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ABSTRACT

This report gives a preliminary account of the analysis of stomach contents of seabirds collected in ice-filled waters in the Eastern parts of Svalbard during the "Lance"-expedition in summer 1984.A total of 40 seabirds of 7 species were collected.The dominating seabirds were Fulmars Fulmarus glacialis and Kittiwakes Rissa tridactyla,with 8 and 18 individuals respectively.The results confirm earlier investigations and state that Arctic Cod Boreogadus saida and different crustaceans,both pelagic and epibenthic forms associated to the sea ice are the main prey species of the seabirds.Fulmars also depend on polychaetes and squid.

INTRODUCTION

During the period 17 July to 14 August 1984 Norsk Polarinstitutt conducted a cruise onboard the research vessel M/S Lance in the marginal ice zone areas in Eastern Svalbard waters (Larsen 1984). The cruise was a part of the new research program called "Pro Mare" (Norwegian Research Program for Marine Arctic Ecology). Norsk Polarinstitutt is responsible for a seabird ecology project in Pro Mare.During the present cruise seabirds were collected to determine the trophic relationship between seabirds and marine invertebrates in the marginal ice zone.This is a continuation of the work performed by Mehlum & Gjertz (1984) on a similar cruise in 1982.

MATERIAL AND METHODS

A total of 40 specimens of 7 seabird species were collected during the cruise.A detailed account of the dates and geographical locations is given in Appendix 1.The birds were shot from the sea ice or from rubber boat.Actively feeding birds were prefered,but most specimens were collected while flying.

Immediately after shooting the birds were disected and their stomach and oesophagus removed and conserved in 70% ethyl alcohol. Some samples were frozen at -20^{0}C for later analysis of energy, protein and fat content,which will be reported elsewhere.

The material was analyzed at the University of Oslo.The stomach/ oesophagus contents were washed onto a 0.5mm sieve.All items were then sorted to the lowest possible taxonomic level by using available keys and,when possible,reference specimens.Identification of prey was primarily based on fish otoliths,squid beaks,polychaete jaws,crustacean exoscéletons and intact specimens.

All otoliths were counted,but only Arctic Cod (Boreogadus saida) otoliths were measured to the nearest 0.1mm using a microscope with a measuring ocular and a magnification of 12.5x. Two otoliths

differing less than 0.2mm in length were considered to be from the same fish.Numbers of fish ingested were estimated as half the number of otoliths within mm length categories.By using the relationship between otolith size and body size it was possible to estimate the size of Arctic Cod ingested.This was done according to Frost & Lowry (1981) where fish length = 2.198x + 1,588 (x is the length of the otolith in mm).

Crustaceans in each stomach were counted,or when present in large quantities their numbers were estimated from suitable subsamples.When whole crustaceans were encountered their lengths were measured to the nearest 0.1mm using a microscope with a measuring ocular and either 12.5x or 60x magnification.The lengths of their posterior parts were measured according to Bradstreet (1980).

The number of polychaetes ingested was determined as half the number of polychaete jaws present in the stomach sample.

The number of squid ingested was determined by counting the lower beaks present in a stomach sample.

Wet weights of all prey samples were determined with the aid of an electronic scale.Weights of items weighing less than 0.1g were disregarded and the items just noted as being present in the sample.

RESULTS

A list of all distinguishable stomach contents for each bird species is given in Table 1.

Bird species account

Black Guillemot Cepphus grylle

Both birds had distinguishable stomach contents (Tab.2). Arctic Cod and the amphipod Gammarus wilkitzkii were the only prey found.

Brünnich's Guillemot Uria lomvia

All three birds had eaten considerable amounts of Parathemisto libellula (Tab.3),other prey items of significance were not found.

Fulmar Fulmarus glacialis

Seven of the eight birds had distinguishable stomach contents (Tab.4).The squid Gonatus fabrici,Arctic Cod and Natantia indet. were the most common prey,but wet weights of significance were not found.

Ivory Gull Pagophila eburnea

Three of the four birds only contained Arctic Cod,while the fourth contained remains of mammal bones/flesh (Tab.5).

Kittiwake Rissa tridactyla

All birds contained fish remains.Arctic Cod was found in 16 of the 18 birds and was the major prey item,both in numbers and by wet weight,found (Tab.6).

Little Auk Alle alle

All three birds were,with the exception of a few fish bones in one bird stomach,empty.

Pomarine Skua Stercorarius pomarinus

All three birds contained remains of fish,of which Arctic Cod were the most numerous (Tab.7).

