that the food remains represented the relative importance of the various species in the narwhals' diet.

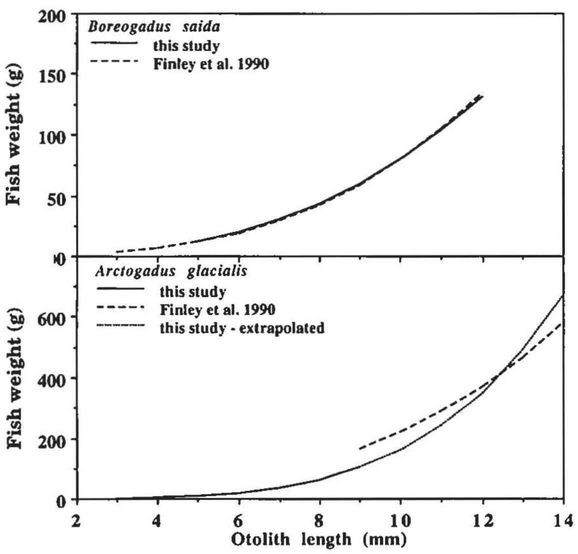


Fig. 1. Above: Regression of fish weight on otolith length for polar cod from Avanersuaq (see Table 1) and the Canadian High Arctic (Finley *et al.* 1990). Below: Regression of fish weight on otolith length for arctic cod from Melville Bugt (see Table 1) and from the Canadian High Arctic (Finley *et al.* 1990).

Whenever possible, squid beaks were identified to species and their lower crest lengths were used to estimate whole-animal weights (see Clarke 1986). Most invertebrates were heavily digested and impossible to identify to species. For a few of the invertebrate remains, weight was estimated by comparing samples of similar size and known weight.

# Results

## Standard material

Ninety-two arctic cod (*Arctogadus glacialis*) and 96 polar cod were obtained from the trawls. (The species that we call arctic cod is called polar cod in North America, and vice-versa). Fish length and fish weight were regressed on otolith length using linear and multiple regression, respectively (Table 1). The correlations for both species were highly significant (Table 1; Fig. 1). For polar cod there was a striking similarity between the standard equation characterising our sample and the equations characterising samples from the Canadian High Arctic (Fig. 1; Finley *et al.* 1990). For arctic cod the Canadian samples covered a larger range than the Greenland samples (Fig. 1; Finley *et al.* 1990), so we used our own equation for arctic cod otoliths between 5 and 9 mm and the Canadian equation for otoliths larger than 9 mm.

## Inferences from stomach contents

The 1984 sample was too small to compare with the 1985 sample. Seventy-three percent of all the samples from both years were from August, the remainder from the end of July or the beginning of September. It was considered appropriate to pool all of the samples for our analysis.

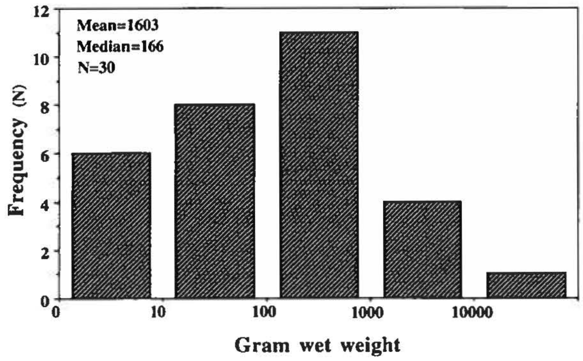


Fig. 2. Frequency distribution of weight of stomach samples.

Table 2. Composition of narwhal diet in Inglefield Bredning during the summers of 1984–85.

| Species | % occurrence in stomachs (N = 30) | % frequency of food items (N = 4359) | % wet weight (47862 g) |
|---|---|---|---|
| *Arctogadus glacialis* | 20 | 14 | 64 |
| *Boreogadus saida* | 47 | 13 | 15 |
| Gadidae sp. | 87 | 60 | 19 |
| Liparis sp. | 7 | <1 | – |
| *Gonatus fabricii* | 23 | <1 | 1 |
| Bathypolypus sp. | 10 | <1 | <1 |
| Crustaceans | 27 | 13 | <1 |

We are uncertain how representative our sample of stomach contents may be for the narwhals feeding in Inglefield Bredning in 1984 and 1985. Empty stomachs were not always collected, and proportions of stomach contents sampled varied. Hence the findings from five empty stomachs are not included in this analysis, and the volume of stomach contents for a given individual must be considered a minimum estimate.

The 30 stomach-content samples contained a total of 3871 otoliths, approximately 2000 eye lenses, 24 cephalopod beaks and some 614 pieces of crustacean. Fourteen of the samples contained less than 100 g of prey items (Fig. 2). However, one of these contained approximately 1200 and another 75 eye lenses, indicating that these whales had fed recently on large numbers of fish or cephalopods.

Arctic cod and polar cod were clearly the dominant prey species for narwhals in Inglefield Bredning in 1984 and 1985 (Table 2). Although otoliths smaller than 5 mm could not always be identified to species, they all came from gadids; most were probably from polar cod since *Boreogadus* tended to be smaller than *Arctogadus* in our sample of narwhal stomach contents (see Fig. 3) and since nearly all of the otoliths <5 mm that were identifiable came from polar cod. We found no obvious difference in the food habits of male and female narwhals, at least with respect to amount and composition of food remains in the stomachs.

