Foods Utilized by Bowhead Whales Near Barter Island, Alaska, Autumn 1979

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Introduction

Bowhead whales, *Balaena mysticetus*, spend the late spring, summer, and early autumn in the Beaufort Sea (Sergeant and Hoek, 1974). On their northward spring migration they usually begin to pass Point Barrow, Alaska, in the latter part of April (Durham, 1979; Braham and Krogman[1]; Marquette[2]). Their penetration of the spring ice sheet from the central Bering Sea is as much as 3,000 km (Tomilin, 1957). During September and October they again pass Point Barrow on their way into the Chukchi Sea, some at least having moved westward along the Alaskan coast (Braham and Krogman, footnote 1). The latest sighting of a bowhead near Point Barrow in the autumn, of which we are aware, was of one seen on 14 November 1977 (Burns, pers. obs.).

The Beaufort Sea is a region of great seasonal extremes. A cover of ice and snow largely prevents photosynthetic primary production for at least 4 months of the year. A brief period of open water occurs each summer, the duration and geographical extent of which vary greatly from year to year. In spite of such conditions, which would appear not to favor regular production of large plankton stocks, several species of animals, including the bowhead whale, use the Beaufort Sea as a summer-early autumn feeding area.

It is not known whether bowheads feed during winter while they are in the Bering Sea. They feed only little or not at all during their spring migration (Johnson et al., 1966; Marquette, footnote 2; Foote[3]). Intensive feeding occurs during summer and autumn in the eastern Arctic (Scoresby, 1820) and indeed in Alaskan waters the only whale stomachs which contained appreciable amounts of food have been taken during the autumn whaling season (Lowry et al., 1978). Large aggregations of bowheads, which appeared to be feeding, have been seen nearshore east of Point Barrow in September (Braham and Krogman, footnote 1; Burns, pers. obs.). Intensive feeding presumably occurs while the whales are in the Beaufort Sea. The quantities and kinds of available food in this region must be adequate to meet immediate bioenergetic requirements of whales and to provide reserves for periods of reduced feeding.

There are no published accounts of what foods are utilized by bowheads in the Beaufort Sea east of Point Barrow. We have recently acquired and examined samples of stomach contents from five of these animals taken between 20 September and 11 October 1979 near Barter Island, Alaska.

Methods

In the field, samples ranging in volume from about 200 to 2,500 ml were randomly collected from the whales' stomachs. From the whale designated as 79-KK-5, an additional nonrandom sample was taken which included primarily large, unusual appearing items. With the exception of whale 79-KK-1, which was recovered 2 days after it was struck, samples were collected within a few hours of the time the whale was killed and landed. Samples were labeled, preserved in a 10 percent Formalin[4] solution, and delivered to Fairbanks, Alaska.

In the laboratory, a 100 ml aliquot of each sample was taken for possible future fatty acid content analysis. The remainder of the samples were drained and gently washed on a 1.00 mm mesh sieve. The stomach contents were then sorted macroscopically into major taxonomic groups, and the volume of each group was determined. The items in each group were examined microscopically when necessary and identified to species if possible. The number of individuals and total volume of each prey species were determined and the lengths of representative specimens were measured. In the case of abundant, small organisms such as copepods, the volume and number of the various species were estimated from subsamples.

Results

Based on the quantities and condition of the stomach contents, all five whales were feeding at the time they were killed. Estimated total volume of stomach contents varied from 19 to 45 l (5-12 gallons). A summary of the species present, approximate abundance in each sample, and those previously reported as food items in whales taken off northern Alaska are presented in Table 1. Copepods were found in all five samples and were the dominant food item in three. *Calanus hyperboreus* was by far the most commonly eaten species. The stomach contents of whale 79-KK-4 were in particularly good condition. In that whale most of the *C. hyperboreus* eaten were copepodid Stage V. Euphausiids, almost exclu-

[1]Braham, H., and B. D. Krogman. 1977. Population biology of the bowhead (*Balaena mysticetus*) and beluga (*Delphinapterus leucas*) whale in the Bering, Chukchi, and Beaufort Seas. Processed rep., 29 p. Natl. Mar. Mammal Lab., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way N.E., Bldg. 32, Seattle, WA 98115.

[2]Marquette, W. M. 1977 The 1976 catch of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos, with a review of the fishery, 1973-76, and a biological summary of the species. Processed rep., 80 p. Natl. Mar. Mammal Lab., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way N.E., Bldg. 32, Seattle, WA 98115.