Table 1

Summary table of prey species found in the different species of seabirds. Numbers indicate how many stomachs in which each item was present. (n=number of birds checked).

Bird species (n) \ Prey species	Empty	Indet.	Hydrocarbon/plastic	*Nereis irrorata*	*Gonatus fabrici*	*Parathemisto libellula*	*Gammarus wilkitzkii*	Natantia indet.	*Bythocaris simplicirostris*	Pisces indet.	*Boreogadus saida*	Cottidae	Blennidae	*Sebastes marinus*	Mammalia
Kittiwake (18)				1				1	2	9	16	1	1	2	
Fulmar (8)		4	4	2	4	1		3		2	4	1			
Ivory Gull (4)		1									3				1
Brünnichs guillemot (3)		1				3				1	1				
Little auk (3)	2									1					
Black Guillemot (2)							1				2				
Pomarine Skua (2)										2	2	1			
No.birds with item present	2	6	4	3	4	4	1	4	2	15	28	3	1	2	1
Occurrence %	5	15	10	7.5	10	10	5	10	5	37.5	70	7.5	5	10	5

Prey size

Arctic Cod

The length of otoliths found in the different bird species is given in Table 8. Only in Kittiwakes and Black Guillemots were enough otoliths found to enable frequency distribution of otolith sizes to be made. Such a frequency distribution indirectly reveals the size range of Arctic Cod ingested by Kittiwakes (Fig.1) and by Black Guillemots (Fig.2). The average otolith size of Arctic Cod ingested by Kittiwakes (4.11mm $\pm$ SD 0.88) corresponds to a fish size of 10.6 cm (Frost & Lowry 1981), with individuals ranging from 7.7 to 17.0 cm. Similarly Black Guillemots on average ingested Arctic Cod of 9.7 cm ranging from 4.9 to 13.2 cm.

Sizes of otoliths found in each bird species were compared with those found in other species. Only between Black Guillemots and Ivory Gulls and between Black Guillemots and Pomarine Skuas were any significant differences found in the sizes of ingested otoliths, those from Black Guillemots being smaller than those from Ivory Gulls and Pomarine Skuas (Mann-Whitney - U-test, $p < 0.05$).

Crustaceans

Few crustaceans were found in the investigated birds (Tab.1). Only in one Black Guillemot and in the Brünnich's Guillemots were measurable crustaceans found. These were G.wilkitzkii (Tab.9) and P.libellula (Tab.10). Tail lengths given are measured according to Bradstreet (1980).

P.libellula was the most numerous amphipod found in this study. A size frequency distribution for P.libellula ingested by Brunnich's Guillemots (Tab.10) is given in Fig.3. This resulted in a mean length of 31.5mm $\pm$ SD 3.9 for the subsample of 27 P.libellula measured out of the total 190 present.

Table 2

Black Guillemot stomach content analysis.

Bird no.	*Gammarus wilkitzkii*	*Boreogadus saida*
28		6
29	6	18
Total no. of items	6	24
Frequency %	20	80
No of birds with taxon	1	2
Occurrence	33.3	66.7
Wet weight	1.6	15.8
% of total	9.2	90.8

Table 3

Brünnich's Guillemot stomach content analysis.

Bird no.	Indet.	*Parathemisto libellula*	Pisces indet.	*Boreogadus saida*
6		97		
9		63		
10	x	30	x	1
Total no.of items	x	190	x	1
Frequency %	-	99.5	-	o.5
No.of birds with taxon	1	3	1	1
Occurrence	33.3	100	33.3	33.3
Wet weight	-	43	-	-
% of total	-	99.9	-	-

Table 4

Fulmar stomach content analysis.

Bird no.	Indet.	Nereis irrorata	Gonatus fabrici	Parathemisto libellula	Natantia indet.	Pisces indet.	Boreogadus saida	Cottidae	Plastic/hydro-carbons
7		1					1		x
8	x					4			x
11		4	5				4	1	
21			2				1		x
26	x								
27			2		2	2			x
30	x		3		x		1		
31				x	x				
Total no.of items	x	5	12	x	2	6	7	1	x
Frequency %	-	15.2	36.3	-	6.1	18.2	21.2	3	-
No.of birds with taxon	3	2	4	1	3	2	4	1	4
Occurrence %	37.5	25	50	12.5	37.5	25	50	12.5	50
Wet weight	0.4	-	1.4	0.4	1.3	-	0.1	-	-
% of total	10.6	-	38.1	11.4	36.1	-	2.8	-	-

Table 5

Ivory Gull stomach content analysis.

