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PRELIMINARY DATA ON FEEDING AND CONDITION OF BARENTS SEA HARP SEALS *(PHOCA GROENLANDICA)* THROUGHOUT THE YEAR

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ABSTRACT

In order to evaluate the ecological role of the most abundant seal species in the Barents Sea, the harp seal *Phoca groenlandica*, field studies have been carried out in September 1990, in February, March/April, June and September 1991, and in March and April 1992.

From examinations of stomach samples (data from 1991 only), it appears that the harp seals sampled had not been feeding either in March/April in the commercial hunting areas (the southeastern parts of the Barents Sea, also called the East Ice) or in the pack ice belt in the Barents Sea in the first half of June. Concurrent estimates of prey abundance using trawl gear in the areas where seals were captured in June, revealed virtually no presence of potential prey in the water column, whereas prawns *Pandalus borealis*, capelin *Mallotus villosus* and polar cod *Boreogadus saida* were abundant in considerable amounts along the bottom.

In September 1991, in the northern pack-ice areas of the Barents Sea, the seal diet consisted mainly of the pelagic amphipod *Parathemisto libellula*, krill and prawns and, to a lesser extent, fish species such as polar cod, sculpins (Cottidae) and snailfish (Liparidae). Trawling revealed large amounts of *P. libellula* in the upper layers of the water column. The fish fauna, mainly capelin and polar cod, was less abundant and occurred mainly along the bottom.

Studies of condition (data from all survey periods) revealed that the harp seals were very fat in September, with dorsal blubber thicknesses often exceeding 75 mm in adult specimens. In June, the seals were very lean with dorsal blubber thickness of less than 20 mm. In winter the thickness of the dorsal blubber was observed to be intermediate the September and June thicknesses (30-50 mm).

INTRODUCTION

The most abundant seal species in the Barents Sea, the harp seal (Phoca groenlandica), has traditionally been exploited by Russian and Norwegian sealers in the pack ice areas in the White Sea and southeastern Barents Sea (the East Ice) (Iversen 1927, Yakovenko 1967, Benjaminsen 1979). Despite the controversies connected with sealing operations in recent years, sealing in this area has been maintained by Russian and Norwegian sealers, both because the harp seal is a renewable resource, and because it may be a significant competitor to man for other marine resources. Since 1978, annual invasions of harp seals in coastal waters of North Norway have caused problems for coastal fisheries (Bjørge et al. 1981, Wiig 1988, Haug et al. 1991, Nilssen et al.1991a).

Harp seals are considered to have a considerable potential for predation upon resources in the Barents Sea, and are now implemented in the multispecies model, MULTSPEC, which may form the basis for a more rational future management of marine resources in the area (see Bogstad et al. 1992). In order to evaluate the ecological role of the harp seals in the Barents Sea, field studies have been carried out, primarily aimed at gathering information about the feeding habits and general condition of the animals throughout the year. The sampling design for these field studies are based on data from the literature and our own field observations about the migratory patterns of harp seals in the Barents Sea throughout the year (see Smirnov 1924, Chapskii 1938, 1961, Sivertsen 1941, Popov 1970, Benjaminsen 1979, Wiig 1988, Nilssen et al. 1991b).

Pilot studies of harp seal feeding along the pack-ice edge were carried out by the Institute of Marine Research, Bergen, in autumn 1981-1983 (unpublished data), and continued in 1987 (Lydersen et al. 1991) and in 1990 (Nilssen et al. 1991b). This report presents field studies which were carried out during winter invasions in coastal areas of North Norway, during the commercial sealing season (April) in the East Ice, as well as in

June along the pack-ice belt in the Barents Sea and in September in the feeding areas in the northernmost parts of the Barents Sea. This study included sampling of harp seals for analyses of stomach contents and concurrent estimates of possible prey abundance using trawl gear. Condition parameters from the seals were also collected.

AREA SURVEYED

Winter

In February to April 1991 and March to April 1992, stomachs and condition data from harp seals were collected in coastal areas (Varangerfjord) of North Norway.

During the commercial sealing season in the East Ice (the areas in the southeastern parts of the Barents Sea north of the White Sea), stomachs from harp seals were collected on board the sealer "Melshorn" in the period March 25 to April 16, 1991 (see Fig. 1).

Summer

From June 1st to June 14th 1991, the ice-going vessel "Polarfangst" was chartered to conduct a survey along the pack-ice belt between Novaja Zemlja and Hopen Island. The survey track is shown in Fig. 1. The observations made were confined both to the pack-ice edge and to some distance into the pack-ice belt. The hunting activities were carried out using a smaller motor-boat specially designed for seal-hunting in the pack-ice belt.

Simultaneously with the "Polarfangst" cruise, Norwegian investigations on prawns were carried out in the Barents Sea. On June 8th, R/V "Michael Sars" trawled with bottom trawl in the

same area and simultaneously with the hunting activities of "Polarfangst", and these trawl data are used to estimate the potential food availability for the seals.

Autumn

In September 1991, a survey was conducted in the northernmost part of the Barents Sea with the ice-going vessel "Selis". The vessel left the coast of Norway on August 28 and reached the pack-ice belt in the areas between Kvitøya and Viktoria Island on September 1 (see Fig. 1). "Selis" then operated in the pack-ice belt as far east as 79° 39' N, 40° 48' E until the ship returned towards Norway on September 14. Hunting activities were carried out using two fast moving inflatable boats (15' and fitted with 40 hp outboard motors) along the ice edge and to some distance into the pack-ice belt.

