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SKRIFTER NR. 149

ODD LØNØ

The polar bear
(Ursus maritimus PHIPPS*)*
in the Svalbard area

NORSK POLARINSTITUTT
OSLO 1970

DET KONGELIGE DEPARTEMENT FOR INDUSTRI OG HÅNDVERK

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Abstract

Statistics of Norwegian catching of polar bears have been compiled. Catching methods are described. Food has been studied by examining stomach contents. Age criteria are given on bacula, testes, femurs, skulls and incisor cementum layers. Reproduction has been studied in the male and female polar bear.

Preface and acknowledgements

My interest in the polar bear was aroused as early as 1946–47 when I spent my first winter in Svalbard, but it was not until 1964–65 that I was able to make a collection of important material.

Many people have contributed a great deal in many ways towards the work presented here, and I must first express my gratitude to all the trappers and crew on the weather reporting stations in Svalbard who have given me information about catches, ice conditions, and observations on the biology of the bear. Special thanks go to Captain HÅKON GODTLIBSEN and the crew on board M/S «Havella», and to the two experienced winter trappers HENRY RUDI and ARTHUR OXAAS.

I am deeply grateful to the director of Norsk Polarinstitutt, Dr. TORE GJELSVIK, and his associates, for the economic support and help I received on my last winter expedition, and have received from them in my work since then.

My gratitude must be expressed to Prof. ROLF VIK and the curator, JØRGEN PEDERSEN at the Zoologisk Museum, Oslo, for allowing me to use their premises, and for many interesting discussions.

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A final word of thanks must go to ÅGE JOHNSGÅRD for a critical appraisal of this manuscript, and to JOY BACKE-HANSEN and MAUREEN KELLY for the translation into English.

EXPLANATION OF SOME GEOGRAPHICAL NAMES

Svalbard – all the islands between 74° and 81°N and 10° and 35°E, that consist of Spitsbergen, Bjørnøya, Hopen, Kong Karls Land, and Kvitøya (figs. 4 and 9).

Spitsbergen is the main section of Svalbard, and consists of the islands Vestspitsbergen,[1] Prins Karls Forland, Edgeøya, Barentsøya, and Nordaustlandet.

Catching areas:

Newfoundland – the pack ice east and north of Newfoundland.

Denmark Strait (in Norwegian: Danmarkstredet, Grønlandstredet, and Stredet) is the pack ice between Iceland and Greenland from 64° to 68°N.

The Jan Mayen area (in Norwegian: Vesterisen) is the pack ice south-west, west, and north of Jan Mayen between 70° and 75°N.

The Barents Sea area – a common term for Nordisen and Østisen.

Nordisen is the drift ice round Svalbard and east towards Franz Josef Land.

Østisen is the pack ice west of Novaja Zemlja and further south towards the White Sea. (The name Østisen is also used, especially in old papers, about Nordisen + Østisen.)

The White Sea is a section of Østisen and consists of the pack ice in the White Sea and the entrance to the White Sea.

SCIENTIFIC NAMES OF BIRDS AND MAMMALS REFERRED TO IN THIS PAPER

Guillemot	*Uria lomvia*
Eider duck	*Somateria mollissima*
Ptarmigan	*Lagopus mutus hyperboreus*
Muskox	*Ovibos moschatus*
Moose	*Alces alces*
Reindeer	*Rangifer tarandus*
Mule deer	*Odocoileus hemionus*
Ferret	*Putorius vulgaris*
Mink	*Mustela vison*
American marten	*Martes americana*
Polar fox	*Alopex lagopus*
Black bear	*Ursus americanus*
Brown bear	*Ursus arctos*
Grizzly bear	*Ursus spp.*
Ringed seal	*Phoca hispida*
Harp seal	*Phoca groenlandica*
Bearded seal	*Erignathus barbatus*
Hooded seal	*Cystophora cristata*
Walrus	*Odobenus rosmarus*
White whale	*Delphinapterus leucas*
Bowhead whale	*Balaena mysticetus*

[1] According to a letter from The Royal Norwegian Ministry of Industry and Handicraft, dated June 10, 1969, to Norsk Polarinstitutt, the name Vestspitsbergen is to be omitted and the island will be named Spitsbergen; the whole group of islands, together with Bjørnøya, is called Svalbard as before. (Editor's note.)

Introduction

Much greater attention has been paid to the polar bear in the Svalbard area during the last 10 to 20 years than before, when few people showed any interest in it other than those who had an economic interest in bear hunting and sealing. Since tourist hunting was organized anew from Norway after 1952, more and more people have brought the bear to our attention. The use of new means of transport has aroused a good deal of anxiety about the fate of the polar bear in all parts of the Arctic. The questions which spring to mind first in connection with this are whether the polar bear can endure the pressure of hunting, which has now arisen, and whether the bear population is common to the whole of the Arctic or whether it is divided up into local groups.

The object of this survey has been to provide a better knowledge of the polar bear, its way of life, and the hunting of it that has been carried on. Greater knowledge of these things can increase the possibility of better management of the polar bear in the Svalbard area, and in this respect, reliable information about the breeding biology of the bear is very important.

It is known from various reports about Arctic trapping and hunting that the bear lives mainly on different types of seals, but there is little detailed information on the extent to which it hunts those seals which are of economic interest to the sealers. Research has therefore been carried out on what the bear lives on.

Catch statistics have been thoroughly dealt with because these provide the best possible foundation for estimating the size of the bear population in earlier times.

I have also included an account of hunting methods and the laws governing the hunting of bears in Svalbard. There have been few restrictions on bear hunting, but a new law is under discussion.

Hunting methods

WINTER HUNTING

The first type of trap for catching polar bears, set in a permanent position, was the steel-trap. KEILHAU (1831) mentions that the first Norwegians to spend the winter in Spitsbergen in 1822–23, set steel-traps to catch bears. It is not known whether these traps were used by earlier hunters. If they were, it must have been to only a slight extent. When Norwegians started to spend the winter there again after 1888, a steel-trap was used only in one case, according to the trapper OXAAS (p. com.). That was on Bjørnøya in the winter 1916. A bear was caught in the trap, but it managed to get away. As the steel-trap was considered to be cruel, it was not used later on.

"Signal" is a type of trap used near the huts. A pole with a piece of blubber on it is erected at a distance of 10–15 metres. There is a line from the bait into the hut where it is fastened to a tin. When the bear pulls at the bait, the tin falls down, giving the signal to the hunter, who then shoots the bear through a hole

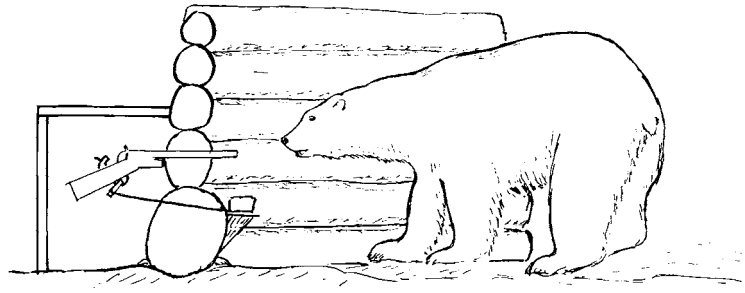

Fig. 1. *Longitudinal cut through an old type spring-gun trap that was in use in Spitsbergen from about 1900 up to about 1925. The stall was built of either logs or stones. The arrangements to fasten the gun and the trigger mechanism are not shown in the drawing.*

in the door. There are only a few bears caught in this way nowadays, as for example from one hunting-ground 1–4 bears a year. The "Signal" trap was of greater importance before the days of dog-teams. The dogs and their smell frighten the bears away from the huts. The "Signal" has probably been used from the very first winter spent in Spitsbergen.

Spring-guns are the most important method of catching polar bears in the winter. It is not known when spring-guns were first taken into use. They were probably not used at all – or certainly very little – by the first winter hunters up to 1860. The guns were expensive, and constructed in such a way that they were unsuitable as spring-guns in the difficult climatic conditions in Svalbard. Before 1850 only flint-lock guns were used (HOEL 1949). The winter hunters in 1889 surely had no spring-guns (Table 3), and those who unwillingly had to spend the winter 1895–96 did not have any (Spitsbergen Gazette 1897). On the other hand, it is quite probable that spring-guns have been used after 1899.

My information about the oldest types of spring-guns comes from the trappers ARTHUR OXAAS and HENRY RUDI, whose first winterings were in 1906 and 1908, respectively. Both of them learned to use spring-guns from their more experienced fellow-trappers. The spring-guns were Bottlenose canons or Remington guns built into traps made of stone or driftwood logs (Fig. 1). The traps were 1.5 to 2 metres long, about 0.7 m wide, and up to 1.5 m high. The weapon was usually adjusted to hit the chest, in some cases the head, and it was placed in a box outside the short wall so that only the muzzle stuck out on the inside of the trap. The bait, a piece of seal blubber with skin, was placed on a shelf or stick on the short wall. The best bait was seal blubber, but if that was not available, a piece of salted bacon could also serve. But that was not nearly so good. A line ran from the bait to the mechanism that pulled the trigger when the bear dragged at the bait.

Bottlenose guns were easy to obtain after bottlenose-hunting decreased just after the turn of the last century. They were used by some winter hunters. The guns were loaded with coarse black gunpowder and had a wad of cork and 10–15 small canonballs. The Remington gun (Norwegian army gun 1867–84) was much

lighter, and these guns with the barrel sawn off were very often used as spring-guns. After the army stopped using Remingtons, they were sold cheaply. In 1904 they were advertised in the newspaper for 5.– N. kr. each.

The oldest type of trap built of stone or driftwood logs was impractical. At the slightest snowstorm, of which there are many in Spitsbergen, the trap was full of snow. They therefore had to be continually dug out. Bears that had been killed by the spring-guns and perhaps frozen stiff in the trap were difficult to get out.

The spring-guns were often not very effective. If there was snow in the trap, the bear stood too high up, and the shot did not hit where it was supposed to. Any snow covering the bait prevented the bear from finding its way to the spring gun. Both OXAAS and RUDI are in agreement that a great number of bears were unfortunately only wounded and that they went on quite a long way before they dropped down dead. Many of them were never found again.

Trapper SØRENSEN (1924) kept a diary when wintering on Hopen 1923–24, and this gives useful information about the hunting of polar bears with the old type spring-guns. SØRENSEN was together with two other men. Trapping conditions were bad (see Table 15), and they did not set their 15 spring-guns before December–January. Poison was not used.

The bears were caught in the following way:

Shot by spring-guns	9
Wounded by spring-guns, later shot	2
Shot, hunted by rifle	14
Total catch	25

The diary also gives the following information:

Bears wounded by spring-guns and lost	6
Bears shot during hunting and lost	1
Bears observed	25

The type of spring-gun trap that is used nowadays soon took over from the old type. It was developed by trapper GUSTAV LINDQUIST about 1920 (RUDI p. com.) The gun, with the barrel often sawn off, is placed in a wooden box built up on feet to a height of 60–70 cm above ground (Fig. 2). The bait is placed in the front of the box and fastened to a firing mechanism as in the older type of trap. These, however, are easier to work with and more effective. All kinds of hand arms have been used, but the Remington gun was mostly used until 1940. Since the last war, more effective and modern army guns have been used, including automatic weapons and, as these can feed themselves, they might shoot 2–3 bears between each time they are controlled.

Loss of catch from the new type of spring-gun trap varies somewhat, according to frequency of control and the trapper's skill in rigging it up. On my first win-

Fig. 2. *A dead polar bear lying in front of the spring-gun. This type has been in use since about 1920.*

tering we had a loss of 25% (catch: 87 bears by spring-guns). On my three later winterings, the loss was 15% (catch: 145 bears by spring-guns). I do not think it is possible to come under 15% with the latest type of spring-gun trap. Some of the number lost are due to the spring-guns missing, and the rest of them are wounded in the head. How many of these bears survive is not known, but most of them probably die.

The use of spring-gun traps makes it impossible to select which animals to kill. My last catch on Edgeøya gives information about the rate of cubs, and females with cubs that were taken by spring-guns. The total catch was 85 bears, 17 bears were shot by regular hunting, and 63 bears were shot by spring-guns, while 5 cubs were shot after the females had been killed by spring-guns. The number of cubs and females in the catch were as follows:

3 cubs shot by spring-gun, females got away.
2 females shot by spring-gun, 2 cubs got away.
4 females shot by spring-gun, 5 cubs shot near the trap.

This gives a total of 6 females and 8 cubs shot by spring-guns, and 2 cubs which got away. All the cubs were about a year old. As cubs under 1½ years will probably have difficulty in managing by themselves, the number of cubs and females was 16 out of 70 (68 + 2 cubs which got away) which had visited the spring-gun traps. That makes 22.9%. If the cubs manage to survive, the percentage will be less. The total amount, of course, varies somewhat, but one must reckon with about 20% females and cubs by spring-guns.

Poison as a means of catching bears was used for many years. According to trapper ARTHUR OXAAS (p. com.), catching bears by poison started seriously in 1906. Before 1906 poison was used to catch foxes in Spitsbergen. As bears occasionally took the bait and died nearby, the trappers realized that poison could also be used to catch bears. At first a piece of poisoned blubber was placed on the ground by the side of a wooden post. This post, standing up as a sign, was put there to show where the bait lay, and to decoy bears to the bait. Bears are inquisitive and like to inspect any thing unusual. Later on, the bait was hung up on the signpost, as high up as 1.5 metres. The bait was usually covered by some canvas material to protect it against rain and birds. Foxes could not get hold of it at that height. The only poison used has been strychnine. The police in Tromsø allowed each expedition to buy 30 g strychnine (RUDI, p. com.).

After 1907 nearly all the hunting expeditions took poison with them to catch foxes and bears. Catching by poison was forbidden by Norwegian law in 1927, but was continued for a long time. Trappers have told me that they had no difficulties in buying poison even in the 1930's. Use of poison also occurred after the last war, but has gradually died out completely.

There was little preparation needed with poison, and it was often used for that reason only.

The length of time from swallowing the bait until death occurs varies greatly, from some seconds to 5—10 minutes or more. It depends on how hard frozen the bait is, how much it has been chewed before being swallowed, and how much the bear already has in its stomach. Some bears vomit and bring up the bait as soon as they taste the poison, and they may walk many hundred metres before they die. Sometimes their tracks could be followed for miles after they had thrown up the bait, with no trace of the poison having had its effect.

The baits had to be erected further away from the shore than spring-gun traps, preferably 50—60 m, as the bears could walk quite a distance after swallowing the poison. Later on, when the fast ice froze along the shore, the poison baits were, of course, easily moved.

There was partly a large loss in catching bears with poison as they went out onto the pack ice and sludge before dying, or they were buried under the snow in places where they were not found. All the same, some trappers were of the opinion that if poison was used in a correct and sensible way, the losses were no greater than those with spring-gun traps. Whether the trapper gets the bear or not, at any rate it does not suffer from injuries after eating poison.

Cage-traps, made of floating timber with a trap-door, have only been used a few times. One of these cage-traps (Fig. 3), which is still on Kapp Martin, was built in 1910 (MOBERG 1960). Two more are said to have been built in 1908 on Eholmen, about 35 km south-east of Kapp Martin (RUDI p. com.). They were only used for a few months, and, as far as it is known, they only caught two bears altogether. RICHTER (p. com.) tells that Norwegian trappers built 3 cage-traps on Jan Mayen. These were most probably calculated to catch both foxes and bears. Cage-traps were very impractical in use as they were soon full of snow at the slightest wind.

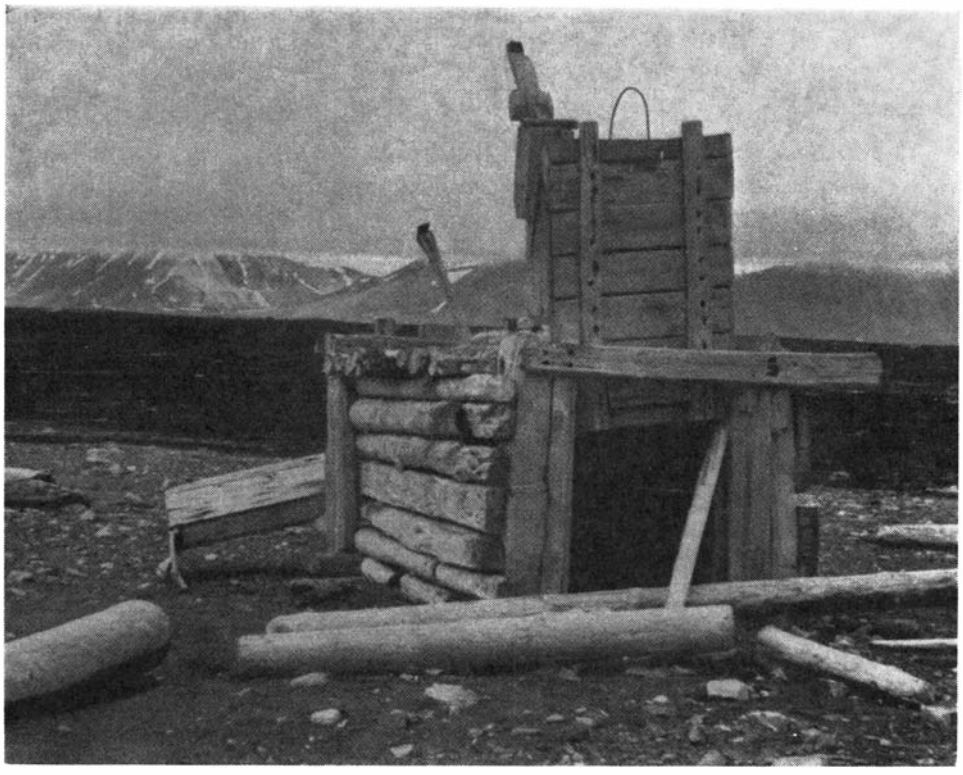

Fig. 3. *This type of trap caught the polar bears alive. They were not practical and therefore used only for a very short time.*

Photo: Ole Friele Backer

Apart from the catch from spring-guns, the hunter also shoots some bears with his own gun. On account of the 3 months or more of darkness, there are few bears shot in the middle of the winter. There are greater possibilities for hunting in the period from the middle of February, when the sun rises above the horizon, to the end of May. On my first wintering, we caught 87 bears by spring-guns, and the rest, 51, were hunted and shot. That was more than usual. It is estimated that 75–85% of a winter catch is trapped by spring-guns.

Another way of catching polar bears is by driving after them with a dog-team. During the chase, one or more dogs are often set loose to be able to ring in the bear and keep it at bay until the hunter arrives with the team. As the bear will nearly always run towards pack ice or open water when it is being chased, this method of hunting is only used on fast ice far away from the border of the pack ice. This method has been very seldom used in Svalbard. On the other hand, it is quite common on the large fjords in East-Greenland.

Snowscooter. There has been little experience in the use of snowscooters for polar bear hunting, as this method was only in use for 4 years before it was forbidden (see p. 43). One expedition in Svalbard used snowscooters, otherwise they have only been used for hunting by mine workers. One of the hunters who

has used a snowscooter says (BJØRNSVIK p. com.): "In the dark season a dog-team is more suitable than a snowscooter. When it grows lighter, the snowscooter has an advantage as it covers a larger area. Most polar bears are frightened and run away when the snowscooter approaches, but a bear is soon caught on flat ice. The snowscooter cannot be used to chase bears on hummocked ice."

SUMMER HUNTING

Sailing ships could not press far into the pack ice, and hunting, therefore, was carried out on the outer floes. Attempts were made to row round the bear in small boats and kill it. When steam and engines were installed in the seal-hunting ships, it also became easier to chase bears in the pack ice.

As soon as the look-out man in the crow's-nest sees the bear on the pack ice, the chase is on. If the pack ice is open, the bear has to swim between the floes, and it is not long before it is caught up with and shot, either from the big ship or from one of the small boats. If the bear is on a large floe or fast ice, some of the crew go out on the ice and shoot it, or else the bear is driven into the water and then shot. In open pack ice the bears have small chances of escaping.

Most of the cubs taken alive are caught from ships in the summer. The female is chased into the water and shot. A slip-noose is put round the cubs; they are pulled on board and put in cages.

Polar bears are very seldom found on land in summer, so all hunting takes place on the pack ice. As a very rare exception, many bears may be found gathered on the islands of Svalbard. This may happen in Kong Karls Land when the pack ice thaws and the bears cannot find the ice again. Captain PEDER P. ULSFJORD came to the islands in 1920, or thereabouts. The crew saw a lot of bears on land and shot 40 in one day, but there were many left (OXAAS p. com.). From earlier times there are a few accounts of large numbers of polar bears gathered on small areas. Captain KULSTAD (1871) tells that in August 1853 he saw more than 50 polar bears on Håøya (south of Edgeøya) and that he caught a great number of them. The reason for so many bears gathering on this little island was that the year before a large number of walruses had been killed by the crew of a ship. The walrus carcases had been food for the bears for a whole year, and there were still a number of them left.

Norwegian polar bear catching in the Arctic

PREVIOUS STATISTICS

Collected statistics covering Norwegian bear catches from earliest times do not exist. The statistics given here have been compiled from information gathered from many different sources. The figures are not complete because some information is missing or has been lost, but even so, they give a good idea of the size of the catch over the years.

The tables are more or less explicit and the periods of unequal length in time,

as the information from which they have been compiled varies greatly in character.

In the section "The winter trappers' catch in various hunting areas", it has been possible to give statistics for the catch of bears in the different hunting grounds covered by the trappers who spent the winter in these areas. The statistics give a much better idea of the development of winter trapping than the statistics for the total catch. Besides making it easier to follow the development of the trapping in each hunting ground, the statistics also give the best information about the distribution of the bear and its denning areas in Svalbard.

HISTORIC SURVEY OF THE NORWEGIANS' CATCH IN THE ARCTIC

Svalbard was discovered in 1596, and whaling began on a large scale in 1611. The whalers were primarily out after the bowhead whale, and the walrus was of secondary importance. Whaling was carried on in the fjords up until 1650, after that, it was mostly carried on out at sea. After 1750, whaling began to decrease, but was carried on until 1820 (KRISTOFFERSEN 1950 and 1951). We know hardly anything about the whalers' bear catches. Presumably they shot bears when they had the opportunity, but their catch was probably very small as they hunted only at the edge of the ice. JONAS POOLE (in Purchas His Pilgrimes 1906), who led the third expedition to Spitsbergen, says they caught five living cubs and killed 27 bears during their visit to the west coast of Vestspitsbergen in 1610.

Russian hunters began to visit Svalbard in the years between 1715 and 1720. There were never many Russians there, but as far as we know there were annual expeditions throughout the Russian trapping period, which lasted until 1853. The Russians carried on partly summer and partly winter hunting from small sailboats – lodjer – but they never hunted the larger whales. The most important catch was walrus, but they also hunted the white whale, the reindeer, the fox, and the bear. We have only a few scattered references to the Russians' catch (KRISTOFFERSEN 1950). The number of bears caught cannot have been large, and nowhere is it mentioned that the Russian hunters who wintered in Svalbard had traps or other trapping devices for bears with them.

According to HOEL (1949), Norwegians began hunting in the Arctic in 1795. They took over from the Russians, and, to begin with, hunted only in Spitsbergen. Later they expanded their hunting grounds so that, at the beginning of 1900, Norwegians were hunting in Novaja Zemlja, Spitsbergen, and Greenland, and on the drift ice from the White Sea and the Kara Sea to Greenland and Newfoundland. The animals they hunted were walrus, white whale, seals, polar bears, foxes, reindeer, and muskox. To begin with, and up to the 1860's, it was essentially the walrus that was hunted. Since then, the different kinds of seals have been the most important animals to have been hunted. Apart from the catch from certain winter hunting areas, the bear catch has always been of secondary importance to the other catches.

THE TOTAL CATCH FROM SEALERS, TRAPPERS, AND HUNTERS

1795–1884

Norwegians began their Arctic hunting in Spitsbergen in 1795 with one boat, and that had to spend the winter there. The next boat arrived in 1819. After that time, hunting developed rapidly, and there were annual hunting expeditions which set out northwards from Norway (HOEL 1949).