Bird no.	Indet.	Boreogadus saida	Mammalia indet.
4		4	
13	x		x
33		2	
34		2	
Total no.of items	x	8	x
Frequency %	-	100	-
No.of birds with taxon	-	3	-
Occurrence %	25	75	25
Wet weight	-	16.8	2.3
% of total	-	88.0	12.0

Table 7

Pomarine Skua stomach content analysis

Bird no.	Pisces indet.	Boreogadus saida	Cottidae
5		5	
12	x	7	4
Total no. of items	x	12	4
Frequency %		75	25
No.of birds with taxon	1	2	1
Occurrence	50	100	50
Wet weight	0.9	0.5	-
% of total	64.3	35.7	-

Table 6

Kittiwake stomach content analysis

Bird no.	Indet.	*Nereis irrorata*	Natantia indet.	*Bythocaris simplicirostris*	Pisces indet.	*Boreogadus saida*	Cottidae	Blennidae	*Sebastes marinus*
1						5			
2						3		1	
3	x					2			
14					1	4	1		
15						1			
16					9	4			
17					1	2			
18					1	1			
19					1	9			
20					2	11			
25						1			1
32						3			
35			x		3				
36				1	1				1
37		1		1		5			
38					3	1			
39						3			
40						2			
Total no.of items	x	1	x	2	22	57	1	1	2
Frequency %	-	1.3	-	2.3	25.6	66.3	1.2	1.2	2.3
No.of birds with taxon	1	1	1	2	9	16	1	1	2
Occurrence %	5.5	5.5	5.5	11.1	50	88.9	5.5	5.5	11.1
Wet weight	-	-	0.1	1.3	2.1	45.0	-	-	-
% of total	-	-	0.2	2.7	4.3	92.8	-	-	-

Table 8

Size of whole Arctic cod *Boreogadus saida* otoliths found in different bird species. Each measurement represents one fish. Two otoliths that differed less than 0.2mm in length were considered to be from the same fish and their mean size noted. All sizes are in mm. (M= mean).

Kittiwake	Black Guillemot	Ivory Gull	Fulmar	Pomarine Skua	Brünnich's Guillemot	Little Auk
2.8 4.1 3.0 4.1 3.3 4.1 3.4 4.2 3.4 4.3 3.4 4.4 3.5 4.5 3.5 4.6 3.5 4.8 3.5 4.8 3.6 4.9 3.8 5.0 3.8 6.0 3.9 7.0 4.0	1.5 3.8 2.7 3.9 3.0 4.0 3.1 4.0 3.2 4.1 3.3 4.6 3.3 4.9 3.3 5.2 3.4 5.3 3.5 3.5 3.5 3.7 3.7 3.8	3.3 3.7 3.7 4.2 4.6 4.6 4.7 5.7	3.5 3.6 4.1 4.1 4.3 4.3 4.3	3.7 3.7 4.0 4.1 4.3 4.5 4.5 4.6 4.9 4.9	5.2	-
n=29 M=4.11 SD=0.88	n=24 M=3.68 SD=0.81	n=8 M=4.31 SD=0.76	n=7 M=4.03 SD=0.34	n=10 M=4.32 SD=0.44	-	-

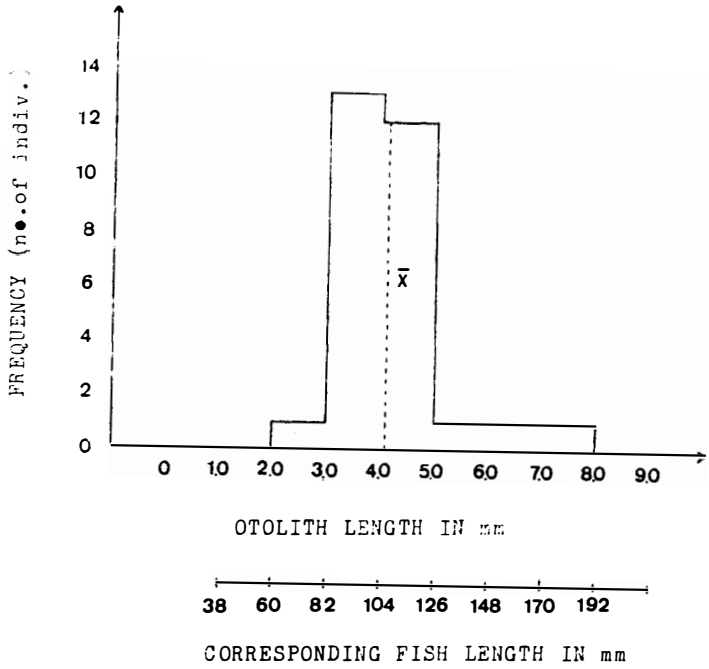

Fig.1
Frequency distribution of lengths of otoliths from Arctic Cod found in Kittiwakes.Mean value ($\bar{x}$) indicated.N=29