[3]Foote, D. C. 1964. Observations of the bowhead whale at Point Hope, Alaska. Unpubl. manuscr., 78 p. Geogr. Dep., McGill Univ., Montreal, Que., Can.

[4]Reference to trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Table 1.—Food items from bowhead whale stomach samples collected at Kaktovik, Barter Island, Alaska, September-October 1979.

Food item	Whale specimen number					Food item	Whale specimen number				
	79-KK-1	79-KK-2	79-KK-3	79-KK-4	79-KK-5		79-KK-1	79-KK-2	79-KK-3	79-KK-4	79-KK-5
Copepods						*Monoculoides* c.f. *M. schneideri*	—	—	X	X	—
Calanus finmarchicus	—	—	—	XX	—	*Munnopsis* c.f. *M. typica*	—	—	X	—	—
Calanus hyperboreus	XXX	XXX	XX	XXX	XX	*Onisimus glacialis*	—	X	—	—	—
Chiridius obtusifrons	—	—	—	XX	—	*Onisimus litoralis*	-X	—	—	—	—
Heterorhabdus sp.	—	XX	—	XX	—	*Rozinante fragilis*[1]	—	—	—	X	—
Metridia lucens	—	XX	—	XX	—	*Weyprechtia heulgini*	—	—	—	X	*
Euphausiids						Family Lysianassidae	X	—	—	—	—
Thysanoessa raschii[1]	—	XX	XXX	XX	XXX	Shrimps					
Thysanoessa inermis	—	—	—	—	X	*Eualus gaimardii*	—	—	—	X	—
Mysids						*Sabinea septemcarinata*	—	—	—	X	—
Mysis litoralis	—	XX	XX	—	XX	Family Crangonidae	X	—	—	—	—
Hyperiid amphipods						Unidentified	—	X	—	—	—
Hyperia medusarum	—	X	—	—	—	Isopods					
Hyperia sp.	X	—	—	—	—	*Saduria entomon*	—	—	—	—	X
Parathemisto abyssorum[1]	—	—	XX	—	—						
Parathemisto libellula[1]	X	X	X	X	*	Cumaceans					
						Diastylis sp.	—	—	—	X	—
Gammarid amphipods						Fishes					
Acanthostepheia behringiensis[1]	—	—	X	—	*	*Boreogadus saida*	—	X	—	—	*
Acanthostepheia incarinata	—	X	—	—	—	*Myoxocephalus quadricornis*	—	—	X	—	*
Apherusa glacialis	—	—	—	X	—	*Pungitius pungitius*	—	—	—	—	*
Atylus carinatus	—	—	X	—	X	Unidentified	—	—	—	X	—
Gammaracanthus loricatus	—	—	X	—	*						
Gammarus sp.[1]	—	X	—	—	—	Pebbles	X	—	—	—	X

XXX = dominant item in sample.
XX = more than 10 individuals in sample.
X = 1-10 individuals in sample.
* = present in qualitative sample only.
[1]Indicates previously reported food items of bowhead whales from northern Alaska (Lowry et al., 1978; Marquette, 1979).

sively *Thysanoessa raschii*, occurred in four samples and were dominant in two. *Mysis litoralis* was common in three samples. Although at least 22 other prey species were identified, none were major components of the food. The majority of identified species were amphipods, most of which are benthic forms.

A quantitative summary of the major prey types found in the samples is shown in Table 2. In addition to the proportion of each sample which was comprised of each prey type, an overall mean percentage of contents was calculated for each prey type based on the volume of subsamples, the proportion of prey types in the subsamples, and the estimated total contents of each stomach. Copepods and euphausiids in combination made up 91.2-99.7 percent of the contents of all subsamples. The relative importance of these two prey types varied markedly from over 99 percent copepods in whales 79-KK-1 and 79-KK-2, to almost 98 percent euphausiids in 79-KK-5. In the overall composition of the food, copepods were more important in terms of volume than were euphausiids. All other food types were insignificant in terms of overall volume consumed.

Table 2.—Quantitative composition of stomach contents from bowhead whales collected at Kaktovik, autumn 1979. For each whale, numbers indicate percent of the sample volume comprised of each prey type.