Simultaneously with the "Selis" cruise, the annual, international 0-group fish survey was carried out in the Barents Sea and adjacent waters. This survey included three Norwegian and two Russian research vessels operating in the Barents Sea south of 77° N and west of Spitsbergen (Anon. 1991). Lookout was kept for seals by the wheelhouse crews on this survey.

MATERIAL AND METHODS

Estimation of prey abundance

In winter, during the collection of harp seal material in Varangerfjord, and during the commercial sealing in the East Ice, no estimation of prey abundance was performed. On the two cruises in June and September the abundance of potential harp seal prey was examined by trawling in the same areas where seals were observed and captured.

During the June survey pelagic trawling was carried out by "Polarfangst", while the research vessel "Michael Sars" was trawling with a bottom trawl in the same area, simultaneously with the hunting activites of "Polarfangst". Prey abundance in the pelagial was examined in the surface layers, at about 15 to 20 meters depth and about 40 to 50 meters depth using a pelagic trawl (made by Fiskernes Redskapsfabrikk, Tromsø, Norway) fitted with a fine (6 mm) "tobis" net in the cod end. The bottom trawling was carried out at approximately 322 meters depth using a "Super Campelen" 1800 mesh shrimp trawl with rubber bobbins, 40 m sweep wires, 19.2 m fishing line length, and fitted with a 8 mm "tobis" net in the cod end. All pelagic trawl hauls lasted for one hour, while the bottom trawl hauls lasted 30 minutes. Data from the bottom hauls were extrapolated to standard hauls of one hour duration.

During the September cruise with "Selis", trawling just above the bottom (10 to 20 meters), in distinct echo-layers (at 20 meters depth) and in the surface layers was carried out using a 12 fathom pelagic "capelin" trawl (made by Honningsvåg Fiskeredskap A/S, Honningsvåg, Norway) fitted with a Simrad trawl eye to monitor trawl depths, and with a fine (6 mm) "tobis" net in the cod end. Bottom trawling was not carried out on this survey due to difficult bottom conditions. All trawl hauls lasted one hour.

Approximate volumes of fish, crustaceans, squid and gelatinous plankton were recorded in all trawl hauls. Fish were also identified and counted, in some cases also length measured, and the crustaceans were identified to the lowest possible taxon.

Capture of seals

During winter in Varangerfjord, seals were either shot from land and picked up with rubber boats, or they were taken as bycatches in gill nets in the commercial coast fisheries. Shot animals were

immediately transported to the shore for weighing, body measurements, and dissection, while samples from the seals taken in gill nets were taken as soon as possible after the seals were landed.

During the commercial sealing in March/April in the East Ice, all seals were shot on the ice. The animals were transported to the vessel where stomachs and lower jaws were collected.

During the June survey all seals were shot on ice floes, either from the small boat designed for hunting activities in the pack-ice, or from the vessel. Killed seals were immediately transported to the vessel for weighing, body measurements and dissection.

The harp seals do not haul out on the ice in September. During the "Selis" cruise, therefore, the seals had to be shot in the water, either from ice floes or from inflatable boats. The inflatable boats were also used to pick up the killed seals from the sea. The same samples were collected from the seals on this cruise as during the survey in June.

In all sampling periods, the seal stomachs were frozen for later laboratory examination of the contents. Lower jaws with teeth were collected for age determination of the seals.

Stomach contents analyses

In the laboratory the stomachs were cut open after thawing. The total weight of the stomach contents was recorded. All fresh specimens of fish and crustaceans were identified by gross morphological characteristics. The fish material was separated from the crustaceans, and the weights of each group were recorded.

The total contents of crustaceans, or a subsample from each seal

stomach containing crustaceans, was weighed and analyzed with respect to species composition (see Nilssen et al. 1991b). Total weight and number of individuals was recorded for each species, and this was used to obtain crude estimates of the numerical distribution of each species in the total seal diet. Mean weights of fresh crustaceans, obtained from random samples taken from the trawl catches, were used to obtain crude estimates of the original biomass of the crustaceans eaten by the seals.

The otoliths in the remaining fish material were collected (see Treacy & Crawford 1981, Murie & Lavigne 1985), and identified to the lowest possible taxon, preferably to species (see Breiby 1985, Härkönen 1986). The total number of each fish species was determined by adding the number of fresh specimens, the number of intact sculls and half the number of free otoliths. All otoliths were measured, and otolith length to fish weight correlations were used to estimate the original fish weight.

No feeding index gives a complete or realistic picture of dietary composition, thus, the dietary contribution of different prey items were recorded as: 1) The percentage occurrence of a given dietary component, defined as the percentage of stomachs which contained one or more individuals of this component, 2) the relative frequency of occurrence of a species was calculated as a numerical fraction of total numbers of all prey categories, and 3) the relative frequence of occurrence was also recorded as the relative contribution of each prey species to the total seal diet expressed in terms of calculated fresh weight (i.e., biomass).

Condition measurements

Measurements of blubber thickness were used as an index to evaluate the condition of the seals. The ventral blubber thickness was measured between the front flippers (towards the sternum), and the blubber thickness was also measured dorsally at the mid-line between the front flippers. In Varangerfjord

1991, only the ventral blubber thickness of the seals was measured. In all the other sampling periods, both ventral and dorsal blubber thickness data were collected. Blubber measurements made during studies of harp seal feeding in the pack-ice area in the north Barents Sea in September 1990 (see Nilssen et al. 1991b) are also included in the present analyse.