We have figures for the catch brought back to Hammerfest for the period 1824–1829, and the bear catch figures have been entered in Table 1. The figures for 1824–26 have been taken from KEILHAU (1831), and for 1827–29 from RODE (1842). RODE also has figures for 1824–26, but as he acknowledges these to be incomplete, KEILHAU's figures for the first three years have been used instead. The hunters who wintered on Bjørnøya in 1824–25 and 1825–26 shot 10 bears. They had rifles only for hunting bears, and shot the animals in the neighbourhood of the winter cabin.

Up until 1871, there is very little and very scattered information about how many boats took part in hunting. What is mentioned in the trapping figures is the walrus, which was the animal which was hunted most. The bear is scarcely mentioned. NICOLAYSEN (1894) writes that during the 5-year period 1830–35, 11 bear hides were taken back to Tromsø after 28 hunting trips, and 24 hides were taken to Hammerfest after 64 trips.

The bear was not hunted very much during the first few years. RODE (1828) writes: "They particularly concern themselves with the spearing of walrus, which yields the best profits... Bears are shot when they are seen, but are not hunted specifically."

Few bears were caught from the boats, although towards the end of the period the size of the catches increased somewhat. This has to do with the fact that, after 1860, hunting became more concerned with seals than walrus, and the boats hunted out in the pack ice much more, where there are more bears (JUEL 1886, HOEL 1949).

There were some few hunters who remained for the winter. They stayed on Bjørnøya and on the west coast of Vestspitsbergen, where there are comparatively

Table 1

Polar bear skins brought to Hammerfest during the years 1824–1829. Bears caught by sealers and trappers.

Year	No. of boats (tours)	No. of trappers	Skins
1824	5	31	32
1825	4	10	3
1826	7	30	10
1827	8	?	4
1828	7	?	16
1829	11	?	1

few bears, and caught mainly walrus. Later, when there were fewer walrus, fewer hunters wintered there, and the first part of the Norwegian wintering period ended in 1866 (HOEL 1949). An attempt was made to catch bears with a steel-trap (KEILHAU 1831), but we do not know whether spring-guns or other trapping devices were used. These winter hunters can scarcely have caught many bears during this period.

Sealing was begun from East-Norway in 1846. The boats which were used, were larger than those used from the north of Norway, and they hunted only in the Jan Mayen area, except for a period of a few years. We have the bear catch figures from these boats for the last three years of this period.

After 1871, we have figures for the bear catch from the boats fitted out from the counties of Troms and Finnmark (Table 2). Only boats which carried out nothing but Arctic hunting during 1878 and 1879 have been included in the table, except for about 15 Greenland shark fishers. Boats which were lost at sea have not been included. For 1871 and 1872, only the catches for the Tromsø boats have been given, while the catches for 25 and 24 Finnmark boats respectively have not been included. All the catches are said to have been made in Nordisen and Østisen.

The sources for Table 2 are Beretning om Norges Fiskerier 1871–75, Statistikk over Norges Fiskerier 1876–78, and Tabeller vedkommende Norges Fiskerier 1879–1884. It is not easy to say just how reliable the figures for Troms and Finnmark really are, but it seems as though the catches from the boats, which were cleared by customs, were entered with great accuracy; half-hides are mentioned for example. Even so, the figures are hardly complete.

Table 2

Catches of polar bears during the years 1871–1884.

Year	Sealers from					
	East-Norway			North-Norway		
	No. of boats	Dead bears	Living cubs	No. of boats	Dead bears	Living cubs
1871	20	–		30+25	74	–
1872	26	–		8+24	28	–
1873	32	–		45	66	3
1874	35	–		38	109	1
1875	?			40	80	2
1876	?			34	103	–
1877	?			37	65	8
1878	?			51	108	2
1879	?			49	102	–
1880	?			22	55	–
1881	?			25	55	–
1882	15	25	–	39	45	4
1883	16	25	–	39	28	2
1884	18	36	–	40	170	5
Sum	–	86	–	–	1088	27

1885–1908

In Table 3 the following sources have been used: The figures for the catches from the East-Norwegian boats are from Norsk Fiskeritidende, except for the years 1897–98–99, where they are missing – here Tabeller vedkommende Norges Fiskerier have been used. In 1886, no figures for the boats are given at all, and here HOEL (1949) has been used. Sealing from Sunnmøre began in 1898 and has continued without interruption (HOEL 1949). The figures for the numbers taking part in hunting from 1898–1902 are from HOEL (1949), the rest are from Tabeller vedkommende Norges Fiskerier. The figures of the catch from the North-Norwegian boats have been taken from Tabeller vedkommende Norges Fiskerier, as these give the most complete figures for the total catches. But since the figures in Norges Fiskerier are more detailed for most of the years, the catch of living bear cubs has been estimated in the following way: the stated capture of living cubs given in Norges Fiskeritidende has been deducted from the total number of bears caught, given in Tabeller vedkommende Norges Fiskerier. This is because, in the latter publication, the numbers of dead and living bears have been added together. The figures for winter catches are from Norsk Fiskeritidende, HOEL (1949), and other sources mentioned in Tables 9 and 11.

As the catch figures for some of the years are missing, I have tried to estimate the approximate figures for some of these years. The estimated catch is in brackets in the table. The figures have been arrived at in the following way: the given figures for this period have been used to calculate the average catch per year per boat. For the East-Norwegian vessels, this works out at 2.1 bears per year per boat. The figure for 1889 seems unreasonably high in relation to other years. Even so, the figure of 111 shot bears is right, since it is confirmed in, among other things, an article in Tromsø Stifttidende, June 19th, 1902. For the Sunnmøre vessels, the average catch works out at 7.6 bears per year per boat.

1909–1923

While the figures for sealing for 1884–1909 seem to be reliable and complete for the most important clearing centres, they are very incomplete for the period 1909–1923. HOEL (1949) writes of these years, "During the first World War there was great prosperity for the sealing fleet up in the north. In 1916, Bodø, Bodin, and Salta also took up sealing, and later took part with up to 15 vessels per year. Unfortunately, there are no complete statistics either for these years, or for the five years following the war. It is not until 1924 that we find more complete accounts of the North-Norwegian sealing. But there is some information available. This shows a tremendous increase in both the size of the fleet and the sealing returns. In 1916, 53 boats were engaged in sealing from Hammerfest, Vardø and Varanger".

The figures in Table 4 are for the sealing fleet, taken from Norsk Fiskeritidende and Tabeller vedkommende Norges Fiskerier for 1909–23, North-Norway excepted, for the years 1915 (IVERSEN 1928), and 1916, 1917, 1918, 1920, 1921, and 1922 (HOEL 1926). For 1910, I have estimated the catch for the 42 vessels which did not submit any figures from the known catch for the ships

Table 3

Catches of polar bears during the years 1885–1908. Figures in brackets are calculated.

Year	Sealers from									Trappers				Total known	Proportion of liv. cubs	Total, known + estimated
	East-Norway			Sunnmøre			North-Norway			Jan Mayen	Svalbard					
	No. of boats	Dead bears	Liv. cubs.	No. of boats	Dead bears	Liv. cubs.	No. of boats	Dead bears	Liv. cubs.	Dead bears	No. of trappers	Dead bears	Liv. cubs.			
1885	26	[54]					41	84	8					92	8	146
1886	23	[48]					45	89	5					94	5	142
1887	24	12					52	215	27					254	27	254
1888	23	61					64	91	4					156	4	156
1889	25	26					64	258	48		?	7		339	48	339
1890	25	49					55	156	15					220	15	220
1891	26	66					57	175	17					258	17	258
1892	23	[48]					58	172	8					180	8	228
1893	18	55					53	255	17					327	17	327
1894	14	17					53	201	4		6	12[1]	0	234	4	234
1895	17	39					46	134	13		11	63	1	250	14	250
1896	18	36					57	208	13		4	4	0	261	13	261
1897	13	11					63	402	53					466	53	466
1898	13	11		3	[22]		71	462	59					532	59	554
1899	7	111		4	[30]		71	239	26		16	27	2	405	28	435
1900	7	[14]		4	[30]		59	313	15					328	15	372
1901	8	[16]		4	[30]		59	209	7		7	15	–	231	7	277
1902	6	[12]		3	[22]		67	302	14					316	14	350
1903	8	3		5	83	7	65	159	14		29	106	1	373	22	373
1904	5	[10]		6	5	0	67	391	25		?	?		421	25	431
1905	4	[8]		10	55	9	70	324	58		26	184	–	630	67	638
1906	4	[8]		13	59	16	71	478	32		14	51	–	636	48	644
1907	4	13		16	105	13	77	416	18	1	52	323	–	888	31	888
1908	4	[8]		16	113	37	78	337	66		35	98	–	651	103	659
Sum	–	736		84	554	82	1463	6070	566	1	–	890	4	8542	652	8902

[1] Here 6 bears shot by 4 trappers on Bjørnøya.

from North-Norway during the period 1909–15. The average catch was 2.3 bears. Sealing from East-Norway came to an end in 1911 (IVERSEN 1941), and the number of bears caught has been estimated on the basis of the figures in Table 3. The estimated catch for the vessels from Sunnmøre has been calculated from the known catches of 1909–23. The average catch per boat per year was 0.9 bears.

The figures for North-East Greenland, where Norwegian trappers wintered for the first time in 1908–09 and the next in 1922–23, have been taken from GIÆVER (1939). The figures for Jan Mayen proper are according to HOEL (1949).

The catch figures for the trappers who wintered in Svalbard are taken from HOEL (1949), Norsk Fiskeritidende 1909–1923, YTREBERG (1962) for 1909, and information I have received from trappers (references given in Tables 8–15). Trappers in Kong Karls Land in 1908–09 had as their total 84 dead and 21 living bears; these have been entered in the figures for 1909. The trappers had to leave the island across the pack ice as no boat managed to get them out. The cubs were shot and only 64 hides were brought to Norway in 1913.

1924–1944

Official statistics for Norway's Arctic hunting were not recorded until 1924, and so the figures can be very incomplete. But from 1924, all the ports of entry were asked to submit clearance figures for all the catches cleared. From then on, the figures were much more reliable, and we can assume that most of the sealing boats submitted figures of their catch.

Table 5 gives statistics of bear catches.

The figures for the sealers have been taken from Norges Fiskerier 1924–1944, but unfortunately they were submitted as a total figure for all boats cleared by customs.

The figures for winter catches in North-East Greenland have been taken from GIÆVER (1939) and LØNØ (1964), and from Torgilsbu in South-East Greenland, quoted in Årsberetning vedkommende Norges Fiskerier (1936), SØRENSEN (1958), and EGGESVIK (p. com.). Torgilsbu was a combined weather reporting and trapping station which was in operation from 1932 until 1940.

The figures for winter catches from Spitsbergen and Bjørnøya have been worked out from HOEL (1949), Norges Fiskerier, 1924–1944, Årsberetning vedkommende Norges Fiskerier, 1924–1944, and first-hand information from trappers who had wintered there (Tables 8–15).

The three bears shot on Jan Mayen were shot by soldiers during the war (RICHTER p. com.).

1945–1968

LØNØ (1965) has accounted for the figures for the Norwegian bear catches from 1945–63; the table has been augmented by a further 5 years. The information for 1964–67 in Table 6 is for the sealing industry, taken from Årsberetning vedkommende Norges Fiskerier 1964–67 and for 1968 from Fiskeridirektoratet (p. com.).

Table 4

Catches of polar bears during the years 1909–1923. Figures in brackets are calculated.

Year	Sealers from									Trappers									Total known	Proportion of living cubs	Total, known + estimated
	East-Norway			Sunnmøre			North-Norway			North-East Greenland			Jan Mayen	Bjørnøya		Spitsbergen and Hopen					
	No. of boats	Dead bears	Liv. cubs	No. of boats	Dead bears	Liv. cubs	No. of boats	Dead bears	Liv. cubs	No. of trappers	Dead bears	Liv. cubs	Dead bears	No. of trappers	Dead bears	No. of trappers	Dead bears	Liv. cubs			
1909	3	[6]		20	28	17	81	118	15	7	28	0	0	2	16	50+?	437	31	690	63	696
1910	4	[8]		23	18	6	42+42	136+[96]	18	6	6	0				33	220	3	407	27	511
1911	2	[4]		24	[21]		100	89	5				0	4	5	26	126	–	220	5	250
1912				26	[23]		92	90	3							9	100	–	193	3	216
1913				27	[24]		93	172	7							1	46	1	226	8	250
1914				31	[27]		75	162	12							?	82	2	258	14	285
1915				33	[29]		79	229	–							10	36	–	265	–	294
1916				50	[45]		?	261	–					2	1	?	4	–	265	–	311
1917				63	[56]		?	160	–					13	13				173	–	229
1918				72	[64]		?	319	–				3			2	4	–	326	–	390
1919				76	[68]		292	594	–										594	–	662
1920				63	38	4	?	449	–							9+?	87	–	578	4	578
1921				28	[25]		?	130	–				0			3+?	20	–	150	0	175
1922				40	20	10	?	188	–				0						218	10	218
1923				46	27	5	129	453	54	7	10	1	0						550	60	550
Sum	–	18		–	513	42	–	3646	114	20	44	1	3	–	35	–	1162	37	5113	194	5615

Table 5

Catches of polar bears during the years 1924–1944.

Year	Total all sealers			Trappers										Total	Proportion of living cubs
				South-East Greenland		North-East Greenland			Jan Mayen	Bjørnøya	Spitsbergen and Hopen				
	No. of boats	Dead bears	Liv. cubs	No. of trappers	Dead bears	No. of trappers	Dead bears	Liv. cubs	Dead bears	Dead bears	No. of trappers	Dead bears	Liv. cubs		
1924	154	733	–						0		?	166	2	901	2
1925	160	570	–						0		29	28	–	598	–
1926	136	134	–						0		37	147	–	281	–
1927	105	255	45						0		15	70	–	370	45
1928	125	430	51			6	18	0	0		29	29	–	528	51
1929	94	322	66			6	40	2	0		35	44	–	474	68
1930	93	250	56			6	11	0	0		34	124	–	441	56
1931	62	77	11			16	35	0	?		34	4	–	127	11
1932	73	149	12	9	12	8	10	0	?		23	35	–	218	12
1933	84	179	12	9	2	6	0	0	?	0	21	31	–	224	12
1934	87	80	5	2	0	22	36	0	0	2	36	29	–	152	5
1935	78	101	7	2	1	6	0	0	0	1	34	111	0	221	7
1936	78	198	26	2	0	10	21	0	0	3	38	157	1	406	27
1937	82	344	42	3	2	8	5	1	0	0	36	146	–	540	43
1938	80	119	19	2	1	9	0	0	0	1	36	105	–	245	19
1939	55	102	6	2	1	18	35	0	0	0	22	4	–	148	6
1940	30	15	0	2	2	11	3	0	0	1	24	130	–	151	0
1941	0					5	2	0	0	1	17	8	–	11	0
1942	0					3	2	0	2		0			4	0
1943	0					0			1		0			1	0
1944	0					0			0		0			0	0
Sum	1576	4058	358	33	21	140	218	3	3	9	–	1368	3	6041	364

Table 7 shows the trophy hunters' bear catches. This kind of hunting is operated from Norwegian boats for foreign tourists. The figures given here have been taken from the catch mentioned in the column 'Boats in Svalbard waters, expeditions and trophy hunters'. The sources of information are LØNØ (1965), GODTLIBSEN (p. com.), and Årsberetning vedkommende Norges Fiskerier 1965–67.

A new kind of hunting began in Svalbard in 1964. The inhabitants of Longyearbyen drove out onto the ice with snow-scooters in March, April, and May in order to hunt bears. None were shot in 1964 or 1965, but in 1966 and 1967, 6 and 19 bears respectively were killed. Two bears were also shot from a helicopter in 1966 (LANDSVERK, p. com.). This form of hunting was forbidden in 1968 (see p. 43).

In Fig. 4, the 68 bears shot by the inhabitants of Longyearbyen have been marked. Of these, about 20 were shot near Agardhbukta.

Ten of the bear cubs recorded in Fig. 4 died or were shot in Svalbard and are recorded as dead bears in Table 6.

Besides the bears imported to Norway, the following animals were lost in this period: 5 cubs caught by trappers died, and 74 hides and 2 living cubs were lost in two shipwrecks (LØNØ 1965).

Table 6

Catches of polar bears during the years 1945–1968.

Year	Newfoundland		Denmark Strait			Jan Mayen area			Barents Sea area			East-Greenland					Jan Mayen proper	Svalbard								Total	Proportion of living cubs
	Sealers		Sealers			Sealers			Sealers			Caught by trappers			Summer expeditions (boats)		Caught by weather station crew	Caught by trappers			Caught by weather station crew		Caught by Norwegian miners	Boats in Svalbard waters, expeditions and trophy-hunters				
	No. of tours	Dead bears	No. of tours	Dead bears	Liv. cubs	No. of tours	Dead bears	Liv. cubs	No. of tours	Dead bears	Liv. cubs	No. of trap.rs	Dead bears	Liv. cubs	Dead bears	Liv. cubs	Dead bears	No. of trap.rs	Dead bears	Liv. cubs	Dead bears	Liv. cubs	Dead bears	Dead bears	Liv. cubs		
1945	0	0	9	0	0	0	0	0	5	195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	195	0
1946	1	0	13	4	0	16	1	0	26	311	55	0	0	0	0	0	0	1	5	0	27	0	2	0	0	405	55
1947	1	0	20	4	5	31	1	0	34	160	24	9	11	1	2	1	0	21	277	3	25	0	3	5	1	523	35
1948	4	1	19	4	0	51	25	0	37	146	21	10	4	1	0	0	0	13	184	10	43	2	3	0	0	444	34
1949	9	0	20	7	2	46	11	0	39	176	22	13	4	0	2	4	1	2	14	0	49	1	5	5	0	303	29
1950	14	1	13	6	0	41	44	5	48	388	55	12	14	0	0	0	0	1	0	0	21	0	2	0	0	536	60
1951	11	0	25	5	1	57	2	0	56	229	32	9	10	0	0	0	0	3	52	3	32	0	4	4	0	374	36
1952	11	0	13	5	0	47	7	0	20	63	12	9	5	0	0	0	0	2	2	0	32	0	5	16	5	152	17
1953	11	5	18	0	0	35	7	0	20	235	43	13	4	2	0	0	0	0	0	0	41	1	3	6	0	347	46
1954	0	1	12	0	0	41	1	0	21	126	19	7	10	0	0	0	0	0	0	0	22	0	3	27	0	209	19
1955	10	4	11	0	0	44	1	1	24	244	45	6	8	0	0	0	0	2	72	0	22	0	6	67	0	470	46
1956	10	0	14	6	0	43	8	0	27	183	43	6	11	0	4	2	0	1	7	0	42	2	4	29	0	341	47
1957	15	6	12	0	0	37	1	0	26	226	17	4	4	0	0	0	0	2	1	0	18	0	1	34	0	308	17
1958	13	1	12	0	0	42	33	2	13	47	0	2	0	0	0	0	0	4	1	0	29	0	2	45	0	160	2
1959	13	1	7	1	0	45	3	0	13	123	0	3	4	0	0	0	0	2	123	0	45	0	5	29	0	334	0
1960	16	3	8	1	0	44	7	0	10	0	0	0	0	0	0	0	0	3	57	0	70	0	9	26	0	173	0
1961	13	2	0	0	0	40	5	0	14	35	0	0	0	0	0	0	0	4	9	0	52	0	2	21	0	126	0
1962	13	0	0	0	0	42	22	0	9	18	2	0	0	0	0	0	0	6	11	0	83	2	14	25	0	177	4
1963	13	1	0	0	0	43	8	0	15	117	1	0	0	0	0	0	2	4	62	0	84	0	4	31	0	310	0
1964	16	2	0	0	0	36	5	0	24	139	0	0	0	0	0	0	0	6	152	0	77	2	3	56	0	436	2
1965	14	1	0	0	0	38	7	0	12	1	0	0	0	0	0	0	0	6	273	0	120	0	5	28	0	435	0
1966	13	3	0	0	0	32	0	0	8	0	0	0	0	0	0	0	0	2	23	0	87	0	8	52	0	173	0
1967	15	7	0	0	0	25	2	0	5	0	0	0	0	0	0	0	0	4	100	2	79	0	22	49	2	263	4
1968	?	0	0	0	0	?	1	0	?	2	0	0	0	0	0	0	1	4	120	0	67	0	31	45	0	267	0
Sum	–	39	226	43	8	–	202	8	–	3164	391	103	89	4	8	7	4	93	1545	18	1167	10	146	600	8	7461	453

Table 7

Catches of polar bears by trophy-hunters on boats in Svalbard waters 1945–1968.

Year	No. of boats	No. of tours	No. of hunters	Catch of polar bears
1945 through 1951	0	0	0	0
1952	1	1	10	19
1953	1	3	5	6
1954	1	5	20	27
1955	1	6	24	26
1956	1	6	22	25
1957	1	4	16	29
1958	1	7	27	35
1959	1	8	28	23
1960	1	7	26	23
1961	1	7	24	21
1962	2	8	24	25
1963	2	11	41	31
1964	3	11	59	56
1965	2	8	35	27
1966	2	13	45	44
1967	2	8	?	38
1968	1	?	?	38

The Russians in Svalbard have passed on the information that from 1955 to 1965 they shot 11 bears (LØNØ 1965, and LANDSVERK p. com.). These bears have not been recorded in any table.

THE WINTER TRAPPERS' CATCH IN VARIOUS HUNTING AREAS

The western coast of Vestspitsbergen

Most of the Norwegian winter expeditions have taken place here. The basis of the hunting activity was walrus, and later, foxes. Except for the two most southerly hunting grounds Hornsund and Sørkapp (Fig. 4), which are the most important areas for the trapping of bears, there will not be any tables covering bear catches. In the areas north of Hornsund, catches have varied from two to up to ten or twelve bears per year per expedition.

The northern coast of Vestspitsbergen

In years when the ice conditions are good, more bears are trapped on the north coast than on the west. The largest catch made by the winter trappers was probably that of 28 bears which were caught by 4 men on Verlegenhuken in 1926–27 (SVENDSEN 1928). Only one instance of the capture of cubs is known of. In the middle of April, 1922, a female, which had two cubs, was shot (OXAAS 1955).

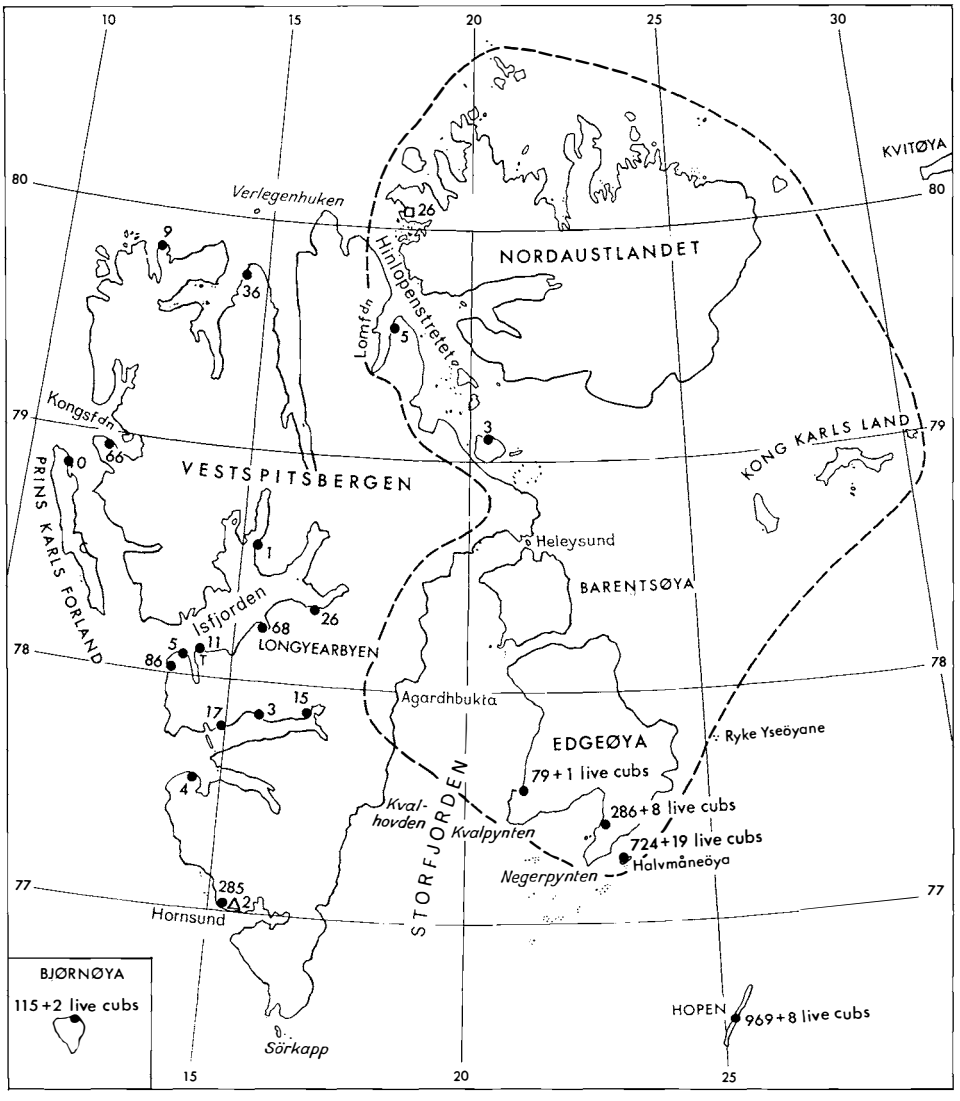

Fig. 4. *The map shows the places where polar bears were caught and the number during the winters from 1945–46 to 1967–68. Dashed line surrounds the denning areas in Svalbard. Kvitøya has never been visited in winter time, but it is very probable that the polar bear also dens on this island regularly.* □ *indicates the number of bears, and where they were killed by the Swedish-Swiss expedition in Murchisonfjorden in 1957–58 and 1958–59.* ⊤ *gives the number of bears caught by the Russians from 1955 to 1965.* △ *indicates the number of polar bears and the place where they were killed by the Polish Scientific Expedition in Hornsund in 1957–58.*

Hornsund

This hunting ground stretches 20 km to the north and 25 km to the south of the fjord. The whole area has been used only when there have been many trappers – otherwise, trapping has been carried on in the area around the fjord. It is a hunting ground where trapping is divided equally between bears and foxes. Winter trappers have been heard of in this area since 1904 (Table 8).