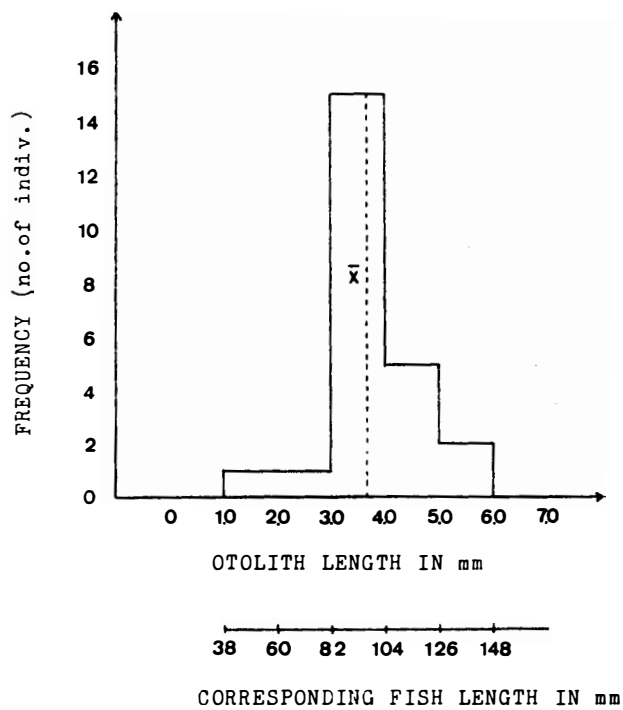

Fig.2
Frequency distribution of lengths of otoliths from Arctic Cod found in Black Guillemots.Mean value ($\bar{x}$) indicated.N=24

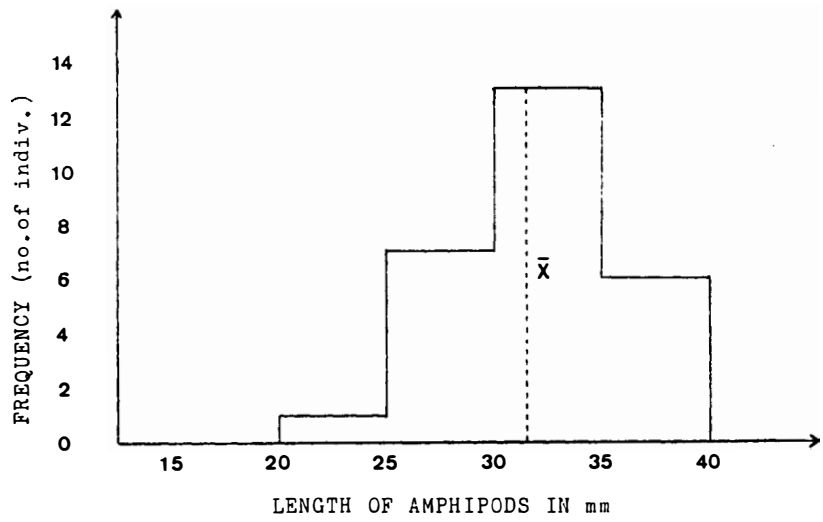

Fig.3
Frequency distribution of lengths of P.libellula found in Brünnich's Guillemots.Mean value($\bar{x}$) indicated.N=27

Table 9
Measurements of G.wilkitzkii from Black Guillemot stomachs.Lengths in mm.

Bird no.	Total no.in sample	Measurable	No.measured	Total length (tail length)
29	6	3	3	26.5(5.0) 26.0(5.0) 32.0(6.0)

Table 10
Measurements of P.libellula from Brünnich's Guillemot stomachs.Lengths in mm.