Age determination

The ages of the seals were determined by incremental growth layers in the dentine of the lower canine teeth, examined in transverse sections using transmitted light (Bowen et al. 1983).

RESULTS AND DISCUSSION

General ice conditions and observations of harp seals

During winter in the ice-free Varangerfjord, most of the harp seals were observed along the shores of both sides of the fjord, but seals were also observed pelagically in the middle and outer parts of the fjord. In periods (a few hours) during the middle of the day, seals were often observed in shallow water, "standing" in a vertical position, with only the snout above the surface, obviously resting. Apparently, Varangerfjord seems to be the western endpoint for the distribution of harp seals in the Barents Sea during winter. Observations made by Russian scientists suggest that harp seals are distributed in considerable number along the entire coast of the Kola peninsula during this part (March) of the year (Andrej Kondakov, Murmansk Marine Biological Institute, Dalnie Zelentsy, Russia, pers. comm.).

During the commercial sealing season in March/April in the East Ice, the seals were observed both in the water and lying on the ice, but always confined to the pack-ice belt.

During the June cruise with "Polarfangst", the ice conditions changed rapidly. Just before the cruise started, the pack-ice belt covered most of the areas to the west of Novaja Zemlja and also some of the areas southwest of Hopen Island. When the vessel arrived the west side of the Novaja Zemlja on June 4th, however, most of the ice had receded and disappeared. When "Polarfangst" reached the areas to the west of Hopen Island on June 11th all ice had disappeared also here. The pack-ice belt was found at about 76° N between Novaja Zemlja and the Hopen Island (Fig. 1). In the areas to the west of Novaja Zemlja, only few scattered harp seals were observed. This was also the general impression gained further west along the pack-ice edge as far west as about 75° 50' N, 36° 00' E. West of this position, smaller groups (up to about 20-25 animals) of harp seals occurred quite frequently. In the areas southeast of Hopen Island, (76° 00' N, 31° 00' E), very large amounts (thousands) of harp seals were observed both on the ice and in the water. Further north and west, again only a few scattered harp seals were observed, and in the open waters west of Hopen Island, no seals were observed. When the vessel left the pack-ice on June 13th, large groups (up to about 100 animals) of harp seals were observed as far south as 75° 27' N, 28° 59' E, these animals were swimming in a north/northeasterney direction towards the areas where the largest seal concentrations were observed.

In September, only a few harp seals were seen in the open waters around Hopen Island. As soon as the vessel arrived at the pack-ice belt in the areas between Kvitøya and Victoria Island (about 80° N, 38° E, see Fig. 1) smaller groups (5-10 animals) were observed. The ice conditions changed rapidly due to strong winds from the north and northeast. The pack ice belt moved southwards as far south as approximately 79° N, 35° E, and became more scattered. Harp seals were observed along most of the surveyed

area at the pack-ice edge and also to some extent into the pack-ice belt. Almost all the harp seals were observed in the water, only 3 or 4 young harp seals were seen lying on ice floes. No harp seals were observed on the vessel's route back to the Norwegian coast, and no harp seals were recorded from any of the research vessels participating in the international O-group fish survey (see Anon. 1991).

Prey abundance - results from the trawl hauls

The data obtained in the trawl surveys have to be evaluated critically with regard to the relative abundance of species at different depths, due to different trawling gear used in the survey periods and also because of different fishing effectivness between pelagic and bottom trawls.

In June, no catches were obtained by pelagic trawling in the upper layers; only a few specimens of krill Thysanoessa spp., the pelagic amphipod Parathemisto libellula and capelin Mallotus villosus were taken in some of the trawl hauls. This was consistent with results from acoustic surveys where no registrations were obtained in the upper layers by the echo-sounder. In the bottom trawl hauls, however, relatively large total catches were taken (about 220 kg in 30 minutes hauls). The prawn Pandalus borealis contributed with about 39 % to the biomass, while the fish species capelin contributed with 41 % and polar cod Boreogadus saida with 10 % to the biomass (see Fig. 2a). Also Sebastes spp., long rough dab Hippoglossoides platessoides, the Atlantic poacher Leptagonus decanonus, Artediellus atlanticus, the sculpin Triglops pingelii and the decapods Sclerocrangon spp. occurred quite frequently in the bottom trawl catches.

In September 1991 trawling confirmed the impression gained during similar investigations in the northern parts of the Barents Sea in 1990 (see Nilssen et al. 1991b). The pelagic amphipod

Parathemisto libellula also dominated both numerically, and in terms of biomass in the trawl catches obtained in the surface and in distinct echo-layers at 20 meters depth (see Fig. 2b). P.libellula was also abundant in considerable quantities in the water layers approximately 20 m above the bottom, but the most dominant species in this layer were krill Thysanoessa spp and capelin. Also the sculpin T.pingelii, polar cod and snailfish Liparis fabricii occured quite frequently in the layers 20 m above the bottom. The echo-depth where the trawl hauls were carried out varied between 230 to 308 m.