Table 8
Catches of polar bears in Hornsund.

Year	No. of trappers	Catch of bears		Notes and references
		Dead	Liv. cubs	
1904–05	?	?	?	Tromsø 17. VIII. 1904
1906–07	6	48	0	Oxaas (p. com.), Moberg (1960)
1907–08	3	49	0	Moberg (1960)
1908–09	2	22	0	Oxaas (p. com.)
1908–09	2	44	0	Oxaas (p. com.), Tromsø 4. VIII. 1909
1910–11	4	?	?	Nordlys 19. XI. 1910
1912–13	1	46	1	Oxaas (p. com.)
1913–14	?	25	0	Bodø Tidende 1. VIII. 1914
1919–20	5	37	0	K. Andersen (p. com.)
1923–24	3	33	0	Sørensen (1958)
1925–26	4	55	0	» »
1926–27	2	30	0	Winther (p. com.)
1931–32	2	15	0	F. Seterdal (p. com.)
1932–33	2	c. 15	0	Bussoli (p. com.)
1932–33	2	?	0	One of the trappers, a woman. A. Jacobsen (p. com.)
1933–34	4	c. 25	0	» » » » » »
1934–35	4	c. 30	0	» » » » » »
1935–36	3	c. 27	0	» » » » » »
1936–37	4	29	0	Two of the trappers women. Ørtbring (p. com.)
1946–47	2	12	0	Hansen (p. com.)
1947–48	1	2	0	» »
1959–60	2	57	0	Borch (p. com.)
1960–61	2	9	0	Nøis (p. com.)
1962–63	2	62	0	Nordnes (p. com.)
1964–65	2	43	0	Bjørnsvik (p. com.)
1965–66	2	23	0	Landsverk (p. com.)
1966–67	2	22	0	Bakken (p. com.)
1967–68	2	55	0	Falch (p. com.)

Bjørnøya

The first Norwegian winter trapping took place in 1923–24. The trappers went to Bjørnøya to catch walrus until 1865; since then, there have been a few trapping expeditions that have gone after foxes and bears. From 1916 to 1928, there was a varying number of miners on the island. Apart from 1916–17, there are no figures for the catches for these years. It is most probable that the catch was minimal. Since 1932, the only trapping in the area has been carried out by the staff of the meteorological station on the island. From 1823–65, there were 10 winter expeditions, and all that is known about them is that 8 men shot 3 bears in 1824–25, and that 8 men shot 7 bears in 1825–26 (Horn and Orvin 1928). See Tables 4, 5, and 9.

Sørkapp

This hunting ground is comprised of the southern part of Vestspitsbergen and the small island to the south. The first Norwegian winter expedition to this area was probably in 1908–09. The bear catch varies considerably because of ice conditions; some years there is very little ice, and therefore there are fewer bears. The ice arrives late here in comparison with the ice in the hunting grounds in the east. The catches are given in Table 10.

Table 9

Catches of polar bears on Bjørnøya. For the years 1823–1865 and 1918–1944, consult text and tables 4, 5, and 6.

Year	No. of trappers	Catch of bears		Notes and references
		Dead	Liv. cubs	
1865–66	7	3	0	ISACHSEN (1921)
1893–94	4	6	0	File of Norsk Polarinstitutt
1908–09	2	16	0	HOEL (1949)
1910–11	4	5	0	One died. OXAAS (p. com.)
1915–16	2	1	0	OXAAS (p. com.)
1916–17	13	13	0	All men were miners. SVENDSEN (p. com.)
1945–46	–	3	0	WESTERN (p. com.)
1946–47	–	6	0	REISVAAG »
1947–48	–	6	0	SØREIDE »
1948–49	–	3	0	DYRØ »
1949–50	–	0	0	JOHNSEN »
1950–51	–	3	0	JENSEN »
1951–52	–	4	0	KILLIE »
1952–53	–	2	0	JENSEN »
1953–54	–	0	0	SØREIDE »
1954–55	–	3	0	HOCHLIN »
1955–56	–	3	0	» »
1956–57	–	0	0	JOHNSON »
1957–58	–	0	0	RØYNAAS »
1958–59	–	2	0	KULSENG »
1959–60	–	4	0	JOHNSEN »
1960–61	–	4	0	» »
1961–62	–	5	0	» »
1962–63	–	17	0	MUNKEBYE »
1963–64	–	6	2	SØRENSEN »
1964–65	–	20	0	LANDSVERK »
1965–66	–	1	0	» »
1966–67	–	0	0	FALCH »
1967–68	–	23	0	» »

Table 10

Catches of polar bears at Sørkapp.

Year	No. of trappers	Catch of bears		Notes and references
		Dead	Liv. cubs	
1908–09	4	50	0	Two men died. Tromsø 24. VII. 1909
1909–10	2	94	0	MOBERG (1960)
1911–12	7	90	0	Bodø Tidende 4. VII. 1912
1913–14	?	46	0	» » 1. VIII. 1914
1914–15	7	34	0	File of Norsk Polarinstitutt
1919–20	4	50	0	K. ANDERSEN (p. com.)
1920–21	3	20	0	» »
1929–30	2	24	0	KRISTOFFERSEN (p. com.)
1932–33	1	25	0	10 spring-guns used. WINTHER (p. com.)

Table 11
Catches of polar bears on Kvalpynten.

Year	No. of trappers	Catch of bears		Notes and references
		Dead	Liv. cubs	
1894–95	5	63	1	Three teams, consult text
1901–02	3	52	1	Two teams. The other team on Zieglerøyane. Consult Table 12
1902–03	5			One team this year. Forced stay. One died. MOBERG (1960), Fiskeritidende (1904)
1906–07	5	65	1	One died. OXAAS and K. ANDERSEN (p. com.)
1908–09	5	45	2	OXAAS (p. com.). Tromsø 4.VIII.1909
1909–10	4	?	?	Nordlys 19.X.1910
1921–22	6	32	0	One died. MOBERG (p. com.), File of Norsk Polarinstitutt
1925–26	?	54	8	File of Norsk Polarinstitutt
1929–30	1	10	0	SVENDSEN (p. com.)
1934–35	2	35	0	BUSSOLI (p. com.)
1935–36	2	11	0	MOBERG (1960)
1946–47	2	79	1	SNARBY (p. com.)

Kvalpynten

There is a good harbour about 10 km north of Kvalpynten. Russians were the first to winter here, and they had a trapping station for several years (KEILHAU 1831). It is probable that the first Norwegian winter trapping in the east of Spitsbergen took place here in 1894–95. We must disregard the 5 men who wintered on Tusenøyane, south of Kvalpynten, in 1833–34 – theirs was an unintentional stay (Spitsbergen Gazette, No. 6, 1897). The expedition of 1894 consisted of 11 men; 4 men stayed on Anderssonøyane west of Barentsøya, 2 on Kong Ludvigøyane, and 5 on Kvalpynten (Tromsø Stifttidende, September 12th, 1895). The catches are given in Table 11.

Kong Ludvigøyane (20 km south-east of Kvalpynten)

The islands are very small and have only been visited by Norwegian winter trappers 3 times. The first time was in 1894–95, when 2 of the 11-man expedition mentioned under 'Kvalpynten' stayed there. There are no figures for these men's catch. In 1898–99, two men wintered there. In Tromsø Stifttidende, September 7th, 1899, it is stated that they caught two living cubs, but that otherwise their results were poor. The last two men to stay there, in 1906–07, trapped together with two men on Negerpynten and Zieglerøya (see Table 12).

Agardhbukta

Very few have wintered on the west side of Storfjorden. An expedition consisting of 5 men wintered there in 1909–10 and made a catch of 10 living cubs, but other catch is not mentioned (BENGTSSEN 1934). One man wintered in 1928–29, and caught a few bears (SVENDSEN p. com.).

Kvalhovden

Two men spent the winter of 1909–10 here and trapped 9 bears (Tromsø, August 31st, 1910).

Negerpynten and Zieglerøya

This area was known and hunted earlier, first by whalers, who extracted blubber over primitive stoves on Zieglerøya, and later by Russians, who may have wintered there. The first Norwegian trappers were there in 1901–02, and their catches are given in Table 12.

Ryke Yseøyane

The islands are very small, and the Russians were wintering there long time ago. The first Norwegian winter trappers landed there in 1967. The two trappers had a catch of 65 bears the first winter and 44 the second. One of the trappers perished at the end of the second season (TORSVIK p. com.).

Halvmåneøya

The first Norwegian winter trapping took place in 1898–99. Before that time, the island had been visited by sealers who were looking for walrus. Pack ice surrounds the island early in the autumn, and the trapping season is long. After the days begin to grow lighter at the end of February, those who trap there have always gone across the ice to Edgeøya and trapped there a little, mainly for living cubs. Most of the catches in Table 13 were made on the island itself or on the pack ice in the immediate vicinity. The best month for trapping is usually February – to quote just one example, two trappers caught 54 bears in February 1936 (RUDI p. com.).

Kong Karls Land

This group of islands has been regarded by sealers and winter trappers as the best hunting ground for bears in Svalbard; but the ice conditions are usually

Table 12

Catches of polar bears at Negerpynten and on Zieglerøyane.

Year	No. of trappers	Catch of bears		Notes and references
		Dead	Liv. cubs	
1901–02	3	–	–	One died. Two teams. Consult Table 11
1904–05	5	?	?	BENGTSSEN (1934)
1905–06	3	?	?	–»–
1906–07	2	25	0	Two teams. The other team on Kong Ludvigøyane, consult text. OXAAS (p. com.)
1906–07	4	37	3	OXAAS (p. com.). Tromsø 25.IX.1907
1909–10	5	50	0	10 spring-guns and poison. ASPMO (p. com.)
1910–11	5	5	0	Forced stay. Three died. ASPMO (p. com.)
1929–30	2	66	0	18 spring-guns. SVENDSEN (1930)
1946–47	2	25	0	RUDI (p. com.)
1947–48	2	55	1	–»– –»–
1950–51	2	52	3	15 spring-guns. LØNØ (author)
1954–55	2	72	0	15 –»– –»–
1964–65	2	82	3	11 –»– –»–

Table 13
Catches of polar bears on Halvmåneøya.

Year	No. of trappers	Catch of bears		Notes and references
		Dead	Liv. cubs	
1898–99	2	9	0	Both died. Tromsø Stift. 3.IX.1899
1906–07	8	82	3	Two teams, four men trapping on Edgeøya Most of the catch taken on Halvmåneøya. Spring-guns and poison used. OXAAS (p. com.)
1908–09	4	?	2	BENGTSSEN (1934)
1909–10	5	60	0	Three died. MOBERG (1960)
1910–11	2	0	0	Forced stay. No ammunition. MOBERG (1960)
1935–36	2	115	1	23 spring-guns. RUDI (p. com.)
1936–37	2	117	0	RUDI (p. com.)
1937–38	2	88	0	RASMUSEN (p. com.)
1939–40	2	115	0	File of Norsk Polarinstitutt
1946–47	3	138	5	LØNØ (author)
1947–48	4	114	10	BJÅEN (p. com.)
1958–59	2	123	0	NESSAN (p. com.)
1963–64	2	118	0	BJØRNSVIK (p. com.)
1964–65	2	145	0	–»–
1966–67	2	76	4	FORFANG (p. com.)

difficult, and the only expedition to have wintered there did so in 1908–09. It consisted of 6 men, who trapped from two winter cabins on the most westerly island. The catch was made up of 84 dead and 21 living cubs. This is the largest catch of living cubs to have been made in Svalbard. As none of the boats managed to get through the ice in 1909, the cubs had to be shot, and the trappers managed to cross the ice to Vestspitsbergen. Since 1939, the bear has been completely protected by law on Kong Karls Land (see p. 43).

Nordaustlandet

The first Norwegian winter expedition stayed here in 1908–09 (SØRENSEN 1958). Comparatively few trapping companies have visited Nordaustlandet since the results of the catch have not been what was hoped for. The northern waters fill up with pack ice very early, and trapping is carried out early in the winter. Hinlopenstretet never freezes because of the current, but, even so, the catches are not as large as those made further south. It is possible that a couple more expeditions besides those mentioned in Table 14 have visited the island.

Lomfjorden

It has been difficult to get an overall impression of the expeditions which have wintered here. I have information about 7. The expedition of 1908–09 was presumably the first, and it caught 27 bears and 1 living cub (Tromsø, September 15th, 1909). The largest catch is probably that made by 5 men in 1910–11, who caught 30 bears (K. ANDERSEN p. com.).

Hopen

The first winter expedition to Hopen was in 1908–09 (SØRENSEN 1958). The island had been visited earlier by sealers on the look out for walrus in the summer.

Table 14
Catches of polar bears on Nordaustlandet.

Year	No. of trappers	Catch of bears		Notes and references
		Dead	Liv. cubs	
1908–09	4	7	2	All men died. OXAAS (1950)
1908–09	4	?	?	Tromsø 10.VIII.1910
1910–11	5	30	0	K. ANDERSEN (p. com.)
1923–24	2	18	2	4 spring-guns. OLSEN (1924)
1923–24	3	?	?	OLSEN (1924)
1928–29	2	14	0	B. JOHANSEN (p. com.)
1933–34	3	?	?	BENGTSSEN (1934)
1933–34	2	1	0	Both died. DAHL (p. com.)
1934–35	2	10	1	SØRENSEN (1958)
1957–58	–	22	0	Scientific exp. LØNØ (1965)
1958–59	–	4	0	–»– –»–

Until 1945, when a weather reporting station was established there, the island had been visited only three times by winter trappers. In certain years there may be difficult ice conditions around the island, and it is therefore difficult to land there.

Since 1945, the men on the meteorological station have trapped bears with spring-guns, and there has always been one or more trappers among them. Trapping conditions have varied a good deal. We can assume the approximate number of days for bear trapping to be the same as the number of days of winter pack ice. Table 15 gives the total of bears caught on Hopen and shows the drift ice conditions during those years trapping has been in operation. By "year's ice", I mean the pack ice around the island from July 1st to June 30th of the following year ; by "winter ice" is meant the drift ice around the island from October 1st to May 15th of the following year. I have received information about the drift ice from the men on the weather station, who have kept diaries, from storm entries

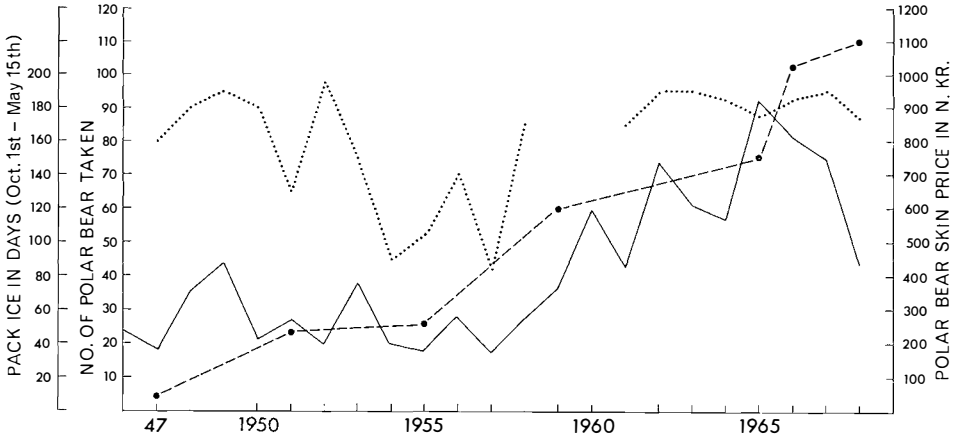

Fig. 5. *Polar bears caught on Hopen* (——). *Winter pack ice in days* (*October 1 to May 15 round Hopen* (. . . .). *Prices received by trappers for raw polar bear skins in Tromsø* (– – –).

Table 15

Catches of polar bears on Hopen.

Year	No. of trappers	Catch of bears		Pack ice in days		Notes and references
		Dead	Liv. cubs	Yearly July 1– June 30	Winter Oct 1– May 15	
1908–09	6	89	1	–	–	10 spring-guns and poison used, 25 bears taken on poison. RUDI (p. com.)
1923–24	3	25	0	–	155	15 spring-guns used. SØRENSEN 1924
1934–35	3	35	0	–	–	33 –»– –»– TRØHAUG 1935
1945–46	4	24	0	–	–	BØRSTING (p. com.)
1946–47	4	19	0	215	160	–»– –»–
1947–48	4	34	2	250	180	–»– –»–
1948–49	4	43	1	230	190	–»– –»–
1949–50	4	21	0	225	180	–»– –»–
1950–51	4	27	0	165	130	EILERTSEN (p. com.)
1951–52	4	20	0	215	195	HOFSØY (p. com.)
1952–53	4	37	1	190	150	15 spring-guns used. DYRØ (p. com.)
1953–54	4	20	0	90	90	HOFSØY (p. com.)
1954–55	4	18	0	120	105	KULSENG (p. com.)
1955–56	4	36	2	160	140	–»– –»–
1956–57	4	18	0	135	85	–»– –»–
1957–58	4	28	0	250	170	S. ANDERSEN (p. com.)
1958–59	4	37	0	–	–	BERGERSEN (p. com.)
1959–60	4	60	0	–	–	–»– –»–
1960–61	4	43	0	240	170	S. ANDERSEN (p. com.)
1961–62	4	72	2	230	190	TORSVIK (p. com.)
1962–63	4	61	0	260	190	BERGERSEN (p. com.)
1963–64	4	57	0	275	185	–»– –»–
1964–65	4	93	0	240	175	53 spring-guns used. BJØRNSVIK (p. com.)
1965–66	4	82	0	300	185	41 –»– –»– TORSVIK (p. com.)
1966–67	4	75	0	270	190	25–30 –»– –»– ALVÆR (p. com.)
1967–68	4	42	0	270	175	FALCH (p. com.)

in the meteorological log-books, and, from January 1963, from ice reports sent from Hopen to Norsk Polarinstitutt (not published). Table 15 and Fig. 5 show that there was little ice from 1953 to 1956. Since 1957, the amount of pack ice around Hopen has been increasing, and in the last few years there have been twice as many trapping days on the island as there were in the 1953–54 and 1956–57 seasons.

The price for buyers of hides of bears trapped in the winter is also entered in Fig. 5. The price is based on notes made during the year I myself hunted, or on reliable information given to me by buyers. Since 1958, both the trapping conditions on Hopen and the price of skins have been good, and this has resulted in large catches. In 1964–65, 93 bears were caught on Hopen, the greatest number ever to have been caught there.

Novaja Zemlja

Information is available about 3 Norwegian winter trapping expeditions in the northern part of Novaja Zemlja; in 1908–09, 4 men caught 38 bears (RUDI p. com.), and in 1909–10, there were two expeditions there, although the catch is not known (Tromsø, July 27th, 1910, and KRÆMER 1940). This was probably

the last year that Norwegian expeditions went there, since the Russians banned further expeditions. In 1910–11, however, 6 Norwegians fitted out by a Russian company wintered there, but their catch is unknown (LYDERSEN p. com.).

Jan Mayen

Jan Mayen was regularly visited in the 16th and 17th centuries by whalers. The first winter trappers on the island were the Norwegians, and they started in 1906 (Jan Mayen 1929). The island has always been a hunting ground for foxes, whereas bears have only been hunted occasionally. During the years 1941–46, there were Norwegian soldiers on the island, but no trappers. The catches are given in the Tables 4, 5, and 6.

North-East Greenland

Norwegians were the first to begin winter trapping in North-East Greenland, and the first expedition arrived in 1908 (GIÆVER 1939). Norwegian trapping activities ceased in the area, however, in 1959 (LØNØ 1964). The total catch is given in Tables 4 and 5, and the figures from here are extremely reliable. The activity in North-East Greenland has always been based on the trapping of foxes, but bear trapping by means of spring-guns has been carried out from some stations. The dotted line in Fig. 6 has been drawn according to the information given by several winter trappers. To the west of this line, that is, the territory in the fjords, bears are rarely seen. Kapp Herschell is the hunting ground where most of the bears have been caught because this territory is nearest to the pack ice. In Table 16, the total bear catch for 1938–1959 is given, divided into the different hunting areas (LØNØ 1964). Since the areas are extensive, some of the bears may have been shot some distance from the main stations.

South-East Greenland

The first Norwegian winter expedition took place in Kulusuk (65°N) in 1893–94, but the results of it are unknown (GIÆVER 1939). In 1931, an experiment was made by 6 winter trappers in South-East Greenland (from 62°40′ to 63°35′N)

Table 16
Catches of polar bears in North-East Greenland 1938–59.