Prey type	Whale specimen number					Overall mean percent of contents[1]
	79-KK-1	79-KK-2	79-KK-3	79-KK-4	79-KK-5	
Copepod	99.7	99.0	23.4	88.3	<0.1	59.8
Euphausiid	—	0.3	67.8	4.9	97.9	37.2
Mysid	—	0.3	7.0	—	0.8	0.2
Hyperiid amphipod	<0.1	0.1	0.5	0.4	—	0.1
Gammarid amphipod	0.1	0.1	0.3	2.4	0.1	0.4
Other invertebrate	<0.1	<0.1	—	2.3	1.1	0.6
Fish	<0.1	0.1	1.0	1.7	—	0.4
Sample volume (ml)	2,406.2	545.2	399.7	131.3	357.9	
Estimated total volume of contents (gallons)	12	5	6	5	10	

[1]The overall mean percent of contents was calculated based on the volume and percent composition of each sample and the estimated total contents of stomachs from which the samples were taken.

Discussion

The samples of stomach contents just described constitute the only data available on bowhead whale foods in the eastern portion of the Alaskan Beaufort Sea. Two whales taken at Barrow in September 1976 had eaten mostly euphausiids (Lowry et al., 1978). The principal euphausiid species (*Thysanoessa raschii*) found in whales taken at Kaktovik was the same as that found in the whales taken at Barrow. This species is widely distributed in Arctic waters (Geiger et al., 1968) and is of greatest abundance in the nearshore neritic zone (Nemoto, 1966). A whale taken at Barrow in May 1977 had eaten mainly copepods (Marquette, 1979). None of the copepod species eaten at Kaktovik were found in the whale taken at Barrow. This is particularly interesting since the main species eaten at

Barrow (*Calanus glacialis* and *Metridia longa*) and Kaktovik (*Calanus hyperboreus*) are all considered to be widely distributed in surface waters of the Arctic Ocean (Grainger, 1965). It is probable that copepods and euphausiids are, overall, the most important bowhead foods in the Beaufort Sea. Mysids and hyperiid amphipods also are concentrated in some regions and may be locally important foods.

A large number of prey species were identified from the Kaktovik whales. Mysids, isopods, and cumaceans were not found among the Barrow specimens. The only previous indication that fishes might be eaten by bowheads was a fish scale in specimen 77-B-5 (Marquette, 1979). Fishes representing three species were found in the whales taken at Kaktovik. In addition, at least 10 species of amphipods and 2 species of shrimp were first recorded as bowhead prey in these samples.

Although organisms such as gammarid amphipods, fishes, and isopods are apparently not major foods of bowheads in terms of quantities consumed, their presence in the stomach contents is of some significance. The presence of pebbles and bottom dwelling species indicates that all the whales taken at Kaktovik had fed at least partially near the sea floor. Pelagic prey far outnumbered the benthic organisms. Therefore, a feeding dive probably involves swimming obliquely from surface to bottom and back, feeding the entire time. *Saduria entomon* has not been found deeper than 44 m in the Beaufort Sea (McCrimmon and Bray, 1962). *Myoxocephalus quadricornis* and *Pungitius pungitius* are characteristic of coastal fresh and brackish water (Andriyashev, 1954; Walters, 1955). Therefore, at least whales 79-KK-3 and 79-KK-5 had fed in relatively shallow, nearshore waters.

Although exploration and development of Beaufort Sea hydrocarbon reserves are underway in Canadian waters and imminent off Alaska, the potential effects of such activities on foods of bowhead whales and food webs of the Beaufort Sea are impossible to predict at this time. The only major bowhead prey species which has been tested for hydrocarbon sensitivity is *Calanus hyperboreus*. This species was found to be "surprisingly resistant to all of the oils tested" (Percy and Mullin, 1975). Hydrocarbon sensitivity data for other key species in the Beaufort Sea food web such as other copepods; Arctic cod, *Boreogadus saida*; euphausiids; mysids; and hyperiid amphipods are urgently needed.

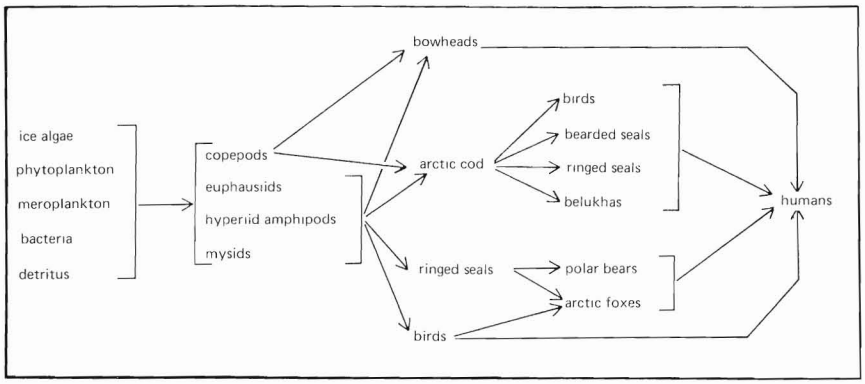

Figure 1.—Diagrammatic representation of major trophic connections in the pelagic food web of the western Beaufort Sea.