Capture of the harp seals

In February to April 1991 in the Varangerfjord, 21 harp seals were obtained (by shooting), and these ranged in age between 2 and 25 years. In March/April 1992 in the same area, data were collected from 44 harp seals. Only preliminary data on age and condition are available from 25 of these seals, and these ranged in age between 3 and 24 years.

During the commercial sealing season in March/April 1991 in the East Ice, 193 harp seals were collected. The collected seals ranged in age between 1 and 31 years.

In June 1991, 239 harp seals were captured. The captured seals ranged in age between about 3 months to 28 years. Three harp seal pups tagged in the White Sea in March 1991 were also captured. During the hunting activities, almost no faeces from the harp seals were observed on the haulting places on the ice floes.

In September 1991, 40 harp seals were captured. These seals ranged in age from approximately 6 months to 20 years. The difficult weather conditions with strong winds and fog hampered the hunting activities considerably.

Harp seal stomach contents

In winter in the Varangerfjord, analyses of the harp seal stomach contents sampled in 1991 revealed that the seals had been eating mainly fish, in particular, capelin, which contributed most to the seal diet both numerically (see Fig. 3a) and when the biomass of the prey orgamisms was considered (see Fig. 3b). Herring Clupea harengus and sandeel Ammodytes spp. were found in quite large amounts, so were codfish and redfish. The prawn Pandalus borealis occurred in about 5 % of the stomachs (see Table 1). These results differ from observations made during the larger harp seal invasions in 1988 in eastern parts of Finnmark (see Haug et al. 1991), which revealed that the seal diet at that time mainly consisted of prawns and codfish and, to a much lesser degree, capelin. However, in 1978 to 1981, the harp seals captured in Finnmark during winter were reported to have eaten mainly capelin (Bjørge et al. 1981). The recent recovery of the Barents Sea capelin stock after the severe collapse in 1985/1986 (Hopkins & Nilssen 1991, Anon. 1992) may have contributed to the increased importance of capelin in the winter diet of the harp seals.

From examinations of the stomach samples collected in March/April 1991 in the East Ice, it is apparent that the seals had practically not been feeding during this period. About 93 % of the stomachs were empty (see Table 1). The others had only fragments of prawn P.borealis and krill Thysanoessa spp.

Examinations of the stomachs collected in June 1991 gave very much the same results as in March/April 1991 in the East Ice (see Table 1). Most of these stomachs (about 86 %) were also empty. Those with contents included fragments from the decapods P.borealis and Sabinea septemcarinata (1.6 % of the stomachs) and otoliths from fish (in about 7 % of the stomachs). The fish species were long rough dab, sculpin T.pingelii, capelin and polar cod. In 7.5 % of the stomachs, unidentified gelatinous contents in fluid form occurred.

The stomach contents analyses of the harp seals collected in September 1991, revealed that the seal diet this year consisted mainly of P.libellula, krill and prawns, but the contribution of fish species was larger this year than in a similar investigation in the same areas in 1990 (see Nilssen et al. 1991b). Polar cod, sculpins (Cottidae spp.) and snailfish contributed with approximately 50 % when the biomass of the prey organisms was considered (see Fig. 4). The contribution of capelin to the eaten biomass was about 3 %.

Blubber thickness

Studies of condition (measurements of ventral and dorsal blubber thickness) in all survey periods revealed that, in September, the harp seals are very fat, with dorsal blubber thickness often exceeding 75 mm in adult specimens (see Fig. 5). In June, the seals are very lean, with dorsal blubber thickness of less than 20 mm. In late winter (March-April) the thickness of the dorsal blubber (about 35 mm) was observed to be somewhere between (about 35 mm) the September and June observations. This suggests that the harp seals have a very intensive feeding period in the summer months (July,August) and in September. The observations of the harp seal condition in winter suggest that the seals also eat quite a lot during late autumn and in winter when they are confined along the western parts of Novaja Zemlja and in the southern parts of the Barents Sea (see Chapskii 1961, Popov 1970). During the breeding season, which starts in the last days of February and lasts to about the middle of March, the adult harp seals eat little or nothing. The feeding behavior of young harp seals in this area is unknown. Observations in Varangerfjord suggest that the seals also feed between the breeding and the moulting period. During the moulting period (April/June), the condition studies and the examination of stomach contents of the seals, suggest that harp seals eat little or nothing.

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Table 1. Frequencies of occurrence of empty stomachs and identified taxa of prey in harp seal stomachs captured in coastal areas of north Norway (Varangerfjord) and in various areas of the Barents Sea during 1991.

Prey item	Percentage occurrence			
	Varanger Feb./Mar. (n=21)	E.-Ice April (n=193)	Hopend. June (n=239)	Kvitøya Sept. (n=40)
Empty stomachs	42.8	93.3	85.8	7.5
Mollusca:				
Cephalopda:				
Gonatus fabricii				7.5
Crustacea:				
Amphipoda:				
Parathemisto libellula				62.5
Gammarus wilkitzki				15.0
Euphausiacea:				
Thysanoessa spp.		0.5		30.0
Decapoda:				
Pandalus borealis	4.8	1.0	0.8	42.5
Sabinea septemcarinata			0.8	20.0
Pisces:				
Clupeidae:				
Clupea harengus	19.0			
Osmeridae:				
Mallotus villosus	19.0		1.3	12.5
Ammodytidae:				
Ammodytes spp.	14.3			
Gadidae:				
Gadus morhua	14.3			
Melanogrammus aeglefinus	14.3			
Boreogadus saida			1.3	30.0
Cottidae:				
Artediellus atlanticus				2.5
Triglops spp.			2.1	55.0
Liparidae:				
Liparis spp.				45.0
Zoarcidae:				
Lycodes spp.				15.0
Pleuronectidae:				
Hippoglossoides platessoides	4.8		0.4	2.5
Platichthys flesus	4.8			
Scorpenidae:				
Sebastes spp.	9.5			5.0
Unident. fish remains	23.8		0.4	17.5
Unident. gelatinous remains		6.7	7.5	