Hunting areas	No. of seasons used	Catches, dead bears
Ottostrand	5	4
Jonsbu	3	7
Revet	17	2
Kapp Herschell	11	51
Hoelsbu	17	7
Myggbukta	17	11
Humboldt	9	9
Antarctichamna and Kapp Peterséns	10	9
Sum	89	100

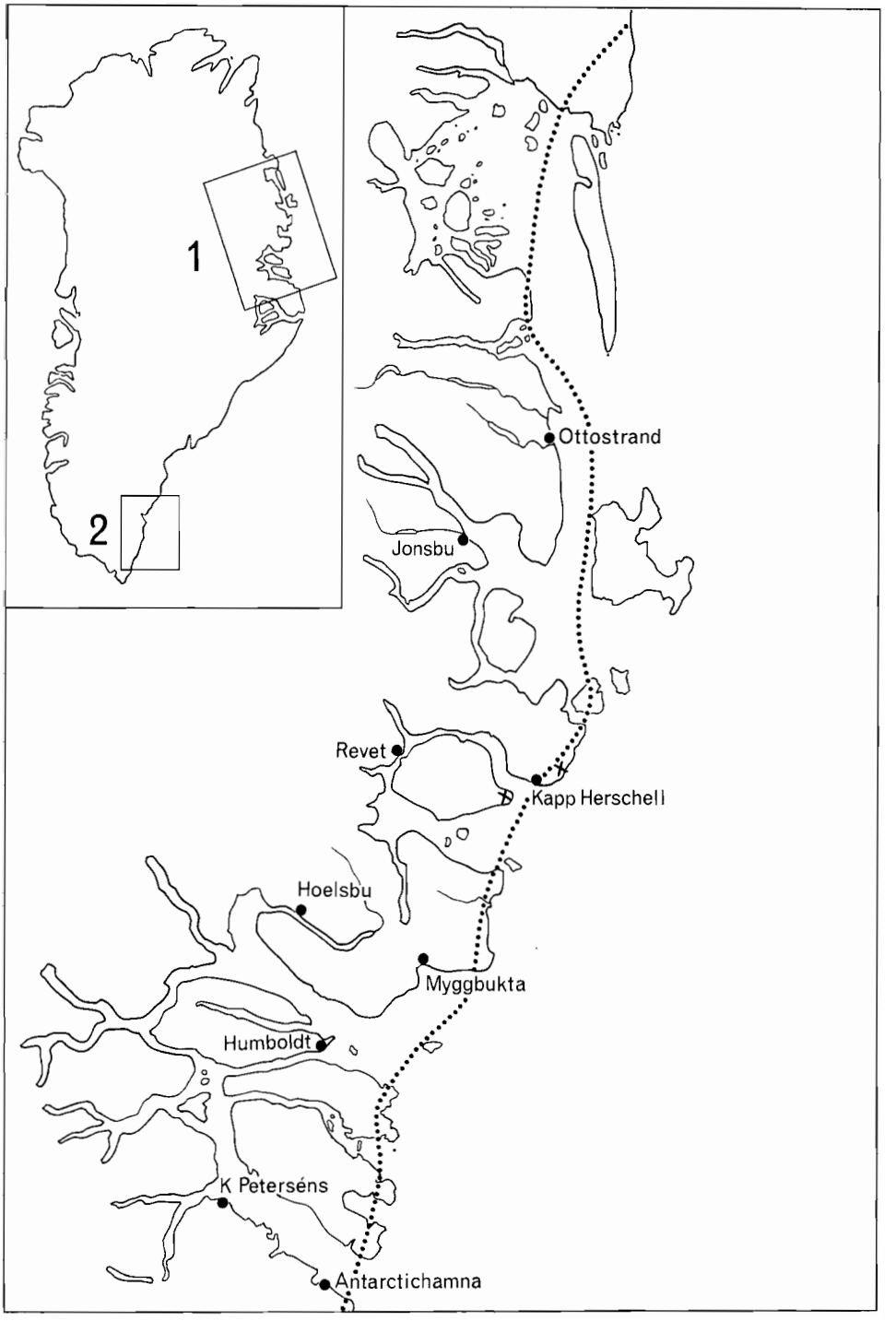

Fig. 6. *The Norwegian trappers' main stations in North-East Greenland (1). The polar bear is rarely found west of the dotted line. The frame marked (2) indicates where in South-East Greenland some wintering has taken place.*

(Fig. 6). This experiment lasted for two seasons; they caught 11 bears in the first season and none in the second (SØRENSEN 1958).

In 1931, a Norwegian weather station, Torgilsbu, was established in South-East Greenland (60°40′N), and the men also engaged in some hunting. The station was in operation until the summer of 1940. The total bear catch for South-East Greenland is given in Table 5.

Franz Josef Land

I am going to deal with bear trapping in Franz Josef Land even though it lies somewhat outside the scope of this section. There had never been Norwegian or other winter trappers in these islands right up until 1929, when they were occupied by the Russians, and since 1929, there have hardly been any purely trapping expeditions. More recently, however, there has been a Russian biological station there (PAROVŠČIKOV 1964).

According to HORN (1930), Franz Josef Land was discovered by the captain of a sealer, a Norwegian called RØNNEBECK, in 1865. Norwegian sealers immediately began to hunt between the islands and on the pack ice to the south. The ice conditions are difficult, and some years it has been impossible to land. Besides walrus, which was of primary importance, bearded seals, harp seals, and bears were also caught. Norwegians were the only people to hunt in this area. HORN concluded that they made 105 tours to Franz Josef Land and the drift ice south of the islands. It is difficult from the catch figures to be able to say just how many bears have been shot in Franz Josef Land, because the trips have been combined with sealing in Øst- and Nordisen (Franz Josef Land was regarded as part of Nordisen). Also, many figures are missing, and many are just given as 'a number of bears'. From HORN's information, I have estimated that up to 1929, Norwegian sealers caught somewhere between 500 and 1,000 bears, many living cubs among them, in the waters between and around the islands.

Even though there is no information from trapper expeditions which have spent the winter in Franz Josef Land, we can still obtain a certain amount of information about the occurrence of the bear in the islands from the reports from scientific expeditions.

NANSEN (1897) says that he and his friend, who were forced to spend the winter on one of the most northerly islands in 1895–96, shot 20 bears. From the end of August until November 8th, they shot 16 bears, of which 5 were cubs. From November 8th to March 8th, they did not see any bears, but from between March 8th and May 19th, they shot 4 more.

JACKSON (1899), who led the Jackson–Harmworth Expedition in 1894–97, and who had winter quarters on the most southerly island (Northbrook), hunted the bears which he saw. It appears from his game list that the winter catch (that is, from October 1st to May in 1894–95) was 31 bears and 4 living cubs; in 1895–96 the catch was 18 bears, and in the last winter it was 6 bears.

The Austro-Hungarian Polar Expedition 1872–74, in the ship «Tegetthoff», was stuck in the ice north of Novaja Zemlja in September 1872, and continued northwards to Franz Josef Land. They came close to land in August 1873, and stayed there until they abandoned ship on May 20th, 1874. PAYER (1877) writes

of the occurrence of the polar bear during the drift northwards: "The bear had cheered us by its numerous appearances during the summer and autumn, but, in contrast, it became rarer during the following winter. December, particularly, passed by without our once catching sight of one. Early in the second part of the winter, however, its appearance became more frequent".

RECAPTURED POLAR BEARS TAGGED IN THE SVALBARD AREA

In the summers of 1966, 1967, and 1968, 4, 51 and 31 bears respectively were tagged on the pack ice east of Svalbard. In the winter 1968–69, 17 bears were tagged on Edgeøya (LARSEN 1967, 1969a and 1969b).

According to LARSEN (1969b) out of the total of 103 bears 15 bears have been recaptured and one resighted. One of the bears was shot in South-West Greenland, and has probably followed the East Greenland Current around Cape Farewell. Of the other 15 bears 5 have been recaptured and one resighted in the summer, and 9 recaptured in the winter in the Svalbard area.

The longest time between tagging and recapturing in the Svalbard area is two years. The bears, which moved to South-West Greenland, had covered a distance of at least 3,500 km in 1½ years (LARSEN p. com.).

DISCUSSION

Conditions which influence polar bear catches

The Norwegian bear catch varies greatly from year to year. There can be a difference in the catch brought in of several hundred bears from one year to the next, as Fig. 7 shows. This variation can have several causes, and some of the conditions which cause the fluctuations in number are indicated below.

The hunting of bears has always been an additional activity of the sealing boats. If sealing is at all possible, then the sealers do not allow themselves time to hunt

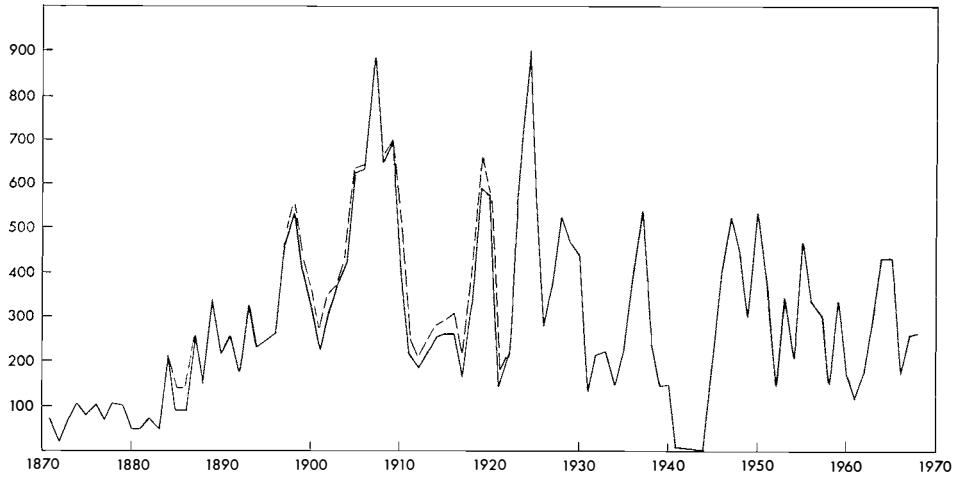

Fig. 7. *Total Norwegian polar bear catch in the Arctic 1871–1968. Known* (——) *and calculated catch* (– – –).

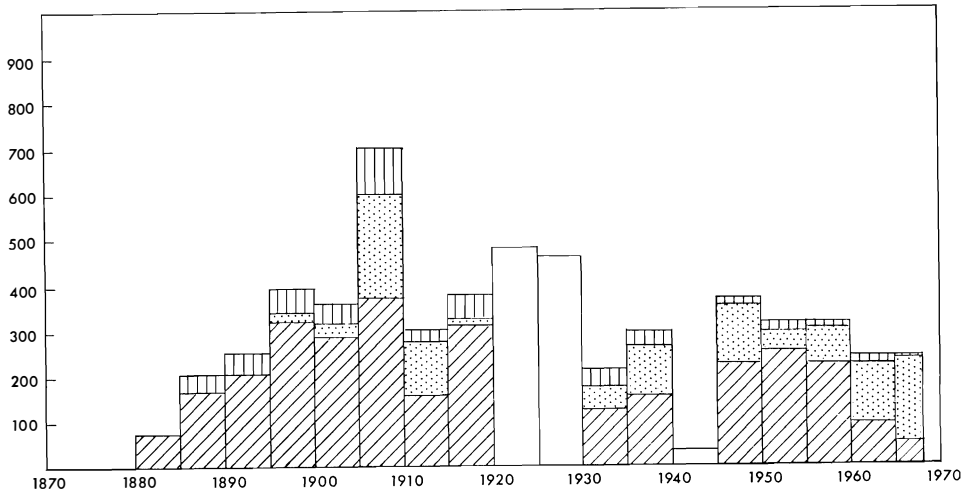

Fig. 8. *The Norwegian catch of polar bears 1880–1968. Average five-year periods (except 1965 to 1968). Here both known + calculated catch have been used. Catch from winter trappers in East Greenland and on Jan Mayen proper not recorded.*

indicates catch taken in the Barents Sea area (Nordisen and Østisen).

indicates winter catch in Svalbard.

indicates catch on Jan Mayen area + Denmark Strait + Newfoundland. Only total catch given for 1920–1929 and 1940–1944.

bears. It is only the winter trappers in some of the hunting grounds in Spitsbergen for whom bear trapping has been the main objective. According to figures quoted by NICOLAYSEN (1894) during the five years from 1876–80, bears amounted to only 1.6% of the total value of the catch brought in to Tromsø. (Reindeer and down amounted to 9% and 4% respectively of the value of the catch for the same boats.) During the five years from 1901–05, bears amounted to 13% of the Arctic catch which was brought in to Tromsø, and of this, 2% was the winter trappers' bear catch. The figures for these last five years have been calculated from figures given in Norges Fiskerier (1901–06).

The expansion of the sealers' hunting grounds has affected the size of the bear catch. The first big change took place when the walrus was almost wiped out along the coasts of Spitsbergen. The boats went over to sealing, or hunted walrus near Novaja Zemlja, which is where Norwegian sealers began hunting in 1867 (HOEL 1949). We can see just how great an influence this had on the composition of the catch from HELLAND's (1905) figures (Table 17), which show the catch per boat which was brought in to Hammerfest during the periods of 1821–29 and 1896–1900. Later, the boats began to hunt in Denmark Strait and Newfoundland, but as the number of bears here is small, this hardly affected the statistics at all.

Pack ice varies greatly over both longer and shorter periods, and this can make for changes in the catch. This is true particularly of certain bear hunting grounds in Spitsbergen, such as Hornsund, Sørkapp, and Hopen.

Table 17

Catches per boat per year taken to Hammerfest during the periods 1821–1829 and 1896–1900.

	1821–1829	1896–1900
Walrus	88	10
Seals	2	610
Polar bear	1	6
Reindeer	20	1
Down (kg)	186	6

The new trapping methods, such as the use of poison and the spring-gun, which were introduced in about 1900, meant that the winter trappers' catches were much larger than before.

The change over from sail to engines in the sealing fleet from 1895 to 1910 (HOEL 1949) meant that it became much easier for the boats to hunt bears in the pack ice.

Prices for bear hides have varied greatly and this has, of course, influenced the interest shown in bear hunting. During the first World War prices were good, but in the 1930's, prices were low, and according to «Årsberetning vedkommende Norges Fiskerier», it was hardly possible to sell bear hides and living cubs in 1931 at all (see Fig. 8 for the years 1930–35). For the first few years after 1945, prices were very low, and even the best winter hides were sold for leather. The number of bears shot during these years, however, is explained by the fact that the price of blubber was good, and the bears were hunted for that reason. In more recent years, prices for bear hides have improved considerably (see Fig. 5).

Something else which also affects prices and also the effort put into trapping, is the ratio between the hides brought to Norway, which are taken by the boats in the summer, and those which are taken by the winter trappers. If there are many winter hides of a high quality the price for summer hides will be low; the opposite is true if there are few winter hides on the market. Let me illustrate this by an example. In 1965, there was only one boat engaged in hunting on the pack ice around Svalbard, and one bear was shot. The boat arrived at our winter quarters, and the crew visited us. The captain told us that they could have shot many more bears, but that they were not interested because the price for summer hides in Norway was very low, as the buyers knew that many winter trapped hides would be coming in that summer.

The figures for the capture of living cubs after 1946 are completely reliable, as there has been a rigorous check on import and transit since then. The figures for before 1930 are much less complete as the sources of information show that dead and living bears have been entered together, although it is difficult to give a clear picture of the extent to which that was carried out.

Most of the living cubs are caught by the sealing boats which hunt in the pack ice around Svalbard in the months of July and August – the number caught by winter trappers is inconsiderable.

The amount of activity in the trapping of living cubs has varied a good deal,

depending on prices and the demand from circuses and zoos. In some years, prices were good, and thus the trapping which brought in living cubs was the most important. This was the case from 1945 to 1955, when the returns for the capture of living cubs were greater than the value of the hides brought to Norway. During the last ten years, the capture of living cubs has virtually ceased because of the strict rules in Norway, governing their import and transit.

Fluctuations in the number of polar bears

Let us go back to what POOLE (in Purchas His Pilgrimes 1906) said about his bear hunting in Spitsbergen in 1610. POOLE, who knew nothing about the country or about hunting conditions, killed 27 bears and caught 5 living cubs, using very primitive means, in June and July. Even though we have not any more reports of bears caught on these early expeditions, we can assume that it was no accident that such a large catch was made that summer. There can be no doubt that at that time there was a group of bears on the west coast of Vestspitsbergen during the summer. The explanation must lie in the fact that in addition to their normal diet, those bears also lived of the large schools of walrus that are mentioned. Recent investigations show that the polar bear can kill walrus (see p. 44). It is also probable that the polar bear's usual pray, the ringed and bearded seals, were more frequent then than now. It is, of course, impossible to say how large the number of bears on the west coast was during the summers of the years after the arrival of the first explorers in 1596.

Today the polar bear is not found on the west coast of Vestspitsbergen in the summer, except for an occasional and rare example, and it is most probable that there have not been more bears since Norwegians began to hunt there after 1800. Captain EIDE (1936), who caught walrus on the west coast of Vestspitsbergen and in all made three tours in the summers 1830 and 1831, writes about his experiences about the polar bear: "I do not think there are many of them... I cannot remember having seen more than five or six, and two of them were killed in the water."

From the information that is available it is possible, for most years at any rate, to make a diagram of the distribution of bear catches made in the different grounds. The catches from the Jan Mayen area, Newfoundland, and Denmark Strait have been combined. Most of the bears have been caught in the Jan Mayen area. The catches from Nordisen, Østisen, and the White Sea have also been combined – most of these catches are from Nordisen. The catches made by winter trappers in Svalbard have been included separately, while the winter trappers' catches from East Greenland and Jan Mayen proper have been left out of Fig. 8, as they were too small to show. The catches have been averaged over five year periods in order to even up the large variations. The distribution shown after 1945 gives the true picture. It is right only approximately from 1885 to 1919, and the distribution has been entered on the diagram so that the catches made by boats from East-Norway and Sunnmøre come under the Jan Mayen area, and the catches made by North-Norwegian boats come under the Barents Sea area. The resulting error is a small one. For 1930–34 and 1935–39 the distribution has been calculated from unpublished figures from Fiskeridirektoratet in Bergen (p. com.).

If we look at Figs. 7 and 8, we see an increase in the amounts of the catches from 1871 to 1907; this is due to an increase in the industry's activity and effectiveness. From 1907 up to today, however, there has been a decrease in the number of bears caught. This decrease in the total catch cannot, as a matter of course, be interpreted as a decrease in the number of bears in those areas where Norwegians have hunted. The catch from Øst- and Nordisen, the most important hunting grounds for bears, has steadily been growing smaller since 1945, and the reason for this is that the numbers of those engaged in hunting have gradually become fewer. There were no sealing boats in Nordisen in 1966 and 1967, but hunting as a sport for tourists has been carried out in this area since 1952. Since 1945, the winter trappers' catch has been relatively large, and the reason for this is the trapping carried out from the meteorological stations.

The catch from the Jan Mayen area has diminished since 1910 (Fig. 8), and many trappers believe that this is because of a decrease in the number of bears in this area (IVERSEN 1941). However, some trappers (DAHL and others, p. com.) believe that the bear has become more frequent again in the Jan Mayen area after 1945, although this has not resulted in increased catches.

The catches from Hopen (Fig. 5 and Table 15) show an increase from 1960. It is unlikely that this is connected with any increase in the number of bears in the area, and its cause is more likely to be found in better trapping conditions (that is to say, more ice) and an increase in trapping activity because of more favourable prices. The first catch in 1908–09 of 89 dead bears and 1 living cub was not bettered until 1964–65. Poison and 8 or 10 spring-guns of the old type were used in that first season, and the trapping conditions were not all that good. RUDI (p. com.), who was one of the trappers during the 1908–09 winter, says that if they had had the equipment that is used today, the result would have been at least 30 or 40 bears more.

If one tries to calculate the boats' and the winter trappers' catches, together with the activity in the industry and the development in the effectiveness of the methods used by both sealers and trappers, the implication is that there has been a decrease in the number of bears in the Svalbard area since the 1900's. It is difficult to estimate the size of the decrease, but it is unlikely to have been as much as 25%. KRÆMER (1940), who was a very experienced Arctic captain and who started in the Arctic in 1895, says: "There are many bears, and the number does not seem to be decreasing, even though in a single year about 400 bears were shot by Norwegian sealers just around Spitsbergen". DAHL (p. com.), who is also a very experienced Arctic sailor, says that there are fewer bears, especially females with cubs, to be seen in Nordisen in the last years.

There has never been any resident population in those areas of Svalbard where the females make their dens, and there have been few winter trappers in these areas. Females have never, or at any rate very rarely, been hunted in their denning areas, and this has been of great importance for the continuation of a numerous and vigorous breed of bears in Svalbard.

The distribution of the polar bear in the Barents Sea area

The area west of 15°E – that is, the pack ice between Svalbard and Greenland

– is not going to be discussed here, since the information about it is incomplete. We only know that the bear occurs there less than in the Svalbard area.

The Svalbard area. – By 'the Svalbard area' I mean the western part of Nordisen, the pack ice around Svalbard and eastwards to 35°E. The catch figures and the winter trappers' figures, which show when the catches were made during the year, and comments from people with experience of the Arctic (LANGUANE, SNARBY, DAHL, GODTLIBSEN, PEDERSEN, OXAAS, and others (p. com.)), give a basis for the estimation of where and when we can expect to find bears in this area.

It must first be ascertained that there is nothing to suggest that the bears wander to or away from the Svalbard area at any time of the year. Just as many bears are to be found here in the summer and winter, with some local deviations because of changing conditions in the pack ice. These deviations can be sizable in the course of the year, when the edge of the pack ice undergoes great variations. The bear is to be found throughout the whole area in the pack ice between Svalbard and Novaja Zemlja, though it is less frequent midway between the two points. Nevertheless, it is usual to find bears on Nordostodden, a spit of ice which forms regularly in the pack ice between 38° and 40°E. We do not know how far east of Svalbard, or how far west of Franz Josef Land the bear roams. Neither is it known whether there is just one group of bears which uses both groups of islands as denning areas, or whether there are two groups, each of which has its dens in its own group of islands. The latter is the more probable, even though the groups may overlap in their hunting grounds in the pack ice between the groups of islands.

In September, when there is normally least pack ice (see Fig. 9), the bear is to be

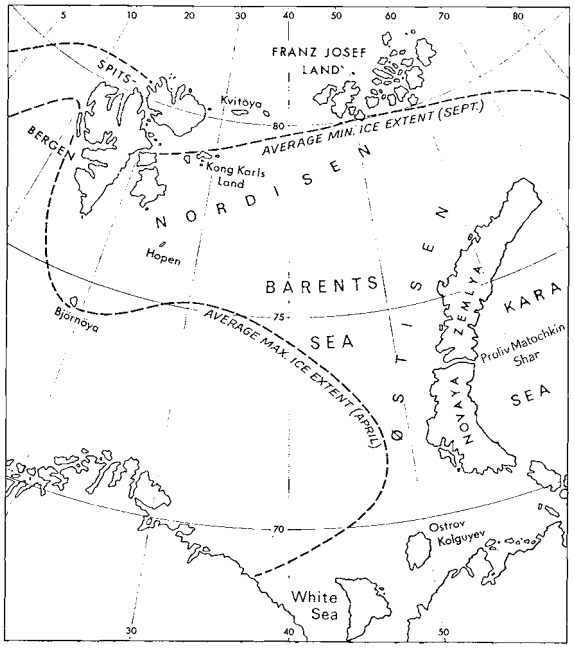

Fig. 9. *Barents Sea area. Dashed lines indicate average maximum and average minimum extent of drift ice. (From Oceanographic atlas of the Polar Seas.)*

found on the pack ice east, north-east, and north of Svalbard. We do not know how far northwards the bear usually goes, but it can be found as far north as 82°N in the summer when there is little ice. In the summer the bear is rarely found on land, and it is exceptional to see bears in those areas where the land is not enclosed by pack ice. Most of the ringed seals, and particularly the bearded seals, follow the pack ice when it recedes.

Under special conditions, Svalbard can be completely free of pack ice for a short period in the autumn, although this seldom happens; the bear then follows the ice when it moves north and east.

When the amount of ice increases again in the autumn and winter, the pack ice again fills up the waters from the north-east. The bear accompanies it, and there are always some bears to be found at the extremities of the pack ice. It is well known among winter trappers in the east of Spitsbergen that trapping begins when the first ice comes. But the bear becomes more frequent after the ice has packed around the hunting ground. The polar night is the time of year when the bear is most frequently found on land, although it hardly ever roams very far inland. It takes a short journey on land, not far from the edge of the pack ice and then goes back to the pack ice again. The areas around the north-eastern parts of Spitsbergen are soon enclosed by close pack ice and there, fewer bears are to be found. Trappers who have stayed on the northern side of Nordaustlandet have caught a few bears which arrived early in the winter. The west coast of Vestspitsbergen is enclosed by pack ice from the south, and that is the reason that the bear is found more frequently the further south towards Sørkapp one goes. The north side is enclosed by pack ice from the north and east. The most northerly part of the west coast is the last to be enclosed by ice, and that is the reason that this part of Spitsbergen is the part which is visited least by bears. Pack ice fills up the large areas of sea south and east of Svalbard until well into the winter, and the bear is to be found on this ice. The catches from Hopen and Bjørnøya show that even during the polar night, the bear is to be found far from land. We know nothing about the distribution of the bear on the pack ice midway between Svalbard and Novaja Zemlja during the polar night, as no observations have been recorded.

By the time of maximum extent of pack ice, which is usually March–April (Fig. 9), the bear will be found all over this large area covered by ice. Fewest bears are to be found on the furthest edge of the pack ice, where it is very open and in the areas far in the pack ice where it is very close.

In the spring and summer, the opposite of what has just been described happens. The huge ice masses thaw away from the south and south-west, and the bear follows the pack ice towards the north and north-east. After a while, the bears are concentrated in a smaller area.

The Franz Josef Land area and the pack ice southwards to the White Sea. – By this area, I mean the eastern part of Nordisen from 35°E and Østisen – that is to say, the pack ice around Franz Josef Land and southwards, west of Novaja Zemlja, to the White Sea.