In the Alaskan Beaufort Sea, bowheads depend primarily on a pelagic food web (Fig. 1). Arctic cod feed primarily on copepods in offshore (greater than 40 m deep) waters during summer (Frost et al.[5]). During the summer, ringed seals, *Phoca hispida*, feed mostly on euphausiids, hyperiid amphipods, and mysids (Lowry et al.[6], 1978). Ringed seals and Arctic cod are probably the most significant trophic competitors of bowhead whales in the Beaufort Sea. Changes in populations of these competing species, whether natural or caused by Alaska Outer Continental Shelf oil and gas development activities, may affect the size and recovery rate of the bowhead population.

[5]Frost, K. J., L. F. Lowry, and J. J. Burns. 1978. Offshore demersal fishes and epibenthic invertebrates of the northeastern Chukchi and western Beaufort Seas. Appendix to: Trophic relationships among ice inhabiting phocid seals. Annu Rep. RU 232, 39 p. U.S. Dep. Commer., Natl. Oceanic Atmos. Admin., Outer Continental Shelf Environmental Assessment Program, Boulder, Colo.

[6]Lowry, L. F., K. J. Frost, and J. J. Burns. 1979. Trophic relationships among ice-inhabiting phocid seals. Final Rep. Beaufort Sea Activities, RU 232, 55 p. U.S. Dep. Commer., Natl. Oceanic Atmos. Admin., Outer Continental Shelf Environmental Assessment Program, Boulder, Colo.

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Some Observations on Urine From a Bowhead Whale

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The analysis of urine is an essential part of any examination of an animal to determine its health status. This is true especially when (for purposes of comparison) there is a large store of data about urine of the species in question. The urine of the bowhead whale, *Balaena mysticetus*, has apparently not been examined.

On 18 May 1978 a urine sample identified as having originated from a bowhead whale, designated by the National Marine Fisheries Service as #78B2, was presented to this laboratory. The urine was obtained by cystocentesis from a male about 8.4 m in length, taken by Eskimo hunters on 2 May 1978 at Barrow, Alaska. The urine was refrigerated until 6 May, then frozen. On 15 May the frozen specimen was prepared for shipment. Unforeseen delays during shipment allowed the urine to thaw by the time it reached this laboratory. Findings are presented here not only for general information but also as a small contribution to the data concerned with the biology of this endangered species.

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Results and Discussion

On routine clinical urinalysis the following observations were made. The urine was dark amber, clear, and had no odor. The pH was 5.5, and the specific gravity (SG) was 1.032; there was a trace of protein; and the tests for ketones, glucose, reducing substances, bile pigments, hemoglobin, and urobilinogen were negative. Microscopic examination of the sediment revealed a few red and white cells, but no casts; however, there were myriads of epithelial cells (some were cornified), and there were some bladder transitional cells and caudate cells. There were many unidentified spheroid crystals (probably urates), and there were also occasional oxalate crystals as well as a few triple phosphate crystals.

On further analysis the following results were obtained: Sodium ion 183 meq/l, potassium ion 14.4 meq/l, chloride ion 433 meq/l, osmolality 1,440 milliosmols/l, creatinine 400 mg/dl, urea N 3,000 mg/dl. The amino acid pattern obtained can be seen in Table 1 and is similar to that seen in adult mammals such as the dog. The

Table 1.—Amino acid content of urine from a bowhead whale.

Amino acid	Nanomoles/mg creatinine
Threonine	31
Serine	28
Asparagine	99
Glutamine	32
Proline	64
Glutamic acid	11
Glycine	84
Alanine	43
α Aminoadipic acid	14.5
α Amino-n-butyric acid	17
Valine	18
Half cystine	115
Cystathionine	25
Methionine	10
Isoleucine	Trace
Leucine	18
Tyrosine	29
Phenylalanine	10
Ornithine	Trace
Lysine	17
1-Methylhistidine	Trace
Histidine	16
3-Methylhistidine	Trace
Arginine	Trace
Trimethyl lysine	204
NN dimethylarginine	31
N'N dimethylarginine	24