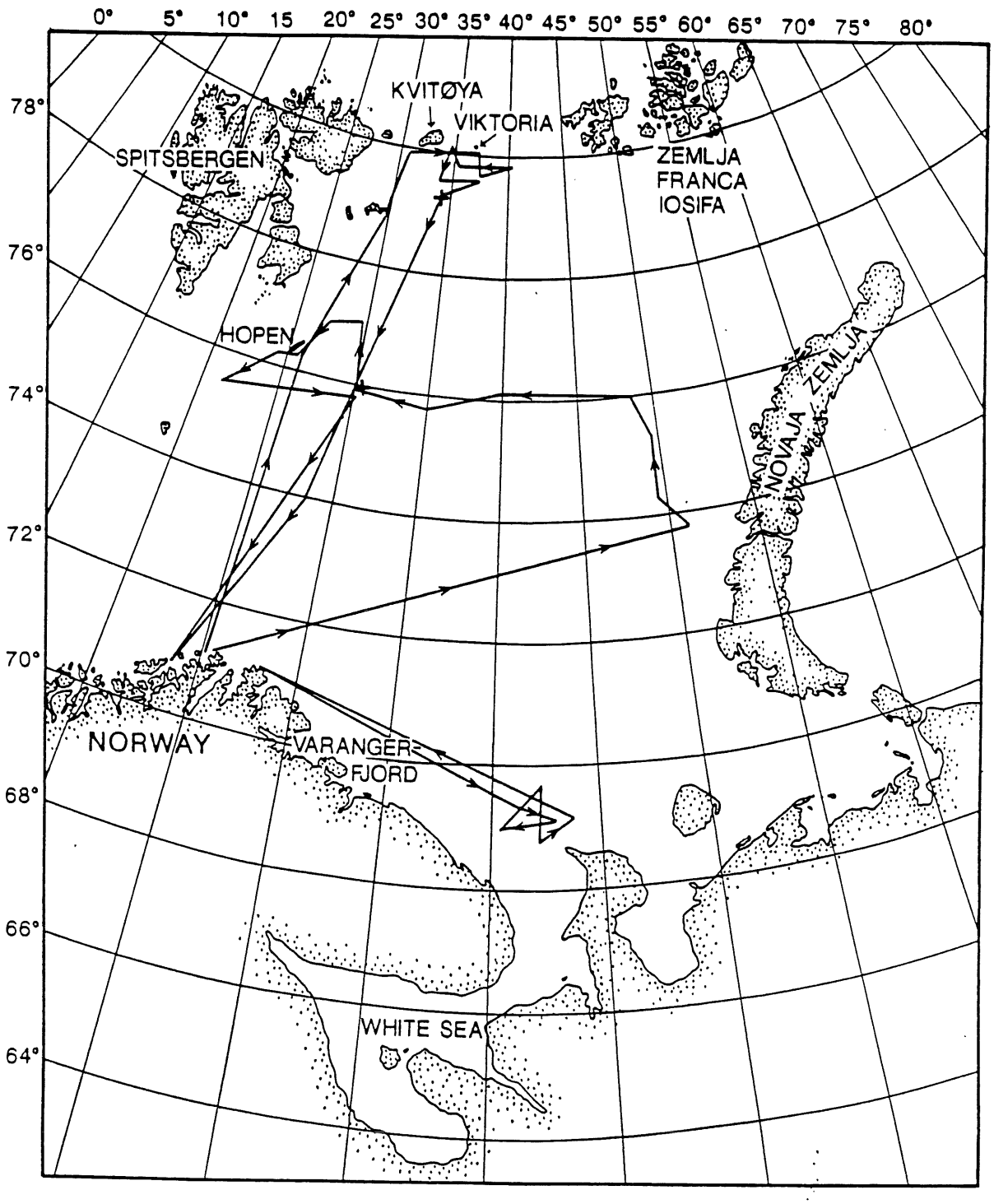

Fig. 1. Map showing the survey tracks of the vessels "Melshorn" (March/April), "Polarfangst" (June) and "Selis" (September) during the investigations in 1991. The two crosses indicate areas of trawling.