It is possible to get a good idea of the distribution of the bear in this area from

information taken from PAROVŠČIKOV (1964), NANSEN (1897), JACKSON (1899), HORN (1930), and from statements by the same trappers who have been mentioned earlier in this chapter. The group of islands called Franz Josef Land is surrounded early in the autumn by pack ice, and in October and November the pregnant females dig themselves into their dens and remain on the islands, while most of the other bears disperse on the pack ice to the south, south-west, and west. Some females have their dens on the east coast of Novaja Zemlja (USPENSKIJ 1965). Southwards in the pack ice west of Novaja Zemlja the bears are usually found as far south as the latitude of Matochkin Shar. The bear becomes steadily less common in the pack ice south of these straits as far as the latitude of Ostrov Kolguyev, and south of Ostrov Kolguyev the bear occurs very rarely. In the opening of the White Sea, where the harp seal has its young at the end of February and the beginning of March, the bear is hardly ever seen. Captain LANGUANE (p. com.), who has hunted there for 13 seasons, has never seen a bear in this area.

In the spring and summer, when the ice thaws, the bear follows the ice northwards, and is to be found in the pack ice south and south-west of the islands, around the islands, and to the north of the islands.

The question of a local group of the polar bear in the Svalbard area

There is nothing in this survey to prove that a local group of bears is to be found in the Svalbard area. Even so, I shall refer briefly to 3 points which indicate that this could be the case.

1) The statistics for the catches show that there are just as many bears on the pack ice around Svalbard all the year round. If the bears in the Svalbard area began to roam away, then there would have to be a simultaneous movement of as many bears *into* the area. This is improbable.

2) The length of the skulls of bears shot in Svalbard (condylobasal length, see 'Age determination') are, on the average, smaller than the bear skulls from Canada and Alaska (measured by MANNING 1964). MANNING says: "There is some evidence that Alaskan adults average a little larger than those from Canada. Certainly northeast Greenland adults are smaller . . . .". No measurements have been given for the material collected from North-East Greenland, so it is not possible to make any comparison with the material from Svalbard. Measurements of skulls from Franz Josef Land are unknown.

3) Fifteen out of sixteen recaptured bears, tagged in the Svalbard area, have been caught in the same area (see p. 35). The bears have been caught both in the summer and in the winter (LARSEN 1969b).

This strongly indicates that the polar bear keeps within limited areas, but the tagged bear, which was shot in Greenland, shows that a few bears at any rate, can roam far away from Svalbard.

Lastly, it must be mentioned that there are signs in other places where the polar bear occurs, that there have been local groups of bears. BRUEMMER (1969) says: "Long ago, though, polar bears were common along the Labrador coast. The 18th century trader-explorer-hunter, Captain George Cartwright, came upon more than a dozen polar bears, scooping salmon out of a south Labrador river in the fashion of the great Alaska brown bears. Dr. Charles Jonkel, of the

Canadian Wildlife Service, believes this may have been a locally learned technique of the Labrador polar bears. Since this group has vanished, no further observations of polar bears catching salmon or char in this manner have been reported".

Laws regarding hunting of the polar bear in Svalbard and Jan Mayen

SVALBARD

The Spitsbergen Treaty of 9th February 1920 gave Norway full and complete sovereignty over Svalbard. The official confirmation of sovereignty was made on 14th August 1925. Before this there had been no laws regarding Svalbard. Anybody was able to hunt there without restriction of any kind.

The following laws have been passed:

1927 Use of poison in hunting prohibited.
1928 Use of steel traps prohibited, applicable also to the polar bear.
1939 Polar bear protected on the group of islands, Kong Karls Land.
1955 Protection of the polar bear extended to surrounding territorial waters of Kong Karls Land.
1957 Catching of live bears prohibited. Exemption may be granted for a limited number on written application from an approved zoological garden, on condition that the bears are not re-sold.
1963 The number of polar bears in trophy hunting from boats was limited to one animal per participant.
1965 Trophy hunting was restricted still further. The shooting of polar bear cubs and females accompanied by cubs was prohibited.
1967 It was prohibited to search for and pursue polar bears by motor vehicle, e. g. snowscooter and snowmobile, or by air transport, e. g. plane and helicopter.
1967 Exemption regarding catching of live bears was extended, whereby the authorities can give permission to catch live animals, if the bears are to be used for scientific purposes.

All these prohibitions are in force today (May 1969).

JAN MAYEN

Jan Mayen came under Norwegian jurisdiction 8th May 1929. Before that there had been no special laws for Jan Mayen.

In 1930 all laws pertaining to Svalbard were made operative for Jan Mayen, including all the regulations regarding polar bear hunting.

DISCUSSION

Before 1927 there were no restrictions on polar bear hunting in Svalbard and the surrounding territorial waters. The prohibition of use of poison did not

materially reduce the catches. Hunters used spring-guns instead, and illegal use of poison occurred for many years. (See "Hunting methods".)

Prohibition of hunting in Kong Karls Land has had little influence, as these islands are often blocked by ice. Only one winter expedition, 1908–09, has hunted there.

The restriction on hunting of polar bear cubs after 1957 has been the most important of all the regulations, as cubs have been very popular. Reduction in total catches has been small but the cubs have been effectively protected.

Regarding use of motor vehicles, see "Hunting methods".

Food

PREVIOUS INVESTIGATIONS

PEDERSEN (1957) shows that the polar bear's bill of fare is varied, but seal – especially ringed seal – is the most important food. This information is from his own and other hunters' observations in Greenland. PAROVŠČIKOV (1964) gives information on what was found in the contents of the stomachs of polar bears in Franz Josefs Land. The most frequent – 68% – was ringed seal, but a surprisingly large amount of the contents was walrus – 22%. There were 4% vegetable remains and 1% birds. The number of animals examined, however, is not given. His investigations also included observations by plane for 3 years. These showed that polar bears on the north-west and central parts of Franz Josef Land to a great extent fed on walrus in the period from March to May. Adult male walrus were also the bears' prey.

The following is a treatment of the food of the polar bear in Svalbard in summer and winter. It is chiefly based on investigations of the contents of the stomachs of animals which had been shot.

MATERIALS AND METHODS

During the winter I spent on Edgeøya, Svalbard, 1964–65, the stomachs of 77 polar bears were examined. Immediately after the bear was skinned, the stomach was taken out and opened. The amount of the contents was estimated and described at once. Samples were put in the stomach again, and it was frozen together with the skin. As soon as the skins were thawed in the spring, the contents were fixed in formaline for later investigation. In 60 cases the rectum was examined on the spot to see if the bear had eaten seaweed. Nothing else was attempted to be deduced from the rectum. In some cases the bear's tracks were retraced to find the place of the last meal where there might be possible left-overs of food. I have made notes about the stomach contents of shot bears from earlier winters in the same area, in particular the winter 1954–55. Then the majority of 72 polar bears were examined on the spot, but no samples were taken.

The crew of M/S «Havella» collected the stomach contents of a total of 95 polar bears during the summers 1961–67. M/S «Havella» caught bears in the floating ice east and north of Svalbard. Most of them were shot in the area around

Hopen. The amount of contents was estimated on the spot, and specimens were fixed in formaline for later examination. Notes were also made regarding food left-overs on the ice after meals, and observations of seals in the water around the ship were made.

It is not always easy to see from the stomach contents exactly which kind of seal the bear has eaten. Bearded seal can be distinguished from other seals by its smooth whiskers. It can also be distinguished by the fact that the groups of hair on a section on the epidermis-corium border form a pattern in groups of three (BERGERSEN 1931). The sections were made with a knife and examined. Whiskers were found in 10 stomach specimens in the winter, and in 16 in the summers. I was not able to distinguish between ringed seal and harp seal on pieces of skin where the ringed seal's colour pattern did not show. Their whiskers are alike, and their hairs otherwise are very similar. In 34 of the specimens in Table 18 it was not possible to distinguish between ringed seal and harp seal. The possible division between the two types of seal is indicated in Table 18. This division is based on an estimation of thickness of skin (hide), size of claws and parts of skeleton. Hairs from the hooded seal with its crenated scales (BERGERSEN 1931) were not found.

RESULTS

Food in winter

As Table 18 shows, most of the stomachs were empty, and in 12 of them the contents were very few. The maximum found in one stomach was about 15 litres. It consisted of pieces of skin from ringed seal with some meat on it, but mostly liquid blubber. Remains of bearded seal were found in one stomach. Of all the different types of seal the ringed seal dominated completely.

Pieces of bear skin were found in the stomachs of three bears which had fed on the skins of bears we had shot. In our catch of 82 bears in 1964–65, 5 skins and 2 whole frozen bears were partly eaten up by bears.

A guillemot was found in one stomach. From March large numbers of birds gather on the bird rocks. Some birds are injured by falling stones or by being driven against the rock in strong wind, and they fall down on the ice below. It is probably only these injured birds the bear is able to catch in winter.

Seaweed was found in 12 stomachs. One bear had 8.5 kg in its stomach. Out of 60 rectums which were examined 4 contained seaweed, but none of the 4 bears had seaweed in their stomachs. The contents under "Various" in the table were only found in very small amounts.

The investigation in 1954–55 showed more or less the same. The remains of two bearded seal were found and the rest was identified as ringed seal. That winter the remains of ringed seal pups were found in the stomachs of several bears shot in March and April. Two bears had eaten small amounts of moss and grass, and several had seaweed in their stomachs. In February 1955 I observed a female bear, together with a year-old cub, diving between ice floes to a depth of 3–4 metres to get seaweed. They both came up with large tangles of seaweed

Table 18

Classification of stomach contents from 77 polar bears caught in the winter 1964–65 on Edgeøya, and from 95 polar bears caught in the summers 1961–67 in the pack ice east and north of Svalbard.

	No. of stomachs collected	Amount			Contents										
		Empty	0–100 g	More than 100 g	Bearded seal	Ringed seal	Harp seal	Food items from harp seal or ringed seal, and a possible division between them: Ringed seal	Food items from harp seal or ringed seal, and a possible division between them: Harp seal	Unidentifiable species of seal	Polar bear	Birds	Seaweed	Moss and grass	Various
Winter															
October	9	3	2	4	1	1	0	3	0	0	0	0	3	1	2 with small stones
November	12	6	5	1	0	1	0	1	0	2	1	0	3	0	1 with pieces of wood
December	10	5	3	2	0	3	0	0	0	1	0	0	2	0	
January	12	6	1	5	0	1	0	3	0	1	1	0	2	0	1 with reindeer scats
February	15	10	1	4	0	1	0	2	0	0	1	0	2	0	
March	12	6	0	6	0	5	0	0	0	0	0	1	0	0	1 with reindeer scats
April	6	5	0	1	0	1	0	0	0	0	0	0	0	0	1 with pieces of wood
May	1	1	0	0	0	0	0	0	0	0	0	0	0	0	
Sum	77	42	12	23	1	13	0	9	0	4	3	1	12	1	
Summer															
June	24	12	4	8	0	2	1	5	1	1	0	2	0	0	
July	37	11	5	21	6	3	1	11	1	3	0	0	2	0	
August	32	14	4	14	3	3	1	6	1	1	0	0	3	3	
September	2	2	0	0	0	0	0	0	0	0	0	0	0	0	
Sum	95	39	13	43	9	8	3	22	3	5	0	2	5	3	

which they laid out on the ice. They selected the best, ate that, and dived again for more. When I left after half an hour they were still doing it. *Laminaria* species were the most common, but *fucus* species were also found.

The polar bear often visits fox-traps in winter. These traps consist of a wooden frame with stones on it. The bear pushes the stones away and takes the bait which is usually ptarmigan. It looks as though the bear likes ptarmigan very much, and it is difficult to keep the traps in order when there are polar bears in the district. There were foxes in the traps on three occasions, but the bear had only eaten the bait and left the fox lying there untouched.

There is a good stock of reindeer on Edgeøya, and bears and reindeer often meet. None of the winter trappers I have asked have seen polar bears kill reindeer or found any traces to show it. In February 1950, I saw a polar bear walking slowly towards a spring-gun. Six reindeer were grazing at a distance of 20–30 metres from the trap. The reindeer stopped eating and watched the bear. The bear stretched its neck and scented the reindeer; it stood still for a moment, turned and went slowly back the same way it had come. In April 1967, trapper STRAND (p. com.) saw a bear eating grass near several reindeer.

Food in summer

As is seen from Table 18, mostly ringed seal was found. The division between bearded seal and harp seal is about the same; two of the bears that were shot had eaten from the same bearded seal.

The remains of two birds were found – probably guillemot.

Only very small amounts of seaweed were found.

On Kong Ludvigøyane in July 1955, I found several excrements with a lot of down (feathers), showing that a bear had eaten eggs from the nests. There are nesting places on Kong Ludvigøyane for many kinds of birds, particularly the eider duck.

DISCUSSION

All the bears examined in winter have been shot on land or on the ice near land. It is probable that the food is of a somewhat different composition for those bears which keep far away from land. Ringed seal is most abundant near land, even though it has been observed far out on the pack ice. The distribution of bearded seal seems to be the same as ringed seal, but is more seldom observed near land in winter. As there is no trapping on the pack ice at sea in the dark season, nothing definite is known about the polar bear's food at that time of the year, but it is probable that the bearded seal suffers greater losses than the ringed seal further away from land. It is also very difficult to know how great a loss there is of harp seal as food for the polar bear in winter. Harp seal lives only on the outermost edge of the pack ice, both summer and winter, and there are probably very few bears hunting for harp seal in winter. On the other hand, it is well known among sealers that polar bears coming to harp seals' breeding places in spring may kill far more pups than they can manage to eat (NANSEN 1924). Harp seals breed in Kvitsjøen, in the Jan Mayen area and off Newfoundland. There are very seldom polar bears in Kvitsjøen. See p. 42. There are more bears in the Jan Mayen area, but the number is rather small compared with the number in Svalbard. This being taken into consideration, the loss of harp seal as food for the polar bear is very small.

There is hardly any doubt that ringed seal is the most important food for the polar bear in Svalbard in the winter. In March and April the polar bear kills many of the ringed seal pups, which are lying in snow hollows near the seals' breathing holes in the ice. In spring 1965, however, we did not find any remains of ringed seal pups in the polar bears that were shot. That was probably on account of the fact that the ice conditions that spring meant that few ringed seal had pups in our trapping area. PAROVŠČIKOV's (1964) investigations in Franz Josefs Land show that there, too, the ringed seal is the polar bear's most important prey.

It has been assumed by trappers and Arctic travellers that the walrus is left in peace by the polar bear (KRÆMER 1940). NANSEN (1924) writes: "Although I have seen a lot of both walruses and polar bears in the same areas in Franz Josefs Land, I have never seen a bear chase a walrus. The walruses were completely indifferent to the bear; it could go close by them without their noticing it. They obviously feel quite safe and superior."

PAROVŠČIKOV's (1964) investigations, however, show that polar bears do hunt the walrus in spring in Franz Josefs Land. In Svalbard there are so few walruses left that they are of little importance as prey for the polar bear. It is the same regarding hooded seal.

Amongst the bears examined in summer, by far the majority are shot on the pack ice far from land. The ringed seal is the most important prey in summer, too. Observations by Arctic travellers show that in summer polar bears kill harp seal lying on the outer floes of the pack ice. But there are relatively few bears that stay there. Most of the bears are to be found spread all around on the pack ice. The bearded seal appears to be the next most important prey for the polar bear in Svalbard. They are found widely spread in the pack ice round Svalbard, where the sea is not too deep. Among the usual types of seal in the North Atlantic, the hooded seal is the least hunted by the polar bear. Trapper SNARBY (p. com.) tells that in March, when the hooded seal gives birth to its pups on the pack ice off Newfoundland and Jan Mayen, the polar bear keeps down its numbers by taking some of the pups. Hooded seals lie spread around in the breeding colony in family groups, and are therefore less liable to be attacked by polar bears than harp seals. In June—July, hooded seals gather on the pack ice in Denmark Strait in large numbers, but observations of polar bears are few.

The polar bear eats seaweed both summer and winter, and to some extent large amounts. The cubs we caught during my wintering played around the hut; they ate some seaweed, even though they had plenty of blubber and meat.

Grass and moss are seldom eaten and only in small quantities. When the pack ice thaws, some bears are forcibly left behind on the islands. Then, for a shorter or longer period, they have to feed on whatever they can find on land.

In 1960, on account of abnormal ice conditions, some polar bears were left behind in Kong Karls Land. LØVENSKIOLD (p. com.), who was on the islands from 28th July to 10th August, had about 15 bears near the camp. They were seen daily eating the thinly-growing grass there. LØVENSKIOLD also tells that in Hornsund in 1952 he saw the track of a bear that stayed on land the whole of July. It probably only had grass as food during that time. A lot of excrements were found, which consisted only of grass. On Bennett Island USPENSKIJ (1963) observed bears in May—June digging up the snow and eating plants in great amounts. On 10th November, in Franz Josefs Land, JACKSON (1899) shot a polar bear that had only grass in its stomach. PEDERSEN (1957) mentions that polar bears left on land in Greenland eat grass and berries.

Birds are of very little importance as food for the polar bear. In winter it only occasionally catches dead or injured birds. In summer a few bears may visit islands where eider ducks and other birds nest, and then they eat a lot of eggs. The polar bear, however, is very seldom seen on these islets at nesting time.

Definite observations have been made proving that polar bears kill their own kind. It is the young cubs especially that suffer this fate (NANSEN 1897, PAROVŠČIKOV 1964). See paragraph on mortality, p. 84. The skins and carcases of shot bears are often fed on by other bears. The dead carcases of whales, walruses, seals, and birds are eaten when the opportunity is there. A great many bears will gather in one place if there is a lot of carrion there. In the summer of 1853 a great

number of polar bears had gathered together on Håøya (south of Edgeøya). The reason was that a lot of walruses had been killed on the island the year before. The bears fed on the remains (KULSTAD 1871).

Really hungry bears may eat anything with no nutrition value at all. Trapper YTRELAND (p. com.) shot a bear in North-East Greenland in August 1950. The bear's stomach was full of wood splinters, which it had gnawed off several old driftwood logs.

Reindeer are left in peace by the polar bear. A muskox, on the other hand, is known to have been killed by a polar bear in North-East Greenland (PEDERSEN 1957).

Age determination

PREVIOUS INVESTIGATIONS

I know of only one work on age determination of polar bears, viz. MANNING's (1964), in which 487 skulls were divided into four age groups according to the stages in the closure of the cranial sutures. The youngest group, with the basi-occipital-basisphenoid suture open, was attempted determined according to chronological age. Further, he gives age criteria based on statistics and closing of sutures up to 6 years.

MATERIALS AND METHODS

Age criteria have been studied on skulls, teeth, bacula, testes, ovaries, uterus, and femurs of 85 polar bears caught in Edgeøya, Svalbard, in the winter 1964–65. In addition there are 13 bacula from polar bears caught in the summer on the pack ice east of Spitsbergen.

Bacula were boiled, cleaned and dried in the air before being measured and weighed. Regarding treatment of testes and ovaries, see p. 65.

Attempts were made to deduce the age by counting the layers accumulating in the tooth cement. The sections for this purpose were made according to two methods. One method is the one described by REIMERS (1968) and used to determine the age of reindeer. It is as follows: the teeth are decalcified in 5% nitric acid for two days and then left under running water for one day to remove the acid. The sections of the teeth were prepared by freezing microtome in thicknesses of 50–100 μ. Longitudinal sections were cut through the pulpa cavity. The sections were stained for 10 minutes in Mayer's acid haemalum (without chlorallhydrate), and then rinsed in water. The sections were mounted in heated gelatine/glycerol and examined in transmitted light. According to the other method, the sections of the teeth were sawn in a double-bladed circular saw with 2,500 r.p.m.. The sections were made about 200 μ thick and mounted on glass with eukit, without being polished.

All the teeth on one side of the lower jaw were extracted on two skulls, male No. 55 and female No. 36. They were treated according to the first method referred to above. Cross-sections were made of bear 36 and longitudinal sections

were made of bear 55. The result showed that all the teeth were serviceable. It was not possible to count the same number of layers in the cementum on all the teeth of each bear. The variations were very small and, in all probability, due more to difficulties in reading than variations in the actual number of layers on the different teeth. The first incisor in the lower jaw was selected for further investigation as it was easily extracted. Longitudinal sections were chosen for practical reasons.

The other first incisor in the lower jaw was also extracted from all skulls, and sections of the teeth were made according to the second method described above. Also in this case, longitudinal sections were made.

For sake of simplicity, this work is based on the assumption that the polar bear female gives birth on 1st January. Regarding time of birth, see p. 80.

The age is given as 1st winter, 2nd winter, and so on. The first winter is the winter of birth. The cubs are born in the den and do not come out before April. This group (M 0 and F 0) are therefore missing in the tables.

EXAMINATION OF AGE CRITERIA

Baculum growth

Baculum growth during the first years shows a very good relevance to age. A division can be made straight away oetween the first four age groups in this material. In age group M 1, the bacula are small and cylindric. In M 2, the bacula have practically the same shape, but at the distal end there is a small knob, which becomes more pronounced with age. The most characteristic trait of the first three groups is the growth in length. As from age group M 4, the length increases very little, but the proximal part of baculum increases considerably in thickness, making it the most dominating part, see Fig. 10. The first four age groups show no overlapping, see Table 20 and Fig. 11. Weight gives better grouping than length. After age group M 5, the weight increases less than before, but there is still some increase. Baculum of bear 48 was broken and had become shorter after healing.

The 13 bacula of polar bears shot in the summer could be divided into 4 groups according to length and shape of the proximal part, see Table 19. These groups fit well in between the winter groups of Fig. 11. The mean values are slightly above the curve which can be imagined drawn between the winter groups. Even though the material is insufficient to provide any proofs, there are indications of a quicker growth in summer than in winter.

The ovary and uterine cornu

The ovaries and uterus from the polar bears included in this material provide no possibility of age grouping, even during the first years. The length (Table 21) and thickness of uterine cornu make it possible to assess whether the female bear is sexually mature or not. As a rough conjecture it can be said that females with uterine cornu longer than 15 cm are sexually mature, as the age of maturity is estimated to about 3½ years.

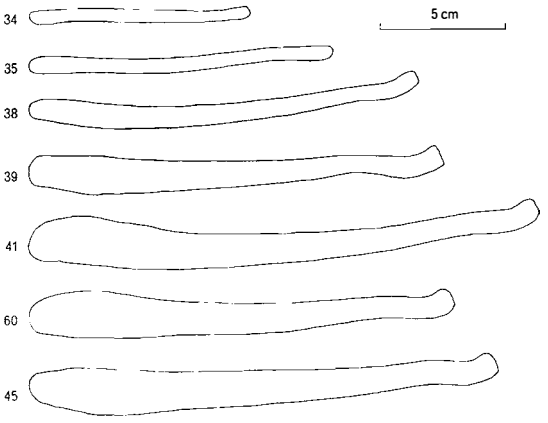

Fig. 10. *Outline of the baculum of the polar bear. One from each age group. All bears taken in January, except 60 that was taken in February.*

Table 19

Weights and lengths of 13 bacula from polar bears caught in summer (June–September).

Groups	No. of bacula	Weight (grams)		Length (mm)		Estimated age
		Range	Mean	Range	Mean	
A	4	5.8– 7.1	6.4	135–143	139	Third summer
B	3	8.7–12.3	10.7	160–167	163	Fourth –»–
C	4	12.4–16.6	14.9	170–175	173	Fifth –»–
D	2	18.6–22.8	20.7	179–185	182	Full grown

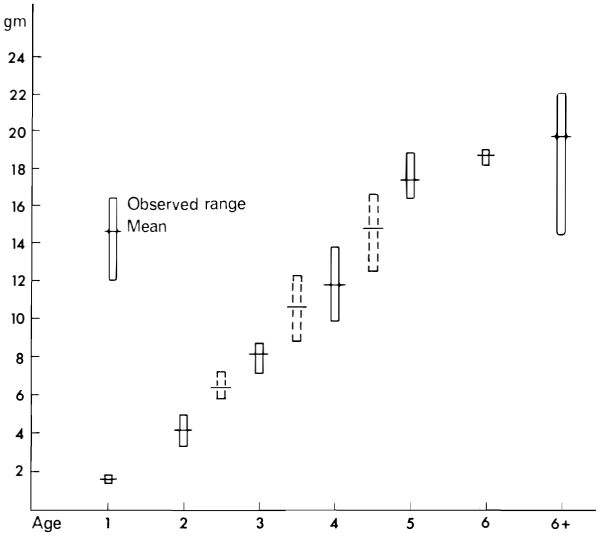

Fig. 11. *Baculum growth in polar bears according to age. Baculum from the summer catch marked with dashed bars.*

Table 20

Age criteria in male polar bear. For explanation of symbol designations, see below Table 21.