Bird no.	Total no.in sample	Measurable	No.measured	Total length (tail length)
6	97	70-80	10	38(10.3) 30(7.4) 32(9.0) 32(8.8) 31(8.3) 24(6.7) 28(7.9) 31(8.1) 27(7.6) 37(10.0)
9	63	30-40	10	33(8.5) 25(7.3) 29(7.8) 33(7.9) 28(8.0) 32(8.3) 35(9.2) 28(7.5) 30(8.2) 34(9.1)
10	30	7	7	36(-) 37(9.5) 26(6.7) 30(8.6) 38(10.2) 34(9.4) 32(8.6)

DISCUSSION

The present material confirms the findings from 1982,that the main summer prey of seabirds in ice-filled waters in Eastern Svalbard are Arctic Cod and different species of crustaceans (Mehlum & Gjertz 1984).The crustaceans consist of both pelagic and epibenthic forms associated with sea ice.The sample sizes of most species are to low to make it possible to determine the diet of the seabirds in the investigated area.However the material collected gives valuable additional information to the study by Mehlum & Gjertz (1984).Sampling will continue in future years to get a more complete picture of the summer diet of these seabirds.

In summer 1984 there was exceptionally little sea ice in the Barents Sea.The marginal ice zone was located north of 81° N in the Eastern Svalbard area.The main part of the bird samples were therefore collected about 2° further north than compared with 1982.

The Arctic Cod was the dominating prey species in Kittiwakes, Black Guillemots,Ivory Gulls and Pomarine Skuas,while in Fulmars the polychaete Nereis irrorata and the squid Gonatus fabrici were also important prey.This is in accordance with Mehlum & Gjertz (1984) and Lydersen et al.(1985).In 50% of the Fulmars investigated small pieces of plastics were found.Plastics are frequently present in stomachs of Fulmars in other areas (Franeker 1983, Lydersen et al.1985) and was also common in the samples from 1982 (Mehlum & Gjertz 1984).

The Arctic Cod in the samples were generally smaller than in the samples from 1982 (Mehlum &Gjertz 1984),according to otolith sizes.The explanation may be that the birds were collected earlier in 1984 than in 1982,or that there may be size differences between populations in the different geographical areas.

In Brünnich's Guillemots Parathemisto dominated the food samples. The sample size consisted of only three birds and may not be representative for the species.However Lydersen et al.(1985) found that Parathemisto was,second to Arctic Cod,the most common prey of Brünnich's Guillemots in Southern Spitsbergen in Autumn.

Two Kittiwakes were found to have eaten Redfish Sebastes marinus.

Since the Redfish is a deepwater species the otoliths found in the two Kittiwakes have probably been ingested as the result of these birds scavanging on wast from trawlers in the area.

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Appendix 1

List of specimens and localities of seabirds collected in Eastern Svalbard/Barents Sea 1984.

No.	Date	Species	Sex	Locality	Position (°N, °E)	
1-84	21.7	Kittiwake	-	St.10	78.40	25.23
2-84	"	"	M	"	"	"
3-84	"	"	F	"	"	"
4-84	"	Ivory Gull	F	"	"	"
5-84	"	Pomarine Skua	M	"	"	"
6-84	"	Brünnich's Guillemot	M	"	"	"
7-84	"	Fulmar	F	"	"	"
8-84	"	"	F	"	"	"
9-84	25.7	Brünnich's Guillemot	M	St.25	79.16	25.09
10-84	"	"	M	"	"	"
11-84	28.7	Fulmar	F	St.69	81.05	26.20
12-84	"	Pomarine Skua	F	"	"	"
13-84	"	Ivory Gull	-	"	"	"
14-84	"	Kittiwake	M	"	"	"
15-84	"	"	F	"	"	"
16-84	"	"	F	"	"	"
17-84	"	"	F	"	"	"
18-84	"	"	M	"	"	"
19-84	"	"	M	"	"	"
20-84	30.7	"	M	St.74	81.14	24.25

Appendix 1 cont.

No.	Date	Species	Sex	Locality	Position (°N , °E)	
21-84	30.7	Fulmar	F	St.74	81.14	24.25
22-84	"	Little Auk	M	"	"	"
23-84	"	"	M	"	"	"
24-84	"	"	M	"	"	"
25-84	"	Kittiwake	F	"	"	"
26-84	31.7	Fulmar	M	"	"	"
27-84	"	"	F	"	"	"
28-84	"	Black Guillemot	F	"	"	"
29-84	"	"	F	"	"	"
30-84	2.8	Fulmar	F	St.132	81.31	27.10
31-84	"	"	M	"	"	"
32-84	"	Kittiwake	M	"	"	"
33-84	4.8	Ivory Gull	-	St.143	81.36	21.12
34-84	"	"	M	"	"	"
35-84	"	Kittiwake	F	"	"	"
36-84	"	"	M	"	"	"
37-84	"	"	F	"	"	"
38-84	"	"	F	"	"	"
39-84	"	"	M	"	"	"
40-84	"	"	-	"	"	"