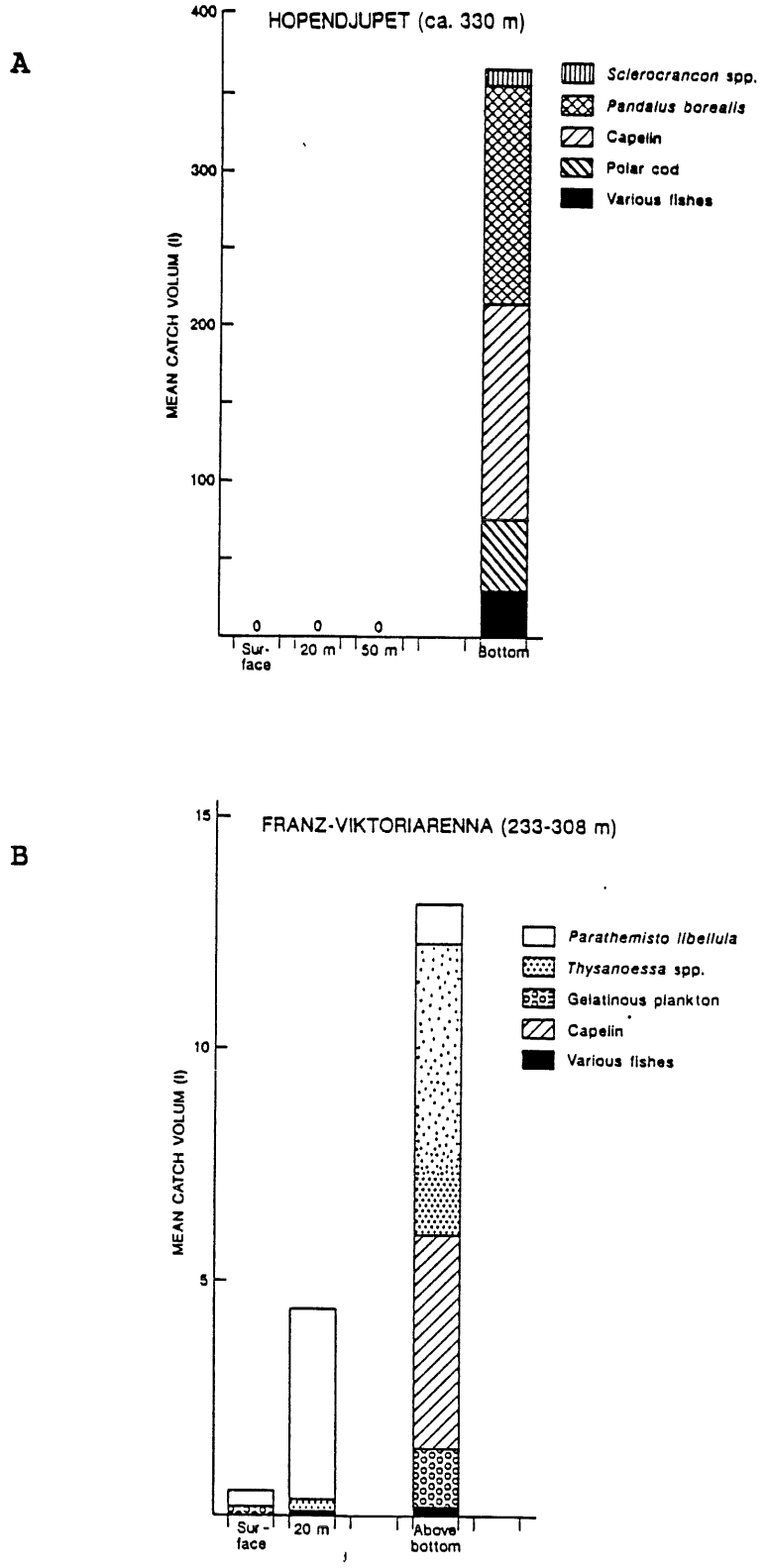

Fig. 2. Mean total contribution (in volume) of various organisms to the catches obtained in standard one hour hauls performed with pelagic trawl at the surface, at 20 m depth, at 50 m depth and 10-20 m above the bottom, and with bottom trawl at two different trawl stations in June (Hopendjupet) and September (Franz-Viktoriarenna). Echo-depth at each station is given in parentheses.