Bear No.	Date	Bacula		Testes weight grams mean	Skull measurements in mm (a)						Cranial sutures (b)							Femur (c)			Teeth (d)		Estimated age	
		weight grams	length mm		Ch	Ib	l	w	l+w	l÷w	OS	MpM	NpM	NF	Na	FP	P	Ec	St	Trm	Emh	Cl	Year	Month
Age group M1 (second winter)																								
81	Sept. 8	–	–	–	65	58	245	137	382	1.79	o	o	o	o	o	o	o	–	–	–	0	–	0	8
82	» 8	–	–	–	60	55	230	125	355	1.84	o	o	o	o	o	o	o	–	–	–	0	0	0	8
83	» 8	–	–	–	58	53	228	122	350	1.87	o	o	o	o	o	o	o	–	–	–	0	–	0	8
20	Nov. 26	1.8	95	4	68	61	267	140	407	1.91	o	o	o	o	o	o	o	3	f	o	0	2	0	10
21	» 26	1.6	90	4	66	59	259	139	398	1.86	o	o	o	o	o	o	o	3	f	o	0	2	0	10
34	Jan. 1	1.6	88	4	68	64	265	144	409	1.84	o	o	o	o	o	o	o	3	f	o	0	1	1	0
59	Feb. 22	1.6	89	4	69	59	273	141	414	1.94	o	o	o	o	o	o	o	3	f	o	0	2	1	1
63	March 6	1.4	84	4	64	55	249	137	386	1.82	o	o	o	o	o	o	o	3	f	o	0	2	1	2
Age group M2 (third winter)																								
12	Nov. 22	–	–	–	84	72	316	169	485	1.87	o	o	o	o	o	o	o	–	–	–		–	1	10
26	Dec. 4	5.0	134	–	86	75	330	177	507	1.86	–	o	o	o	o	o	o	–	–	–	6	4	1	11
27	» 5	4.9	131	11	87	74	330	171	501	1.93	o	o	o	o	o	o	o	3	f	h	4	4	1	11
35	Jan. 6	3.4	121	7	80	68	300	154	454	1.95	o	o	o	o	o	o	o	3	f	o	2	5	2	0
67	March 9	3.3	118	10	80	67	300*	163	463	1.84	o	o	o	o	o	o	o	3	f	o	2	4	2	2
85	?	–	–	–	79	–	290	155	445	1.87	o	o	o	o	o	o	o	3	f	o	2	–	–	–
Age group M3 (fourth winter)																								
1	Oct. 16	7.1	144	13	90	82	345*	186	531	1.86	o	o	o	o	o	o	o	3	f	h	5	5	2	9
37	Jan. 6	8.7	166	19	92	–	350	180	530	1.94	o	o	o	o	o	o	o	3	f	h	8	5	3	0
38	» 14	8.5	156	22	91	72	337	177	514	1.91	o	o	o	o	o	o	o	3	f	h	7	5	3	0
Age group M4 (fifth winter)																								
4	Oct. 23	12.6	172	35	102	79	350	206	556	1.70	o	o	o	o	o	o	o	3	f	h	4	6	3	9
6	» 24	9.9	152	28	92	77	335	182	517	1.84	o	o	o	o	o	o	o	3	f	h	7	7	3	9
23	Dec. 1	10.9	162	36	103	83	369	210	579	1.76	o	o	o	o	o	o	o	3	f	f	9	5	3	11
39	Jan. 23	13.8	165	39	96	88	371	197	568	1.88	o	o	o	o	o	o	o	3	f	f	8	7	4	0
48	Feb. 5	10.2	115	33	91	76	329	183	512	1.80	s	o	o	o	o	o	o	3	f	f	7	7	4	1
55	» 18	13.5	169	49	93	88	342	198	540	1.73	o	o	o	o	o	o	o	3	f	f	9	7	4	1
58	» 22	11.7	162	30	100	79	353*	197*	550	1.79	–	o	o	o	o	o	o	3	f	h	7	6	4	1

Age group M5 (sixth winter)																								
5	Oct. 23	18.1	195	38	103	90	365	212	577	1.72	f	o	o	o	o	o	o	2	r	f	8	9	4	9
29	Dec. 11	16.9	191	28	100	93	372*	217*	589	1.71	–	o	o	o	o	o	o	3	f	f	13	6	4	11
30	» 23	16.7	183	33	98	86	356	211*	576	1.73	f	o	o	o	o	o	o	3	r	f	10	7	4	11
41	Jan. 24	18.9	203	49	110	98	378	221	599	1.71	–	o	o	o	o	o	o	2	r	f	10	8	5	0
50	Feb. 14	18.0	184	48	112	95	398	231	629	1.73	f	s	o	o	o	o	o	1	r	f	10	8	5	1
61	March 1	16.4	174	51	102	86	354	205	559	1.73	f	o	o	o	o	o	o	3	r	f	8	8	5	2
Age group M6 (seventh winter)																								
16	Nov. 23	18.9	189	52	107	96	376	222	598	1.69	f	f	o	o	o	s	o	0	k	f	12	9	5	10
60	Febr. 25	19.0	169	65	109	95	373	225	598	1.66	f	f	o	o	o	o	o	1	k	f	14	9	6	1
69	March 16	18.2	190	74	107	92	363	229	592	1.59	f	s	o	o	o	o	o	0	k	f	7	11	6	2
Age group M7																								
72	March 26	14.5	168	56	102	92	355	216	571	1.64	f	f	s	f	s	s	s	0	k	f	12	12	6+	
44	Jan. 1	18.0	181	69	110	92	378	227	605	1.67	f	f	o	s	o	f	f	0	k	f	13	13	6+	
22	Nov. 27	21.3	187	49	115	106	395	257	652	1.54	–	s	s	s	o	f	f	0	k	f	11	10	6+	
49	Jan. 8	20.3	183	60	106	92	377	236	613	1.60	f	f	f	f	s	f	s	0	k	f	11	12	6+	
65	March 7	21.6	194	70	98	102	381	242	623	1.57	f	f	f	f	s	s	s	0	k	f	9	12	6+	
66	» 9	21.0	185	66	114	91	378	231	609	1.64	f	f	f	f	s	f	f	0	k	f	17	13	6+	
45	Jan. 30	21.0	186	66	105	94	368	226	594	1.63	f	f	f	f	s	f	f	0	k	f	11	14	6+	
43	» 27	18.0	188	41	106	91	–	–	–	–	–	f	f	f	f	f	f	0	k	f	17	16	6+	
42	» 27	18.2	183	33	106	94	362	226	588	1.60	f	f	f	f	f	f	f	0	k	f	11	16	6+	
3	Oct. 21	19.5	191	52	111	102	397	249	646	1.59	f	f	f	f	f	f	f	0	k	f	14	18	6+	
73	March 31	19.7	182	63	105	97	377	235	612	1.60	f	f	f	f	f	f	f	0	k	f	12	12	6+	
70	» 26	19.8	182	58	106	93	361	227	588	1.59	f	f	f	f	f	f	f	0	k	f	16	16	6+	
24	Dec. 4	19.8	188	54	111	101	377	246	623	1.53	f	f	f	f	f	f	f	0	k	f	16	19+	6+	
17	Nov. 25	20.6	193	48	115	89	384	241	625	1.59	f	f	f	f	s	f	f	0	k	f	19	16	6+	
51	Feb. 15	22.1	190	55	107	103	386*	242	628	1.60	f	f	f	f	f	f	f	0	k	f	13	15	6+	

Table 21

Age criteria in femal polar bear. For explanation of symbol designations, se below.

Bear No.	Date	Ovary mean weight grams	Length of uteri cornu cm		Skull measurements in mm (a)						Cranial sutures (b)							Femur (c)			Teeth (d)		Estimated age	
			1	2	Ch	Ib	l	w	l+w	l÷w	OS	MpM	NpM	NF	Na	FP	P	Ec	St	Trm	Emh	Cl	Year	Month
Age group F1 (second winter)																								
11	Nov 8	1.2	6	7	61	58	235	131	366	1.79	o	o	o	o	o	o	o	3	f	o	0	0	0	10
18	» 11	1.1	7	8	57	54	232*	121	353	1.92	o	o	o	o	o	o	o	3	f	o	0	0	0	10
33	Dec 29	–	–	–	56	55	226	130	356	1.74	o	o	o	o	o	o	o	3	f	o	0	2	0	11
54	Feb 18	–	9	10	76	63	281	147	428	1.91	o	o	o	o	o	o	o	3	f	o	4	0	1	1
57	» 18	1.5	10	10	68	59	259	142	401	1.82	o	o	o	o	o	o	o	3	f	o	0	2	1	1
75	Mar 1	2.1	10	10	71	65	275	154	429	1.79	o	o	o	o	o	o	o	3	f	o	3	2	1	2
77	» 10	1.8	11	8	66	56	–	140*	–	–	o	o	o	o	o	o	o	3	f	o	0	2	1	2
Age group F2 (third winter)																								
2	Oct 16	2.3	14	17	79	72	306	164	470	1.87	o	o	o	o	o	o	o	3	f	h	6	5	1	9
7	» 24	–	10	13	82	69	–	165*	–	–	–	o	o	o	o	o	o	3	f	h	6	3	1	9
9	» 31	1.6	12	11	82	69	313*	173	486	1.81	o	o	o	o	o	o	o	3	f	h	5	2	1	9
14	Nov 22	2.9	11	15	84	71	–	170	–	–	o	o	o	o	o	o	o	3	f	h	6	3	1	10
40	Jan 23	1.5	9	9	76	65	301*	162	463	1.86	o	o	o	o	o	o	o	3	f	h	6	5	2	0
46	Feb 5	2.0	11	11	75	65	298*	157*	455	1.90	–	o	o	o	o	o	o	3	f	h	4	2	2	1
Age group F3 (fourth winter)																								
8	Oct 31	–	–	–	85	74	313	168	481	1.86	o	o	o	o	o	o	o	3	f	f	7	4	2	9
15	Nov 22	2.5	13	17	88	77	320*	180	500	1.78	f	o	o	o	o	o	o	3	r	f	6	5	2	10
28	Dec 11	2.5	14	15	88	74	320	173	493	1.85	s	o	o	o	o	o	o	3	f	f	7	7	2	11
47	Feb 5	2.2	10	10	88	76	324	181	505	1.79	o	o	o	o	o	o	o	3	f	f	6	5	3	1
53	» 17	3.7	15	15	82	69	317	174	491	1.82	s	o	o	o	o	o	o	3	f	f	6	6	3	1
76	Mar 6	–	13	16	92	77	–	187*	–	–	–	o	o	o	o	o	o	1	r	f	8	6	3	2
Age group F4 (fifth winter)																								
25	Dec 4	2.2	19	15	94	74	321	185	506	1.74	f	o	o	o	o	f	s	0	rk	f	6	7	3	11
36	Jan 6	–	18	18	90	78	327*	186*	513	1.76	f	o	o	o	o	o	o	0	rk	f	6	6	4	0
52	Feb 15	2.9	18	18	89	81	320	186	506	1.72	f	f	o	o	o	o	o	0	r	f	9	8	4	1
78	Mar 27	–	–	–	85	71	327*	179	506	1.83	f	o	o	o	o	o	o	0	k	f	7	7	4	2

Age group F5

13	Nov 22	–	16	–	87	73	332	180*	512	1.84	–	f	o	–	s	f	s	0	k	f	8	8	4+
32**	Dec 29	–	–	–	83	79	317	184	501	1.72	–	f	o	s	s	f	o	0	k	f	8	10	4+
10**	Nov 8	2.4	17	14	83	77	333	180	513	1.85	f	f	o	f	s	f	f	0	r	f	8	12	4+
31	Dec 29	2.6	18	18	91	78	–	191*	–	–	f	f	o	s	s	f	f	0	k	f	9	10	4+
74**	Mar 1	2.7	17	18	91	78	318	189	507	1.68	f	f	o	f	s	f	f	0	k	f	7	11	4+
56**	Feb 18	2.3	15	15	89	74	332	191	523	1.74	f	f	o	f	s	f	f	0	k	f	10	9	4+
19**	Nov 26	2.8	17	19	94	82	334	198	532	1.69	f	f	s	f	o	f	f	0	k	f	8	12	4+
68**	Mar 11	2.7	16	17	90	82	331	201	532	1.65	f	f	s	f	s	f	f	0	k	f	11	12	4+
71	» 26	3.4	15	18	87	77	329	183	512	1.80	f	f	s	f	s	f	f	0	k	f	7	11	4+
62**	» 6	3.0	14	18	91	80	319	198	517	1.61	f	f	f	f	f	f	f	0	rk	f	10	12	4+
79**	Apr 29	2.6	20	–	92	89	343	204	547	1.68	f	f	f	f	f	f	f	0	k	f	11	12+	4+
80**	Dec 4	4.4	17	17	85	74	333	186	519	1.79	f	f	s	f	f	f	f	0	k	f	8	11	4+
64	Mar 6	2.0	19	19	85	82	326	193	519	1.69	f	f	f	f	f	f	f	0	k	f	12	17	4+

(a) Skull measurements:

- Ch = coronoid heigth
- Ib = interorbital breadth
- l = condylobasal length
- w = zygomatic width
- l+w = condylobasal length + zygomatic width
- l÷w = condylobasal length ÷ zygomatic width

(b) Cranial sutures:

- OS = basioccipital-basisphenoid
- MpM = maxopremaxillary
- NpM = nasopremaxilllary
- NF = nasofrontal
- Na = internasal
- FP = coronal
- P = palatine
- o = suture open
- s = -»- semi-fused
- f = -»- fused

(c) Femur:

- Ec = epiphyseal closures on caput femoris, trochanter major and condylus tibialis & fibularis: O=all closed, 1=one open, 2=two open, 3=three open
- St = lateral supra-sesamoid tubercle: f = flat, r=coarse, k=knotted
- Trm = trochanter minor: o=the epiphysis flat, h=hat-like, f=ossified

(d) Teeth:

- Emh = Height of enamel line on upper canines in millimetres
- Cl = Numbers of layers in first incisor cementum on lower jaw
- * = The measurement is taken after the broken skull is joined together
- ** = Females accompanied by cubs or yearlings

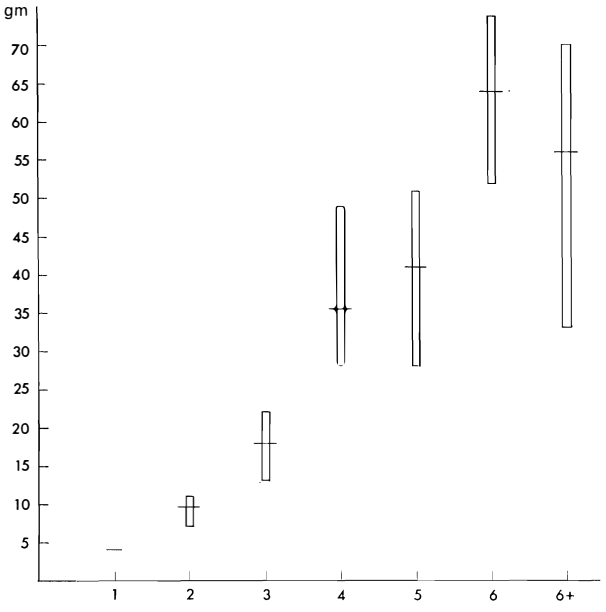

Fig. 12. *Testis growth in polar bears according to age. For explanation of symbols, see Fig. 11.*

Testis growth

The weight of the testes gives a good criterion for the first 3 age groups, see Table 20 and Fig. 12. The weight continues to increase until M 6, but there is no possibility of age grouping after M 3. Regarding variation in weight of testes during the year, see Fig. 16.

Skull development

Sexual dimorphism. — The cubs' skulls are rounded at the back. From the second age group of either sex this part turns more oblong, and the development is more pronounced with age. In the fifth winter the males develop a pronounced sagittal crest, which extends to the frontal bone. This crest may posteriorly be several centimetres high. The females also develop a sagittal crest, but it is not so high and never extends further than half way along the interparietale suture. From the age group M 4 (roughly 4 years old), the sagittal crest is useful in sex identification of the skulls.

Skull growth. — Of the many measurements taken of the skull, the total of condylobasal length and zygomatic width (l + w in Tables 20 and 21) appeared to give an adequate impression of its growth. The first age groups of either sex can be singled out by this criterion (Fig. 13). There is overlapping in the older groups of both sexes.

Coronoid height and interorbital breadth (Ch and Ib in Tables 20 and 21) increase rapidly with age. The first two age groups of males are distinguished by these measurements, whereas there is already a slight overlapping between the two youngest female age groups.

The proportion between condylobasal length and zygomatic width (l ÷ w in

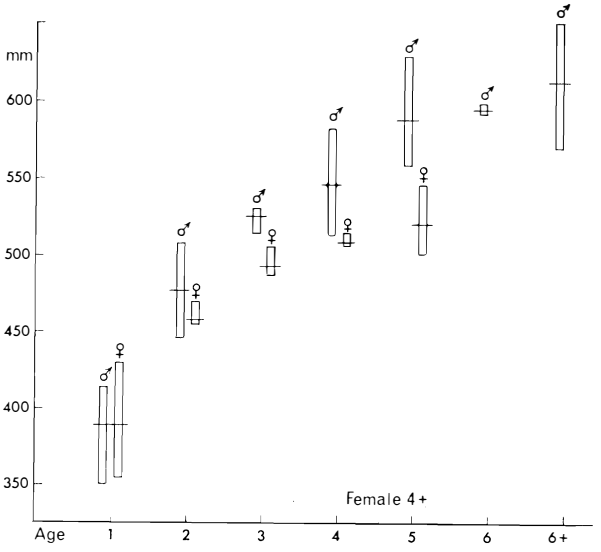

Fig. 13. *Skull growth, condylobasal length + zygomatic width, in polar bears according to sex and age. For explanation of symbols, see Fig. 11.*

Tables 20 and 21) increases from birth up to the second age group of both sexes, but after that decreases with age. This proportion gives no age grouping but is included to show increasing age. Regarding the males, the proportion is greater than 1.70 for all groups up to and including M 5, but less than 1.70 for groups older than M 5. The proportion appears to decrease also after the longitudinal growth of the skull has finished. This is due to the fact that the width of the skull still increases. The closure of the suture on arcus zygomaticus progresses very slowly.

Cranial sutures. – In Tables 20 and 21 the different stages in the closure of 7 cranial sutures are given. In the males the basioccipital-basisphenoid suture is closed first. Only one male bear in group M 4 had this partly closed during the winter. As this suture was closed in all older bears, it must take place during the fifth summer. The next suture to be closed is the maxopremaxillary. This is closed in most specimens in group M 6 and older. The other sutures are closed in the age group M 7; it is not possible to state anything definite, but it seems likely that it takes place during a short period of the bear's lifetime.

The basioccipital-basisphenoid suture is also the first one to be closed in the female. It starts already in age group F 3. Complete closing of the suture probably takes place early in the following summer. The next sutures to be closed is the maxopremaxillary and the coronal.

Femur growth

The length of the femur, which is measured from the trochanter major to the distal end, is not given in the tables but is shown in Fig. 14. The femur of bear 43 is not included as it had been broken and become shorter during healing. The two first age groups of the males can be distinguished by this measurement, but

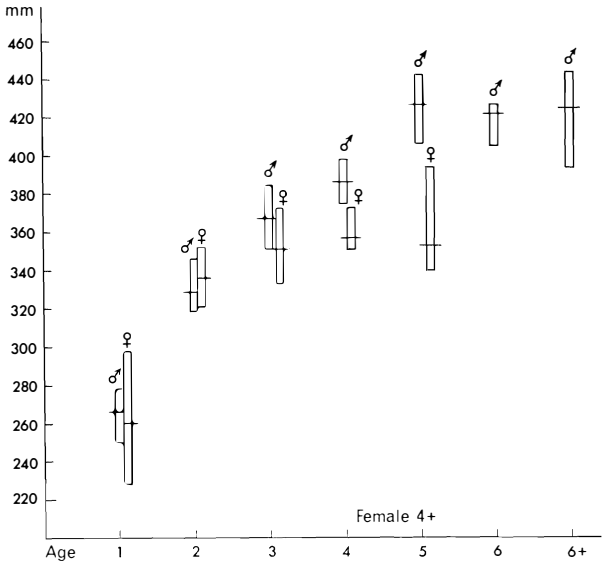

Fig. 14. *Femur growth in polar bears according to sex and age. For explanation of symbols, see Fig. 11.*

there are overlapping in the other groups. Only the first group of females can be distinguished in this way.

The proximal end of the femur ossifies from two centres, of which one is for the caput femoris and the other for the trochanter major. The distal end of the femur ossifies from a single centre at the condylus tibialis and fibularis. Closure of the three epiphyses (Ec in Tables 20 and 21) occurs within a short period of the lifetime. The male starts ossification in the age group M 5. This is generally completed during the sixth summer (about 5½ years of age). In the female it occurs two years earlier, in the fourth summer.

The lateral supra-sesamoid tubercle, St in Tables 20 and 21, which has been used to determine the age in mink (LECHLEITNER 1954), has a similar development in the polar bear. The tubercle is flat and smooth in the younger bears. Later a coarse surface develops, and finally a knotted conical elevation. In the male age groups the tubercle is flat and smooth in the first four, coarse in group M 5, and with the knotted elevation in the older ones. In the female the knotted stage of the tubercle is not so obvious. The tubercle is smooth and flat in group F 1 and F 2 and in most cases in F 3.

The epiphyses on the trochanter minor changes in shape according to age (Trm in Tables 20 and 21). To start off with, it is hardly raised at all, nearly flat, and it loosens when boiled. Later the epiphysis forms a hat on the trochanter minor, with protruding edges. Finally it is ossified and the protruding edges disappear. This criterion is not very helpful in males as the hat-like stage is found in three age groups. Regarding the females, on the other hand, most of the epiphyses fall off when boiled, or are very small in the age group F 1. In the next group, F 2, they all have the characteristic hat-shaped epiphysis. In group F 3 the hat-like stage has disappeared.

Body weights and lengths

As females about to give birth bury themselves in the snow in the most uninhabited areas on the earth, there are few data to be found regarding new-born cubs in natural surroundings. There are some data from Canada (HARINGTON 1968), but none from Svalbard. The most accurate knowledge of polar bear cubs, their size and progress, comes from zoological gardens. Fig. 19 shows the growth of three males and three females, and the curve is drawn according to information from KOST'JAN (1954). On the third day after birth the mean weight for males was 788 grammes and for females 696 grammes. The cubs opened their eyes when they were 30 days old.

There is great individual variation in total length and total weight (Table 29) in each age group. Weight and length can only be used to find a division between the first age groups in males and females.

In group M 1 the males weigh from 66 to 117 kilogrammes.
In group M 2 there is only one weight – 160 kilogrammes.
In group F 1 the females weigh from 56 to 95 kilogrammes, and
in group F 2 from 112 to 154 kilogrammes.

As shown in Fig. 15, the lengths of the male and female are very much alike up to the age of two years. After that the female grows more slowly and they are fully grown at the age of four years. The male, on the other hand, continues to grow up to the age of six years. The total length for males varies in age group M 1 from 125 to 148 cm, and in group M 2 from 175 to 185 cm. The females in F 1 measure from 127 to 151 cm and in F 2 from 164 to 183 cm.