Because many of the otoliths were shortened by digestion, the distribution of estimated fish lengths has a negative bias. One stomach contained a large proportion of almost unaffected otoliths, together with some partly digested otoliths similar to those found in the other stomachs.

The length distributions of both polar cod and arctic cod (Fig. 3) are biased by the lack of positively identifiable otoliths smaller than 5 mm. This bias may explain why the mean lengths of both species are larger in this study than they were in the study at Pond Inlet by Finley & Gibb (1982).

Food intake has been underestimated in this study because of reduced otolith lengths or complete disappearance of otoliths due to digestion. Only one of the stomachs from which contents were sampled – that of a 4.3 m male taken on 3 August 1984 – contained a substantial amount of food remains (32 kg).

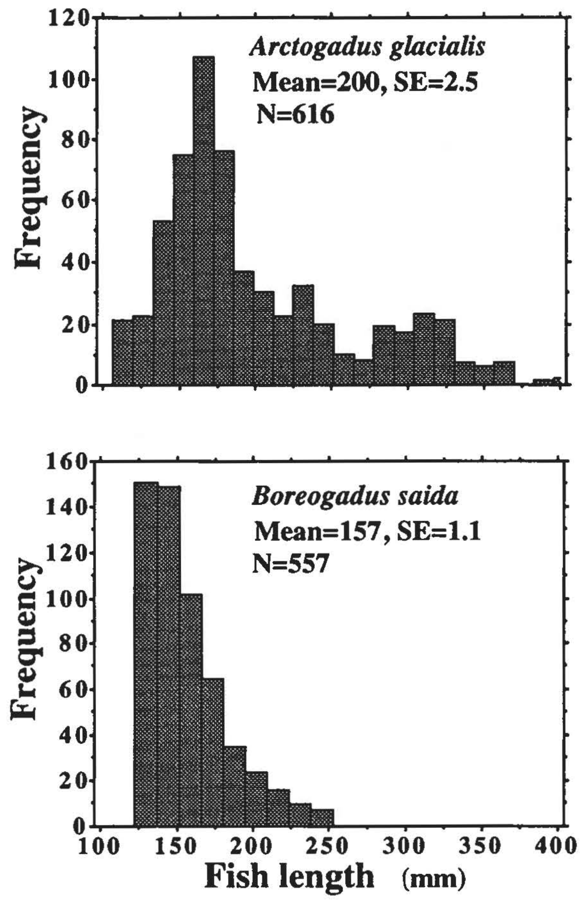


Fig. 3. Length distribution of polar cod (*Boreogadus saida*) and arctic cod (*Arctogadus glacialis*) calculated from otoliths retrieved from stomach samples of narwhals from Inglefield Bredning.

# Discussion

Vibe (1950) stated that narwhals in some parts of the municipality of Avanersuaq fed equally often on polar cod and Greenland halibut (*Reinhardtius hippoglossoides*) and that crustaceans were important in the diet as well. Meldgaard & Kapel (1981) found polar cod and *Gonatus fabricii* in an adult male narwhal from Melville Bugt.

The dominant food species (64%) in our sample was arctic cod. This species constituted a smaller percentage (ice edge: 1.4%, ice cracks: 23.6%, open water: 3.3%) of the narwhal diet in Pond Inlet, northern Baffin Island (Finley & Gibb 1982). The other identified gadid species, polar cod, constituted 15% in Inglefield Bredning, compared with 55.1%, 15.3% and 94.5% in the three respective habitats of Pond Inlet (Finley & Gibb 1982).

Halibut was not found at all in our study, which was also the case for the open-water samples in Pond Inlet (Finley & Gibb 1982). However stomachs from animals caught at the ice edge and in ice cracks contained 31.8% and 55.0% wet weight of halibut, respectively, in the Pond Inlet area (*Ibid.*). Bruemmer (1971) observed halibut in the stomachs of narwhals taken in Inglefield Bredning in 1971 and reported evidence that halibut were abundant in the area at the time of his visit. Many hunters have recently told us that narwhals eat halibut, and halibut are caught on longlines in Inglefield Bredning during the winter (Kaj Søby, pers. comm. 1988). In a recent investigation of local knowledge in Northwest Greenland 30 out of 32 hunters interviewed in Avanersuaq municipality stated that they had found halibut remains in the stomachs of narwhals (Thomsen 1993). Halibut otoliths are considered less susceptible to digestion than are otoliths of the smaller cods, so halibut otoliths should remain in narwhal stomachs for longer periods than otoliths from polar and arctic cod (*cf.* Finley & Gibb 1982). Inglefield Bredning is the northern limit of the range of the Greenland halibut (Muus 1981), and thus recruitment of this species into Inglefield Bredning could be highly variable from year to year.

*Gonatus fabricii* constituted approximately 1% of the diet of narwhals in Inglefield Bredning. This was less than found in the Pond Inlet area where this cephalopod constituted 16% on average for the three habitats (see above) examined by Finley & Gibb (1982). The cephalopods of the genus *Bathypolypus* could not be identified to species but were probably *Bathypolypus arcticus*, a bottom-dwelling octopus. If this supposition is correct, then we can conclude that narwhals in Inglefield Bredning dive to depths of at least 350 m, which is the minimum depth in the middle of Inglefield Bredning.

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