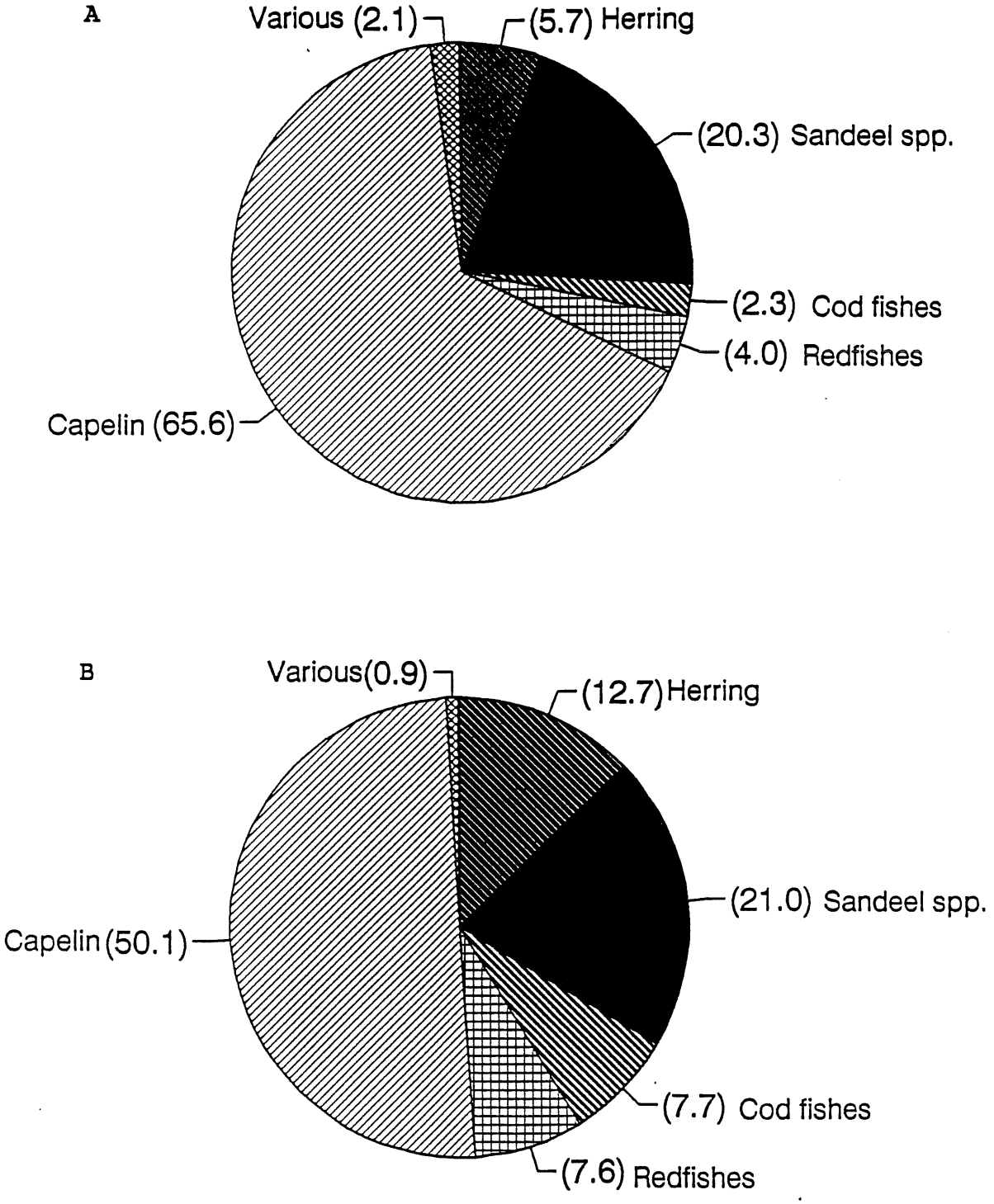

Fig. 3. Food composition of harp seals taken during February to April in Varangerfjord 1991 based on: A) Relative frequency of occurrence of each prey item given as numerical fractions of all prey specimens. B) Relative frequency of occurrence of each prey item in terms of calculated biomass.