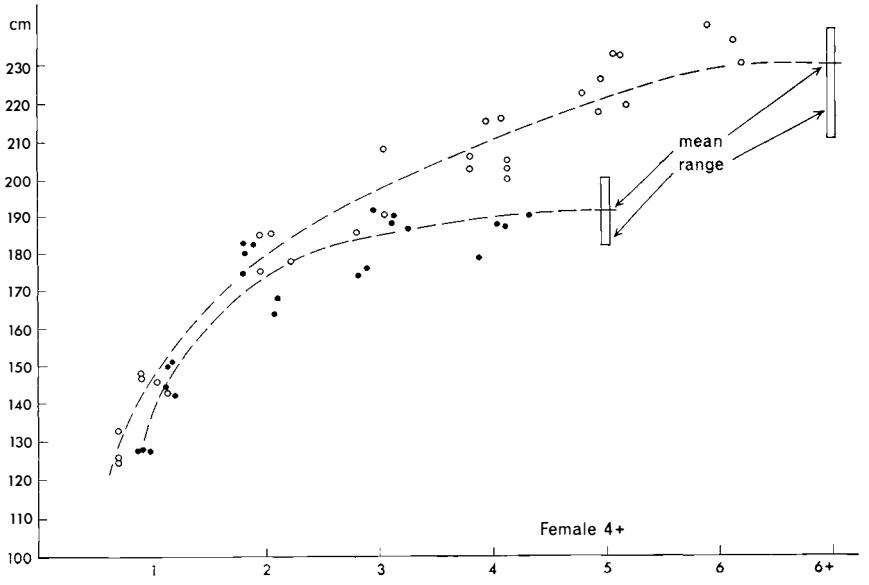

Fig. 15. *Body growth, total length in polar bears according to sex and age* ○=male, ●=female.

Tooth replacement

The three bear cubs we caught alive, 29th April and 1st May 1965, were shot on 9th September. As they had not become tame enough, it was impossible for us to study teething during the time we had them in captivity. When the three skulls were examined they showed that all the milk teeth, except the canines, had been replaced before 9th September. The canines were half way out. The cubs 20 and 21, shot on 26th November, and all the others shot in their second winter, had replaced their canines. It looks as though the polar bear gets its permanent dentition when it is between 9 and 11 months old.

Height of the enamel line on canines

In Tables 20 and 21 the height of the enamel line on the canines in the upper jaw is given. Posterior on the canine the enamel line forms an angle, and the height is measured from the bone level and up to the point of this angle. The mean of these two measurements, Emh, is given in the tables. This does not give any possibility for grouping according to age, but it gives a good idea of increasing age.

Closure of pulp cavity

As it is more difficult to decide the age of females than males, X-ray photographs were taken of the canine in the lower jaw of a number of females in order to measure the pulp cavity. The X-ray was taken while the tooth was in the jaw, and the width of the pulp cavity was measured at the bone line. All the bears in Table 21, from bear 57 to 78, were photographed. In the age group F 1 the width was 10–14 mm. This was the only group to be distinguished by this measurement; there were overlappings in the other groups. In group F 2 the width was already reduced to 3–5 mm, in F 3 it was 2–3 mm, and in F 4 it was 2 mm.

Incisor cementum layers

The study of tooth growth has proved to be a very useful method of deducing the age of many species of mammals. It is the best method regarding seals (Laws 1961). When Marks and Erickson (1966) were studying black bears of known age, they found that the layers in the dentine could not be used, but, on the other hand, the number of layers in the cementum agreed with the number of years of age. Stoneberg and Jonkel (1966) also found annual layers in the cementum of black bears of known age. Manning (1964) found that the layers in dentine on polished sections of canines from the polar bear did not have any correlation with the age.

In this study a great deal of time was spent on finding an age determination based on layers in the cementum. The following description is based on the method with decalcified teeth. The layers seen here consist of alternating light (translucent) and dark (opaque) bands in the cementum. The layers which can be seen in the polar bear give a very varied picture. On some bears definite layers are deposited, whereas on others they are more indefinite and spread. On the same tooth there may be places in the cementum where layers are not observed, or are very indistinct. If one follows the layers in the sections, one will see that they often split up, overlap, and vary between being distinct and indistinct. For

this reason registration of the number of layers is very difficult. Pl. I, fig. 1, shows a transverse section of the first molar in the lower jaw of bear 36, and the picture is taken of the part adjoining the second molar. It shows five layers; the innermost is very indistinct and the third and fourth practically overlap. Pl. I, fig. 2 is a photograph of the same section as Pl. I, fig. 1. It has been taken from the lingual side where the tooth has a constriction in the middle. The layers are split up and difficult to count.

Layers deposited during the first years are widely spread and usually difficult to observe. Layers deposited at a higher age are usually clearer and denser. See Pl. I, fig. 6. Pl. I, fig. 3 shows a longitudinal section of the first incisor in the lower jaw with eight layers. The innermost layer can be seen only in one place.

All the layers counted (Cl in Tables 20 and 21) are from the first incisor in the lower jaw.

On many teeth some of the layers are deposited in pairs. (Pl. I, figs. 3 and 4.) This does not usually happen in the whole section. All the same, it is clear that the layers tend to lie in pairs, in some bears more so than in others.

The result in Tables 20 and 21, compared with the other age criteria, indicates that there are two layers deposited per annum during the first years. Pl. I, fig. 7 shows two layers deposited on the tooth of a bear 13 months old. Pl. I, fig. 8 shows a male, 1 year and 11 months old, with 4 layers. The second layer is very indistinct and can only be seen by adjusting the microscope.

As the estimated age is considered to be very certain in males up to 4 years of age and females up to 3 years, it appears that 2 layers are deposited in the cementum each year up to an age of 4 years. Two annual layers are most likely deposited in the following years, too. As no older bear of known age has been examined, nothing definite can be stated regarding the deposit of layers in later years.

To judge by the way the teeth are worn down in the male bears 3, 17, 24, and 43, they are the oldest individuals. They have from 16 to 19 + layers in the cement. If we presume a deposit of 2 layers per annum, it indicates an age from 8–10 years. This is probably too low an age, even though bears living under natural conditions are less likely to live as long as those in captivity, where they have lived to an age of 35–40 years (HARINGTON 1964). This indicates that only one layer is deposited in later years. It may also be possible that 2 layers are deposited per annum, but so close that they appear as one.

No skulls from polar bears caught in the summer were investigated. As the cubs have layers on their teeth in their second winter, before they are one year old, it indicates that the layers are deposited in the autumn or early winter.

In the material there were two females accompanied by 4-month-old cubs and seven with cubs about one year old. It was not possible to show any difference in the layers of the female bears' teeth. This shows that the long period of hunger the pregnant female experiences in the den does not cause any difference in the depositing of layers, see Pl. I, fig. 5.

The number of layers is the mean value of three readings of the maximum number of layers found per tooth. None of the counts were identical. In about 20% of the teeth, somewhat different numbers of layers were counted with a

maximum deviation of 4 each time. Attempts were also made to determine the age by reading "the pattern", as one wide layer or two adjoining layers were regarded as "one year". By reading the pattern in this way, many results were probably correct, e.g. Pl. I, figs. 3 and 4. But in most cases readings according to this principle gave such great deviations that the results could not be used.

Sections made according to the other method, without decalcification, turned out to give such great deviations that the result has been omitted here.

DISCUSSION

At first, age determination is discussed on the basis of all criteria except layers in the incisor cementum.

Group M 1, the first age group among the males, are clearly distinguished by the weights of bacula and testes, and by the measurements of the skull. They are cubs in their second winter, i. e., about 1 year old.

Group M 2 are distinguished by the same criteria as the first group. They are young animals in their third winter.

Group M 3 are best distinguished by the weights of bacula and testes. The total of l + w, condylobasal length plus zygomatic width, comes within the range of M 4, but there are only three specimens in this group. They are young animals in their fourth winter.

Group M 4 are mainly distinguished by the weight of bacula. The total l + w gives some overlapping towards the next group. The lateral supra-sesamoid tubercle is still flat and smooth, whilst in the next group it is in the coarse stage of transition. They are bears in their fifth winter.

Group M 5 are distinguished from M 4 by the suture basioccipital-basisphenoid being closed. It is distinguished from M 6 by the suture maxopremaxillary still being open, except on bear 50 which has it partly closed. The group is also distinguished by open sutures in the femur. They are bears in their sixth winter. Finally, all groups up to and including this group (M 5) show the proportion l ÷ w greater than 1.7, whereas the older groups have a proportion less than 1.7.

Group M 6 are distinguished by still having most of the sutures of the skull open. The femur in these bears already has its full length. They are supposed to be in their seventh winter, but the classification is uncertain as nothing is known about the time needed for the cranial sutures to be closed. By comparing the growth of the femur with the growth of the body it appears that the males are fully grown at an age of between 5 and 6 years.

Group M 7 consist of animals older than 6 years. Several have broken and worn teeth indicating a high age.

Group F 1, the first age group among the females, are clearly distinguished by the measurements of the skull. They are females in their second winter.

In group F 2, the total of l + w shows no overlapping with the next group, but it is likely that an overlap would have occurred if this measurement had not been missing from bear 14. The coronoid height shows a very slight overlapping with the next group. The safest criterion for this group appears to be the hat-like

stage of the epiphysis on the trochanter minor. They are females in their third winter.

In group F 3 the total of l + w shows some overlapping with the older groups. Closing of the basioccipital-basisphenoid suture occurs in this group. With all older specimens the process is completed. Apart from No. 76, the epiphyses of the femur are all open, whereas in the older specimens they are ossified. The lateral suprasesamoid tubercle is flat and smooth in most cases, turning rough or knotted later. By comparing all these criteria, the group appears to be definite. They are females in their fourth winter. The femur is fully grown in length the following summer. This, together with the curve regarding growth, show that the females are fully grown between 3½ and 4 years of age.

Group F 4 are definitely uncertain and have been singled out through the sutures of the skull. It is assumed that they are females in their fifth winter. It is possible that one or more of the females placed in the next group should have been included here.

Group F 5 consist of older animals. Further grouping is not possible with these criteria.

With the help of these criteria, the age of the males up to 4 years can be determined with a high degree of certainty. The best single criterion is the weight of bacula. The age of females is more difficult to determine as they are fully grown two years earlier than the males. Only one-year olds can be safely determined through one single criterium — l + w.

From what can be deduced from the wear on teeth, and the ossification of the arcus zygomaticus suture (not included in the tables), it looks as though males reach a higher age than females. Three males had the arcus zygomaticus suture obliterated and four were in the last stage of obliteration, whereas it was not obliterated in any female.

MANNING (1964) found that the basioccipital-basisphenoid suture was closed in males aged 3½ to 4½ years. This discrepancy is due to the fact that MANNING operates with one age group less than I do here. The male polar bears presumed to be 3 and 4 years old in this study would be determined 3 years old according to MANNING. This must be due to the fact that he lacks information about the weight of testes and growth of the femur in his material. Further, he only has two bacula, 8.2 and 12.5 gr from his three-year olds (caught in the winter). According to the results of this work, they must belong to two age groups.

The formation of layers in the tooth cement continues as the polar bear becomes older. According to the results there is a strong indication that two layers are deposited every year in the first four years, and probably likewise in the fifth and sixth year. This investigation, however, cannot prove anything definite regarding later years, as no polar bear of known age was examined. It is considered probable that two layers per annum are also deposited later on, but that they lie so close together in most cases that they are seen as one layer. This method is not useful for an exact age determination as the layers are not deposited with obvious enough markings. The differences are too great in the different readings. It is possible that the layers in the cement could be used if another method was found with a better technique than the two methods used here.

A very interesting fact came to light as a result of this investigation. There are two layers per annum deposited in the tooth cement of the polar bear during the first four years, but only one layer per annum in the black bear (STONEBERG and JONKEL 1966) and the grizzly bear (MUNDY and FULLER 1964).

LOW and COWAN (1963) found that in some cases two layers per annum were deposited in the tooth cement of the mule deer. In these cases the two layers were so close together that one year consisted of a wide light layer and then a thin dark layer, then another thin light one and finally a dark one. The explanation suggested was that the first dark layer was deposited during mating time, and the other dark layer in the winter when the animals had difficult grazing conditions. SERGEANT and PIMLOTT (1959) are also of the opinion that the difficult grazing conditions in winter are the reason for a dark layer being deposited in the tooth cement of the moose. Another interesting fact is that it looks as though the polar bear gets its layers at the same time of the year as the grizzly bear and the black bear. MUNDY and FULLER (1964) establish the fact that the dark layer of the grizzly bear is formed in the autumn before it hibernates. STONEBERG and JONKEL (1966) have come to the same result regarding the black bear.

It is not easy to point to conditions in way of life or growth which ought to be possible reasons why layers are deposited in the tooth cement of the polar bear. Apart from pregnant females, the polar bear does not den, and there is no period of the year when it becomes thinner (see p. 90). Females that have been in the den and given birth do not show any difference in the layers either. There is nothing in the material to explain why layers are deposited on the teeth. All the same, it should be pointed out that the polar bear is exposed to great changes in light conditions every year. These are the same for the males and females as it is the dark season of the year when the female may be in the den.

Breeding biology and population structure of the polar bear in the Svalbard area

PREVIOUS INVESTIGATIONS

There are very few data on the breeding biology of the polar bear. From various zoos there are known observations of pairing and parturition from PRELL (1930), KOST'JAN (1954), AFONSKAJA and KRUMINA (1958), DITTRICH (1961), and VOLF (1963).

Arctic expeditions have given some information about the denning habits of the polar bear from more or less occasional observations. More important contributions on this subject have been made by KOETTLITZ (1898), MANNICHE (1910), FREUCHEN (1935), Van de VELDE (1957), and PEDERSEN (1957). In recent years more important investigations have been made on denning habits. In Franz Josef Land, PAROVŠČIKOV (1964) has studied migration and mapped the area where the pregnant females find their denning places. He also gives data from dens, and weights of cubs taken from the dens. A similar investigation has been made by

USPENSKIJ and ČERNJAVSKIJ (1965) on Wrangel Island. From Arctic Canada, HARINGTON (1968) has studied structure and temperature of the dens and occurrence of polar bears in the dens. He also gives interesting data of polar bear embryos.

MATERIALS AND METHODS

Gonads from 46 males and 36 females were collected from my wintering on Edgeøya 1964–65. Testes from 5 bears on Halvmåneøya 1964–65, and testes from 15 bears on Hopen 1963–64 were also collected. All these places are situated south-east of Spitsbergen. The crew of the Arctic vessel M/S «Havella», which hunted in the pack ice east and north of Spitsbergen, collected gonads from altogether 60 males and 32 females during the summers 1961–67, on the author's request.

On account of the conditions during winter hunting, it may take as long as 4–5 days after the bears have been killed before they are skinned. After skinning the testes were still fastened to the skin, but the reproductive organs of the females were laid inside the skin. The frozen skins were thawed in the spring, and all the material was put in formaline as quickly as possible. Bears shot in summer were skinned immediately, and the gonads put in formaline.

After the material had been kept in formaline and sent to Oslo, it was taken out, cleaned, measured and weighed. The testes and the epididymis were dissected free from the tunica vaginalis. The testes were weighed without the epididymis. Sections were made from different parts of two testes in the frozen material, and two testes from what was collected in the summer – altogether 4 bears. Whole testes had a similar development, and sections from the rest were taken from the middle. Sections of the epididymis were from both body and tail. The specimens were cleaned, dehydrated, embedded in paraffin, sectioned about 8 μ and stained with Hematoxylin and Eosin and Van Gieson Hansen. The ovaries were cut away and weighed. Each ovary was then cut crosswise (across) in slices 2 to 3 mm thick. Corpora lutea and the follicles were counted with the aid of a magnifying glass (10×). Uterus cornu were cut lengthwise and examined for fetus and placental scars. Two cross-slices were taken from each ovary which was used for histological examination. They were taken at a distance of ⅓ from the ends of the ovary. The methods used for making sections and dying were the same as those used for the testes.

Sections were made of the testicles of 42 bears. They were selected according to quality and in such a way that they covered as much of the development throughout the year as possible. Sections were made of the ovaries of 44 females, and selected in the same way as for the males. As the material collected during the winter had been lying frozen for several months, the quality of the sections was somewhat reduced, but not so poor as to prevent us from studying the most important changes during the year. There is no division between right and left testes or ovaries. They have just been called 1 and 2.

The histological classification of testes and epididymis used in this study is almost the same as ERICKSON and NELLOR (1964) used in their work on the black

bear. Seminiferous tubules were classed in three categories: 1) solid, tube-like structure with no lumen, 2) tubules with a well-developed lumen, and finally, 3) spermatic epithelium showing sign of regressing from a functional state.

Leydig cells were classified as 1) active, with the nuclei vesicular and cytoplasm ample with evidence of secretory vacuoles, 2) low pre-seasonal or post-seasonal activity with few or no vacuoles, 3) inactive, with small and dense nuclei. Epididymis were classified as 1) maintained, epithelium with high secretory cells, 2) declining, little or no secretion, 3) atrophic, the epithelium disorganized, and finally 4) pre-seasonal repairing.

The age used in Tables 22 and 23 is the same as described in the chapter on "Age determination". It has been possible to decide the age of a few of the bears caught in summer; this is explained in the text. The males are grouped in immature and mature, based on the weight of bacula, weight of testes, total length, and the histological examination. The females are grouped according to total length, development of uterus cornu, weight of ovaries, and the histological examination.

All the photographed sections are stained with Hematoxylin and Eosin.

RESULTS AND OBSERVATIONS

Reproduction in male polar bears

Testicular weights. — The weight of the testes increases until the polar bear is 6 years old (Fig. 12). The heaviest testis (without epididymis) weighed 89 gr. It was from a big bear shot on Hopen 25th March 1964.

The weight of the testes varies greatly during the year. Fig. 16 shows the weight of testes of 88 sexually mature animals as a function of season. The diagram shows that there is a great increase in weight from December to April. The increase in weight during the time from the gonadal rest in October–November

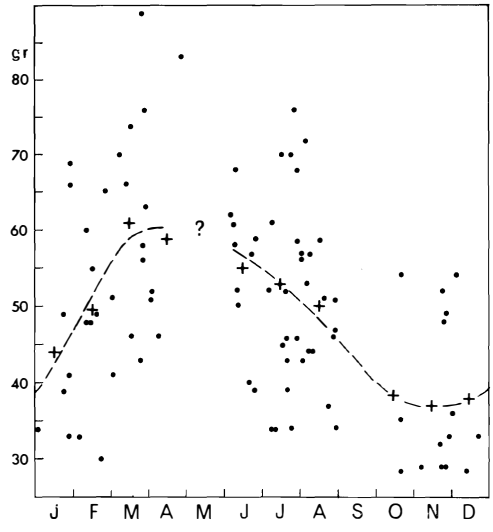

Fig. 16. *Testis weights of polar bears as a function of season. + indicates the monthly mean value.*

up to April is about 50%. The diagram shows the heaviest monthly mean weight, 61 gr, in March. Owing to the lack of material from April and May, it is not possible to say when the heaviest testicular weight occurs in the polar bear. But it is most probably at the end of April or the beginning of May, immediately before mating time begins.

Histology of the testes. – The first sign of recrudescense in the testes from the rest stage in October and November (Pl. II, fig. 9) of the mature polar bear starts in December. From December the seminiferous tubules increase relatively rapidly to the end of January and then more slowly, but the tubules are still widely separated until the end of March. The intertubular spaces consist of loose connective tissue, and the tubules or sex cords are solid cords of cells.

At the end of January the sex cords have increased many times since the rest stage, but the intertubular spaces still occupy half or more of the testes (Pl. II, fig. 10). The tubules are closed, but about one third of the tubules exhibit all stages of spermatogenesis. The cells are all dense, and it is very difficult to distinguish the various cell types that form the seminiferous epithelium (Pl. II, fig. 11). In the body and in the tail of the epididymis there is a light load of spermatozoa mixed up with abnormal and immature germinal elements (Pl. II, fig. 12). In January differences in the left and right testes were noted. Later it seems to be the same development stage in both testes. There are some individual differences in the bears. The activity state of bear 41, taken January 24, was more advanced than the others taken later in January and early February.

The season with low activity in the testes lasts until the middle of April. In February–March (Pl. II, fig. 13), and the first part of April, the tubules are still closed, but occupy more and more of the intertubular spaces. In the tubules the development of germ cells are still difficult to observe. In the epididymis the epithelium is repairing and more spermatozoa are also to be seen, but still mixed up with abnormally formed cells. Until this time, beginning of April, it is probable that the testes do not produce sufficient mature spermatozoa for fertile breeding.

From January to April the Leydig cells are few and relatively small with elongated nuclei and dense cytoplasm with few or no cytoplasmic vacuoles.

Unfortunately there are only 5 specimens from April and May, and one of them is immature, see Table 22, but the bear taken April 27 shows that great changes have taken place during the last part of April. The seminiferous tubules have been further enlarged, but there are still some spaces between them (Pl. II, fig. 14). Most of the tubules have got lumen, and the spermiogenesis could easily be observed in almost all of them (Pl. II, fig. 15). The body of the epididymis is filled with spermatozoa, but few are seen in the tail.

The period with high sexual activity in the testes starts in late April or early May and lasts to the end of July and even to the beginning of August in some bears, see Table 22. In the specimens collected in this time, the seminiferous tubules lie compressed together (Pl. II, fig. 16 and Pl. III, fig. 17). The small intertubular spaces are mostly occupied by active Leydig cells and some fat cells (Pl. III, fig. 18). The Leydig cells have big, round vesicular nuclei and vacuolated

Table 22

Reproduction data of the male polar bear. For explanation of designations, se below.

Specimen No.	Collection date	Testes weights (grams)		Age (a)		Histological evaluation			
		1	2	Year	Month	Seminiferous tubules (b)	Spermatogenesis (c)	Leydig cell activity (d)	Epididymis (e)
37	Jan 1	18	19	3	0	S	I	I	–
38	» 14	18	25	3	0	S	I	I	–
41	» 24	50	48	5	0	S	M+	A	R
44	» 27	65	72	6+		S	M+	A	R
45	» 30	65	66	6+		S	M+	A	R
48	Feb 5	31	34	4	1	S	M+	A	R
49	» 8	59	60	6+		S	M+	A	R
55	» 18	48	50	4	1	S	M+	A	R
60	» 25	64	65	6	1	S	M+	A	R
65	Mar 7	66	73	6+		S	M+	A	R
66	» 9	66	–	6+		S	M+	A	R
67	» 9	9	10	2	2	S	I	I	–
69	» 16	73	74	6	2	S	M+	A	R
T2	Apr 1	43	58	m		S	M+	A	R
T5	» 3	51	52	m		S	M+	A	R
T3	» 9	45	46	m		S	M+	A	R
3920	» 27	83	–	m		O–S	M	A+	M
3922	May 5	5	–	1	4	O–S	I	A+	–
A2	Jun 7	52	–	3	5	O	M	A+	M
A3	» 8	61	–	m		O	M	A+	M
C2	» 21	22	–	2	5	O	I	A+	M
B2	» 25	39	–	3	5	O	M	A+	M
A9	Jul 6	19	–	2	6	O	I	A+	M
A10	» 6	52	–	m		O	M	A+	M
1961–9	» 20	46	–	m		O	M–	A+	M
A13	« 24	70	–	m		O	M	A+	M
C6	» 29	12	–	2	6	O	I	A+	M
C7	» 30	69	66	m		O	M–	A–	D
C8	Aug 8	57	–	m		O	M	A+	D
A18	» 20	51	–	m		O	M–	A+	D
A19	» 22	37	–	m		O	M–	A–	D
3	Oct 21	51	52	6+		R	MI	I	At
4	» 23	32	37	3	9	R	MI	I	At
5	» 23	37	38	4	9	R	MI	I	At
16	Nov 23	49	55	5	10	R	MI	I	At
17	» 25	46	50	6+		R	MI	I	At
20	» 26	4	–	0	10	S	I	I	–
22	» 27	48	50	6+		R	MI	I	At
23	Dec 1	34	37	3	11	R	MI	I	At
24	» 4	50	58	6+		S	MI	I	At
29	» 11	27	28	4	11	S	MI	I	At

(a) Age:
m=sexual mature

(b) Seminiferous tubules:
O=open lumina
S=closed lumina
O–S=open and closed lumina
R=regressing

(c) Spermatogenesis:
I=not active – immature
MI=not active – ceased
M=active
M–=active- incomplete postseasonal
M+=active- incomplete preseasonal

(d) Leydig cells:
A=preseasonal low activity
A+=breeding season high activity
A–= postseasonal low activity
I=inactive

(e) Epididymis:
R=repairing
M=maintained
D=declining
At=atrophic

cytoplasm. The epididymal tubules also lie pressed together, and its epithelium is secretory with big, ovale nuclei (Pl. III, figs. 19 and 20).