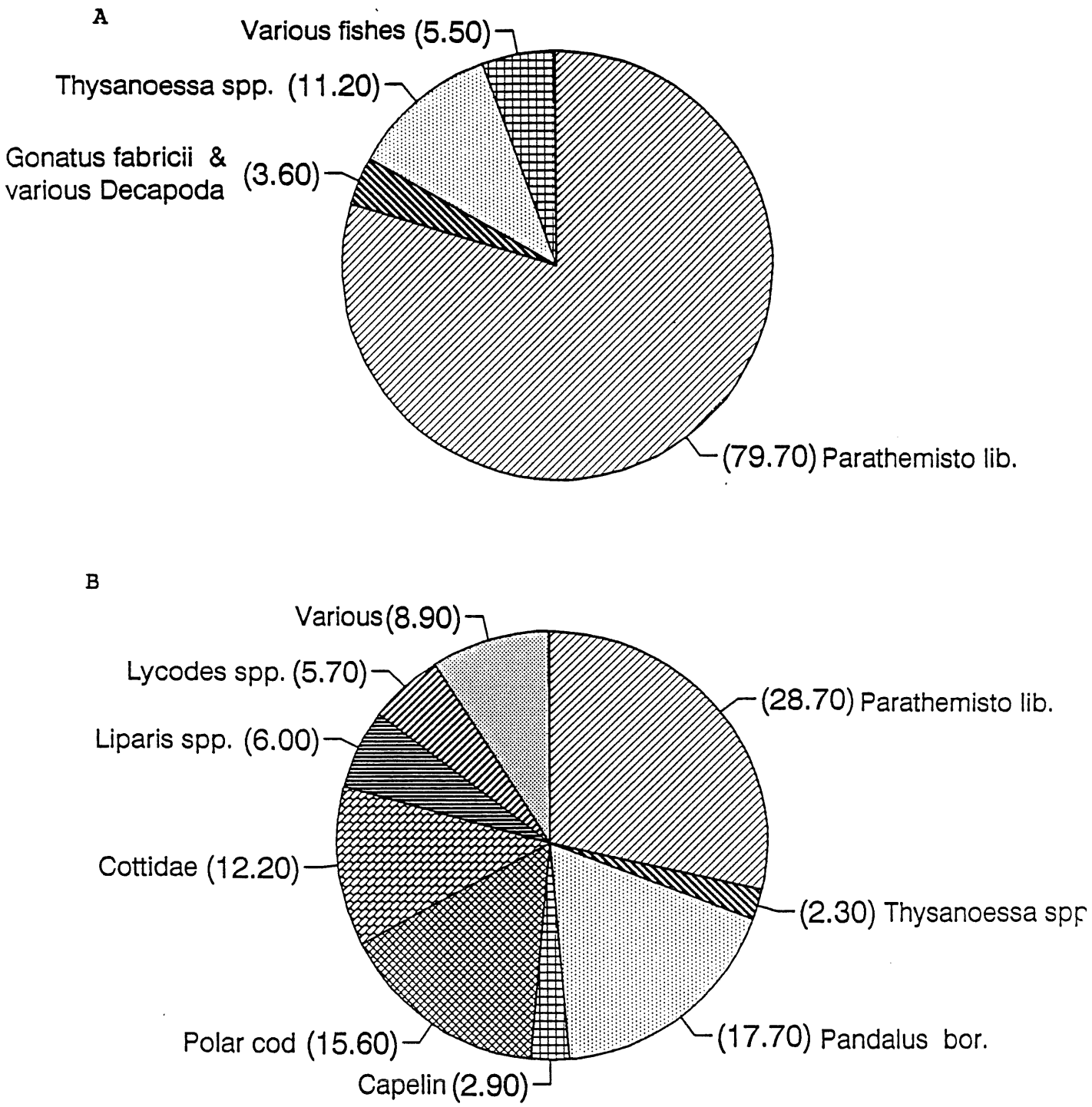

Fig. 4. Food composition of harp seals taken during September 1991 in the areas south of Kvitøya and Viktoria island based on: A) Relative frequency of occurrence of each prey item given as numerical fractions of all prey specimens. B) Relative frequency of occurrence of each prey item in terms of calculated biomass.

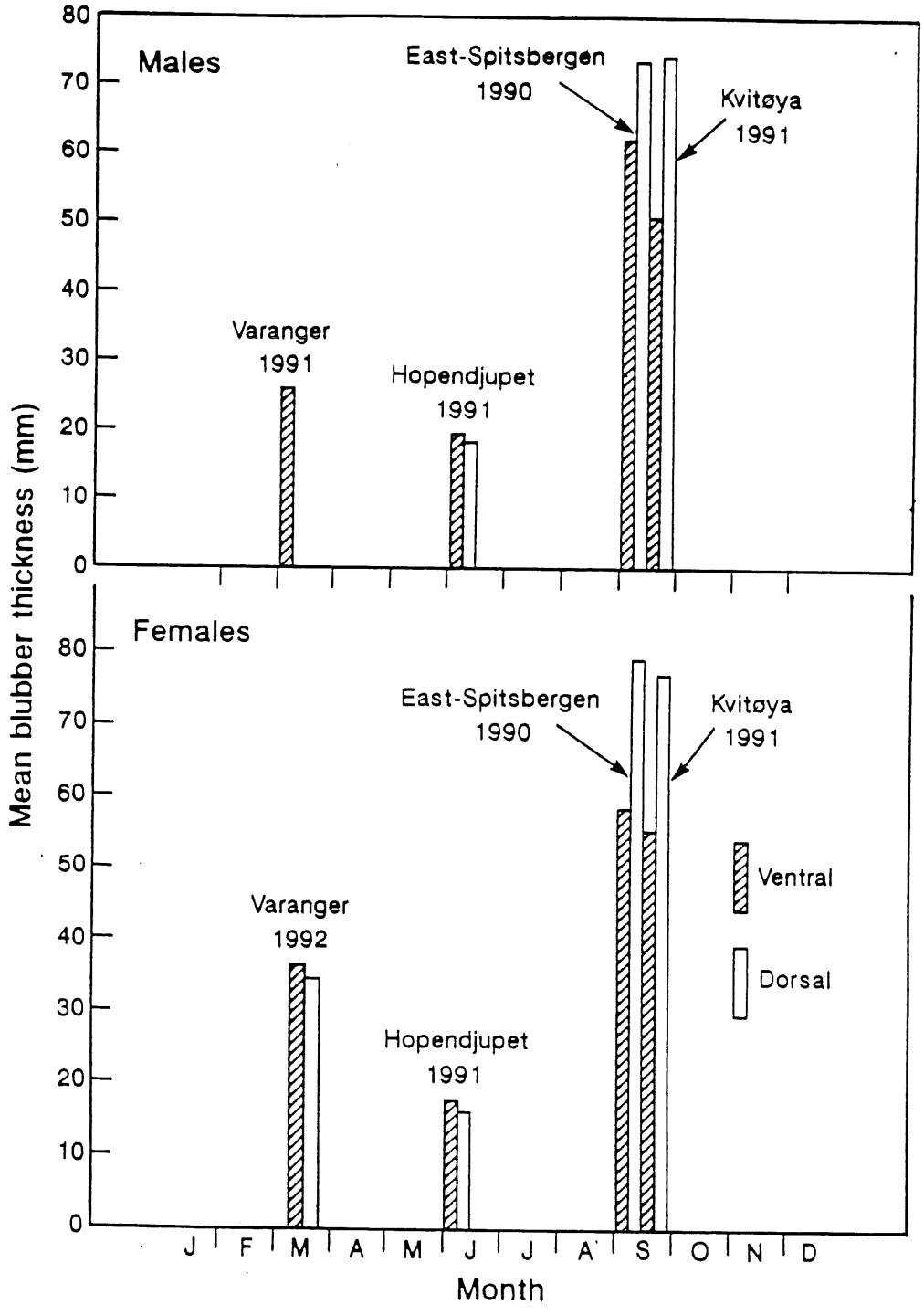

Fig. 5. Measurements of ventral and dorsal blubber thickness from adult (6 years and older) harp seals caught in Varangerfjord 1991 and 1992, in Hopendjupet 1991, east of Spitsbergen 1990 and south of Kvitøya and Viktoria Island 1991.