In the last half of July we get the first sign of atrophy in the seminiferous tubules. The spermatogenesis ceases, and in most of the tubules we get extrusion into the lumina of cytoplasmic droplets and abnormal and immature cell forms (Pl. III, fig. 21). In August, except in bear C8 (Pl. III, fig. 22), which still has active spermatogenesis, only a few tubules produce spermia. Spermatozoa are present in small quantities in both body and tail of epididymis until August 20. The atrophy in the epididymis starts in the end of July. The tubules shrink, and groups of cells are pressed into the lumina (Pl. III, fig. 23). This is first observed in the tail.

There are no specimens between August 22 and October 21, but during this time the complete degeneration of the testes occurs. The seminiferous tubules shrink to only a fraction of what they are in the breeding season. The spaces between the tubules are invaded by loose fibrous, connective tissue. The degeneration of the epididymis also continues, and at the end of October the tubules are considerably smaller than in the breeding season. A heavy, fibrous, connective tissue invades the area round the tubules, previously occupied by smooth musculature (Pl. III, fig. 24). The epididymal epithelium breaks up in a discontinuous sheet of cells (Pl. IV, fig. 25).

The period of complete gonadal rest in the male polar bear lasts for two months, October and November.

Male sexual maturity. — As shown in Table 22, one yearling (bear 3922), 4 bears about 2½ years old (bears 67, C2, A9, and C6), and 3 bears about 3½ years old (bears A2, B2, and 4) were examined. The specimens' ages that are not given in the chapter "Age determination" are age determined by their baculum weights. The specimens C2, A9, and C6 have bacula weights 7.1, 6.2 and 5.8 gr respectively, and their age is estimated to be about 2½ years. The bears A2 and B2 have bacula weights 11.2 and 12.3 gr, and their age is estimated to be about 3½ years.

The histological examination of the yearling collected on May 5 shows some testicular activity. The seminiferous tubules are enlarged, but they are not occupying more than half of the testes, and in the intertubular area functional Leydig cells are seen.

The three 2½ years old bears, collected June 21, July 6 and 29, have enlarged sex cords, not far from the condition found in mature bears. Most of the seminiferous tubules have lumen, and the spermatogenesis comes to the secondary spermatocyte and spermatid stage (Pl. IV, fig. 26). In a couple of the tubules of the bear collected June 21, in the height of the breeding season, a few spermia were seen. In the intertubular area well-defined functional Leydig cells are seen. The epididymis of these bears shows a development like the mature bears. The tubules have a very light load of immature and abnormal germ elements, so few of the immature and abnormal germ elements produced in the seminiferous tubules are shed to the epididymis.

The bears A2 and B2, both 3½ years old, show the same testicular development

as all the older bears (Pl. IV, fig. 27). The tubules of the epididymis (Pl. IV, fig. 28), are filled with spermatozoa, and there can be little doubt that these two 3½ years old bears have reached sexual maturity.

Observations of breeding habits. – Here are some observations of polar bears' behaviour which indicate that rutting time is about to begin or has begun.

On March 8, 1951, I shot a big male bear which had two bleeding wounds in its head and one on the side of its chest. Another big bear was seen at the same time. Their tracks showed that they had been fighting; they had not been fighting about food.

On March 10, 1955, a big male and a female were standing quite still, rubbing noses, when I noticed them. After more than 10 minutes in the same position they were disturbed by me and walked slowly up the mountain side, with the male a few steps behind the female the whole time.

On March 26, 1965, I saw a big male bear on the ice near Negerpynten. It let out a roar every fifth second at the same time as it looked eagerly to one side. A female with a year-old cub was running along at a distance of a hundred metres. The female looked towards the male the whole time it was running. On retracing the tracks, I found that the female and the male had been about 8–10 metres from one another, but the female and the cub had run away. It was the first time I had heard a bear roar in that way without being wounded.

On April 27, 1967, near Hinlopenstretet FLØTTUM (p. com.) saw a male bear trying to mate with a dead female, which had just been shot, see Fig. 17.

On Hopen, April 30, 1955, KULSENG (p. com.) saw two bears playing for several hours. They also attempted to mate.

In Lomfjorden, May 7, 1967, FLØTTUM (p. com.) saw a female together with a male. The male licked her in the face and smelt at her tail. It tried to make advances, but was rejected.

The reason for the lack of observations later in the spring is that bears are very seldom seen by the winter hunters as they keep further away from land.

On June 20, 1924, Captain KRÆMER (1940) saw two bears mating on the pack ice near Hopen. He estimates the mating time for polar bears to be from the middle of May until the end of June.

Reproduction in female polar bears

Gross description of the ovaries and reproductive tract. – The reproductive tract of the female polar bear is of the typical carnivore type. The two uterine cornu meet in the relative short corpus uteri. The length of the cornu in adults is 15 to 20 cm. Usually one of the cornu is 2 to 3 cm longer than the other. In the immature bears the cornu are 9 to 15 cm.

The ovaries are somewhat flattened oval bodies in shape. The heaviest weight was 7.9 gr. This ovary contained two corpora lutea. The average weight is higher in the summer than in the non-breeding season in winter owing to the development of follicles and corpora lutea. One of the ovaries of bear 28 had an abnormal weight (*Torquatio ovarii*) of 28.6 gr (Table 23).

No embryo was found. In fact, no embryo has ever been found in the female

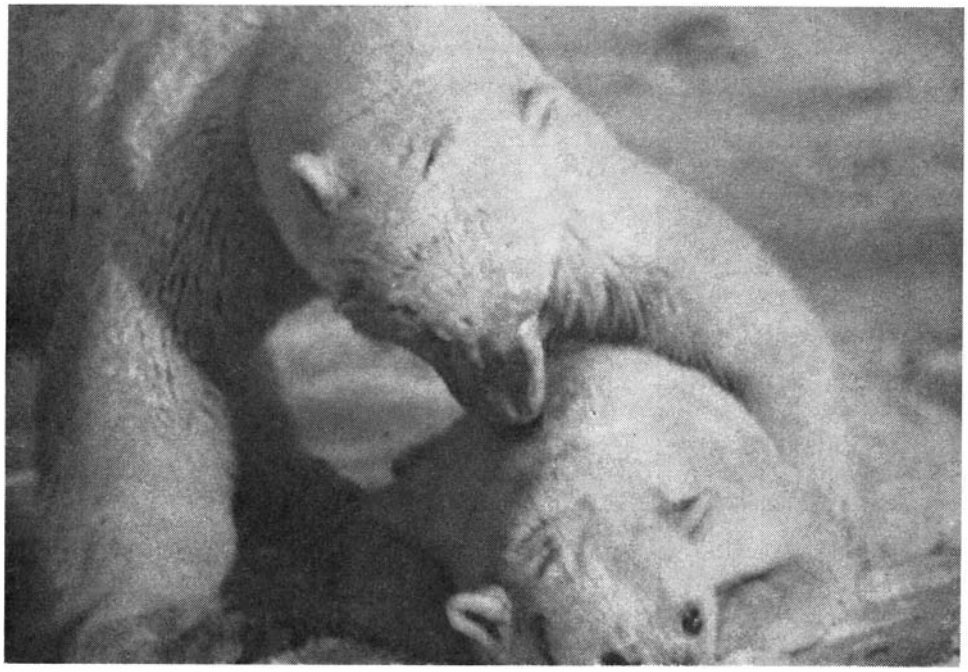

Fig. 17. *A male polar bear trying to copulate with a newly shot female bear. April 27.*
Photo: S. FLØTTUM

polar bear in Svalbard or North-East Greenland. The trapper RUDI (p. com.) told me that in the nineteen–twenties a reward of 5,000 Norwegian kroner was offered by a foreign museum to the trapper who could provide a polar bear fetus. The Norwegian hunters searched for it eagerly for many years, but not a single embryo was found. This indicates that visible embryos are not to be found until the female dens.[1]

Placental scars were found, but owing to formalin bleaching it was not possible to decide whether there were scars or not in many cases. The use of placental scars to indicate earlier pregnancy had to be given up in this work.

Histology of the ovary. – During the late non-breeding season, which lasts from October to the end of March, there are no marked microscopic differences in the ovarian structures. The majority of the ovary consists of loose connective tissue with a poor organization of cells. The cells are mostly spindel-shaped with dense cytoplasm and dark compact nuclei (Pl. IV, figs. 29 and 30). As shown in

[1] After this paper has gone to print, THOR LARSEN (p. com.) informed me that the trapper, TORSVIK, caught a female with two fetus on Ryke Yseøyane on December 21, 1968. After 10 months in formaline the male fetus weighed 120 gr and the female 115 gr. Both were without hair. Since nothing is known about the growth of the fetus of the polar bear, it is impossible to know exactly when they would have been born. But I would presume, according to the information gained regarding newborn cubs from KOST'JAN (1954), that the parturition would have taken place in the middle of January. It is most probable that this female had just left her den for a short time. No den was found on Ryke Yseøyane.

Table 23

Reproduction data of the female polar bear.

Specimen No.	Collection date	Age (a)		Ovarian weights gms (b)		No. of follicles						Corpora lutea		Notes
						1 (in mm)			2 (in mm)					
		years	months	1	2	<3	3–6	>6	<3	3–6	>6	1	2	
40	Jan 23	2	0	1.6	1.4	10	0	0	10	0	0	0	0	
46	Feb 5	2	1	2.1	2.0	0	0	0	4	0	0	0	0	
47	» 5	3	1	2.2	2.3	17	0	0	8	0	0	0	0	
56	» 18	4+		2.0	2.6	18	0	0	12	0	0	0	0	Accomp. by 1 cub
62	Mar 6	4+		3.0	3.0	33	0	0	33	0	0	0	0	–»– –»– 1 »
64	» 6	4+		2.1	1.8	3	1	1	4	1	0	0	0	
71	» 26	4+		3.6	3.3	0	0	0	8	0	0	0	0	
74	Apr 1	4+		2.6	2.9	6	0	0	20	0	0	0	0	
75	» 1	1	2	2.3	2.0	33	0	0	58	0	0	0	0	
79	» 29	4+		2.6	–	9	3	0	–	–	–	0	–	Accomp. by 1 4-months cub
80	May 1	4+		4.5	4.3	60	0	0	40	0	0	0	0	–»– –»– 2 –»– –»–
1962–1	Jun 4	m		3.3	3.0	100	0	0	130	0	0	0	0	
1964–1	» 6	m		3.8	–	59	0	0	–	–	–	1	0	
1963–3	» 9	m		4.1	3.4	44	2	2	43	4	2	0	0	
1965–1	» 18	m		6.2	3.6	22	3	2	13	2	2	0	0	Two large atretic follicles
1963–4	» 21	2	5	2.2	1.8	28	2	0	19	2	0	0	0	
1961–2	» 22	m		7.9	–	55	2	0	–	–	–	2	–	
1963–5	» 27	m		2.9	3.0	23	9	0	30	0	0	0	0	
1962–3	» 28	m		2.9	2.9	20	2	0	20	3	0	1	1	
1961–4	Jul 7	m		3.0	3.1	44	1	0	40	3	0	0	0	
1963–8	» 13	m		4.1	–	20	0	0	–	–	–	1	–	
1965–3	» 19	m		3.8	1.9	48	1	0	55	0	0	2	0	
1967–10	» 22	m		2.9	4.0	25	0	0	27	0	0	2	0	
1963–9	» 24	m		5.3	5.8	58	0	0	46	0	0	1	1	
1965–7	» 31	m		2.7	4.1	43	1	0	33	2	0	2	0	
1965–8	» 31	m		3.4	3.1	38	0	0	32	0	0	1	1	
1962–13	Aug 8	m		4.1	2.4	22	0	0	27	0	0	2	0	
1963–14	» 18	m		2.2	3.2	5	0	0	14	0	0	2	0	
1961–16	» 19	m		4.0	4.4	0	0	0	6	0	0	1	1	
1962–14	» 27	m		3.1	5.0	24	0	0	32	0	0	0	2	
1963–16	» 27	m		3.6	2.9	23	0	0	42	0	0	2	0	
1963–17	» 27	2	7	2.5	2.5	22	0	0	22	0	0	0	0	
1963–18	» 30	m		4.0	3.2	12	0	0	23	0	0	2	0	
1961–21	» 30	m		3.4	3.4	20	1	0	13	0	0	2	1	
1964–22	Sep 1	m		6.1	2.6	18	0	0	22	0	0	0	2	
2	Oct 16	1	9	2.2	2.4	0	0	0	0	0	0	0	0	
9	» 31	1	9	1.9	1.4	0	0	0	0	0	0	0	0	
10	Nov 8	4+		2.5	2.3	2	0	0	7	0	0	0	0	Accomp. by 1 cub
11	» 8	0	10	0.9	1.5	0	0	0	0	0	0	0	0	
18	» 25	0	10	1.1	1.1	0	0	0	0	0	0	0	0	
19	» 26	4+		2.6	3.1	9	0	0	17	0	0	0	0	–»– –»– 2 »
25	Dec 4	3	11	2.3	2.1	3	0	0	0	0	0	0	0	
28	» 11	2	11	2.5	28.6	12	0	0	–	–	0	0	0	
31	» 29	4+		2.8	2.4	5	0	0	0	0	0	0	0	–»– –»– 1 »

* (a) Age: m=sexual mature. (b) No division between right and left ovaries. They are called 1 and 2.

Table 23, vesicular follicles are found in the ovaries, but they are all old and atretic.

In the two bears shot on April 1, the first sign of pre-seasonal activity in the anestrous bear is evident. The connective tissue of the stroma is beginning to be replaced by cells containing ample cytoplasm and round nuclei (Pl. IV, fig. 31). Even though a prelude to the breeding season can be seen, the ovarian tissue has

by no means the same development as later in the season. Except for primordial and secondary follicles, no growing follicles have been seen up to this time.

Growing Graafian follicles were first seen on June 4, and are from now on common in all the ovaries not containing corpora lutea (Pl. IV, fig. 32). In the polar bear, as in other mammals, we must assume that the growth of the follicles past the secondary follicle phase, increases rapidly. But owing to the lack of specimens in April and May, it is not possible to know at which time this development starts; most probably it is in early May.

It is regrettable that viable, large follicles were not obtained. Bear 1965–1, shot on June 18, had two large follicles, 10 mm in diameter, but they were both atretic (Pl. V, figs. 33 and 34). The ovary was sectioned serially, but no trapped oozyts were found. The reason why the oozyts were not found, was that parts of the liquor folliculi and oozyts had been lost during the work with the sectioning. The degeneration process must have started recently, the walls of the follicles are not more than 0.5 mm–2 mm thick. The granulosa cells have disappeared, and the theca interna cells have proliferated and formed a luteal type tissue. As viable, large follicles were not found in any of the other bears, the preovulatory growth of the follicles must be a rapid and shortlived process in polar bears as in most other mammals. The two large atretic follicles indicate strongly that the polar bear has induced ovulation following mating, as ERICKSON and NELLOR (1964) have proved for the black bear.

In some Graafian follicles the oozyts measured from 70 to 130 μ in diameter (Pl. V, fig. 35).

The ovary in the breeding season contains a great variety of structures. Most of the follicles degenerate before they reach 3 mm in diameter, and atrecia among these small follicles is much in evidence. The first sign of atrecia is loosening of the granulosa layer. Then the theca interna cells invade the follicle. The cells that replace the follicles are large with rounded, vesicular nuclei and much like the cells in corpora lutea, but are not so large as these (Pl. V, figs. 36 and 37). Some of the follicles are completely filled during the breeding season, while others remain open or partly open. Primary and secondary follicles are more abundant than during the non-breeding season, and they are mostly found in irregular groups beneath the tunica albuginea. The cells in the stroma come to a high functional state (Pl. V, fig. 38).

The covering, or germinal epithelium, consists of a single layer of flattened cells during most of the year. The epithelium is often invaginated into the subjacent tunica albuginea to form small fold-pits or sub-surface crypts. In the breeding season the ovary is covered by a very apparent cuboidal epithelium. In one case, bear 1961–1 with two large follicles, the ovary had a nice cuboidal epithelium, but outside the large follicles the epithelium was stretched to a sheet of discontinuous flattened cells.

All the corpora lutea found show a radial organization. From theca, strands of connective tissue grow inward converging on the starlike central body which is made of undifferentiated connective tissue. All corpora lutea measured 7–10 mm in diameter, and there was no tendency to show that the size of the corpora lutea was increasing towards the autumn. The first corpora lutea was found on June 6

and the last on September 1, so it was not possible to follow the development of the corpus luteum in the important phase in the autumn and to the term.

The lutein cells possess rounded or polygonal profiles and average 20–50 μ in diameter (Pl. V, figs. 39 and 40). The cytoplasm of the lutein cells shows more variability. Many of the cells are homogeneous, others show vacuolation. Some of the lutein cells have one or a few vacuoles, which may occupy a great part of the cell. All the corpora lutea show the same high activity from June to September, but with a tendency to less gross vacuolation towards September (Pl. VI, fig. 41). After ovulation the cells in the ovarian stroma assume an endocrine type appearance (Pl. VI, fig. 42).

In the bear 1963–18 an accessory corpus luteum was found. It was a small corpora, measuring 1–1.5 mm in the ovary not containing corpora lutea. It was found in a little atretic follicle in which the growth of theca cells had stopped at an early stage, and the rest of the antrum was filled with cells like the cells in the true corpora lutea, but slightly smaller (Pl. VI, fig. 43).

The first corpora lutea was found on June 5 and the next on June 22. After this date all the mature female bears, except two, had corpora lutea, and as mentioned earlier, the bear shot on June 18 had two large atretic follicles. Further, apart from a few, all the follicles with greater diameter than 3 mm are found from June 9 to July 7 (Table 23). This indicates that breeding in the Svalbard area takes place from the beginning of June to the middle of July. Owing to the lack of specimens in April and May, the exact beginning of the breeding cannot be proved, but most likely breeding may occur already in early May – or even in the last days of April – lasting to the middle of July, with a peak period of about three weeks starting from the middle of June.

During the breeding season, one of the ovaries seems to be more active than the other. Out of 12 cases of multiple ovulations, only four were divided between both ovaries.

The development in the ovary of the two immature bears, 1963–4 and 1963–17, is much like the ovary of mature bears. Follicles up to 6 mm were measured.

It is not possible to find out exactly, when the activity in the ovary declines, because all the bears in July, August, and September had corpora lutea and are assumed pregnant. But from late October the histological examination shows that the ovary is in the inactive state as described in the beginning of this chapter.

The ovaries of two females with lactating cubs about 4 months old were examined. The corpus luteum at that time was reduced to a small corpus albicans about 1 mm in diameter. (Only one corpus albicans was found. The ovaries were not sectioned serially.) The ovaries of these two lactating bears, shot close to the breeding season, showed development of primary and secondary follicles, but no growing Graafian follicles. There is very little difference between the cells in the stroma and the cells replacing the atretic follicles, and all the cells appear to have a state of functional activity at this time (Pl. VI, fig. 44).

The bears 10 and 19, shot in November, and 56, shot on February 18, had lactating cubs. The females had milk in the mammarian glands. The bear, shot on March 6, had also some milk in the glands and was probably lactating. It was

not possible in any of these lactating bears to find microscopic differences in their ovarian tissue and the ovarian tissue of other anestrous female bears.

Female sexual maturity. – There is very little basis for deciding the age of the female bears shot between June 4 and September 1 (Table 23), so that these bears do not help us to decide when females become sexually mature. The female is fully grown two years before the male. It was, therefore, natural to presume that the female became sexually mature earlier than the male. The male is sexually mature when about 3½ years old, and it could be presumed that the female was ready for mating at an age of 2½ years.

Examination of the ovaries did not support this supposition. Bears 28 and 47, presumed to be 2 years and 11 months and 3 years old respectively, are not sexually mature (Table 23). Bear 1963–17, shot August 27, has uterus cornu which are only 7.5 cm long, and a total length of 190 cm. It is most probably 2½ years old, but has no corpora lutea. This is also the case with 1963–4.

It is more than likely that the females do not take part in mating before they are 3½ years old. According to the composition of the bear population (Table 27), some females do not mate until even later, for the first time at an age of 4½ years.

Ovulation rate and litter size. – Corpora lutea do not diminish until September. It is not known what kind of development corpora lutea undergo after that time as no ovaries have been examined. Their development is probably the same as in the black bear, where corpora lutea are maintained until the birth of the cub (ERICKSON and NELLOR 1964). The persistence of corpora lutea during pregnancy makes it possible to estimate the frequence of ovulation in the polar bear. This is an average of 2.07 in females where both ovaries were accessible. Out of 14 pairs of ovaries, there was none with only 1 corpus luteum; 13 had 2, and 1 had 3 corpora lutea.

It is not possible to estimate the conception rate as the placental scars have been too bleached in formaline to be able to see them clearly.

Nor is it possible to get any data about the size of the litter at birth as this takes place in the den, which is not left before about three months later. However, the observations recorded in Table 24 should give correct data about the litter size when the female leave the den with her cubs. The observations are from Edgeøya and Hopen after 1946. In my opinion the result is more reliable than it would be if other, more scattered, and chance information was included. Trappers have studied this field thoroughly. Of the 24 litters, which were studied there, are 1 litter of triplets, 14 litters of twins, and 9 of one cub only. These give an average of 1.67 per litter.

The material, which ovulation rate and litter size are compiled from, is too small to give any definite ideas about ova loss and intra-uterin mortality of embryos and fetuses.

The difference (2.07–1.67) indicates that there is some pre-parturition or post-parturition mortality in the den. Female bears in captivity have been known to eat their cubs (PRELL 1930, and AFONSKAJA and KRUMINA 1958), and it is possible that this also happens under natural conditions.

Table 24

Litter size in the polar bear. Catch of cubs and observation of tracks of litters on the south-eastern part of Edgeøya and Hopen after 1946.

Date	Size of litter 3	2	1	Informant	Notes
Mar 10–65			x	Author	Tracks. The female probably forced to leave the den, we had visited it twice
» 28–51		x		»	The den not found, large cubs
Apr 8–48			x	BJÅEN	The cub taken in the den, small cub
» 9–67			x	FORFANG	The den not found, small cub
» 10–48			x	BJÅEN	Taken when leaving the den
» 10–48		x		»	Taken in the den
» 11–47		x		Author	The den not found, small cub
» 13–51		x		»	Tracks
» 15–56		x		KULSENG	Taken when leaving the den (on Hopen)
» 17–62		x		TORSVIK	–»– –»– –»–
» 18–65		x		BJØRNSVIK	Tracks
» 19–67			x	FORFANG	The den not found, small cub
» 20–47		x		Author	–»– –»– small cubs
» 20–67		x		FORFANG	–»– –»– –»–
» 23–48		x		BJÅEN	Taken when leaving the den
» 23–48			x	»	Taken in the den
» 23–51		x		Author	The cubs run away
» 27–47	x			»	Tracks
» 29–47			x	»	The den not found, large cub
» 29–65			x	»	–»– –»– large cub. Weight May 6, 29.3 kg
May 1–65		x		»	–»– –»– Weight May 6, 15.8 and 16.3 kg
» 3–48			x	BJÅEN	–»– –»– large cub
» 5–48		x		»	–»– –»–
» 9–51		x		Author	Small cubs. Left the den a few days before, sand in the fur
Total: 24 litters				Litter-size frequency: single cub 37.5 per cent twin cubs 58.3 –»– triplet cubs 4.2 –»– Mean littter-size: 1.67	

Pregnancy sequence. – An analysis of the polar bear population in winter and the ovulation rate in females in the summer catch give us something definite to build on for judging how often females bear young. Most females with year-old cubs leave them before the mating season starts (see p. 83), and it is natural to believe that these females are on heat that season and therefore give birth every other year. A few females stay together with their year-old cubs until after the mating season and are most probably not on heat that summer.

The composition of the bear population in winter (Table 27, p. 86) shows that mature females do not always give birth every other year. If this had been the case, all mature females would either be together with their year-old cubs, or in their dens, giving birth to new cubs, during the winter. Four females had no young the winter they were shot, and these can, at the most, have young in the third year after the last pregnancy. Of course, it must be taken into consideration that one or more of these females may have been together with cubs and lost them, or they may have been sterile.

Table 28 shows the composition of the population in summer. Nine out of the 40 females shot were not mature. The ovaries of 8 of them were not preserved.

Examination of the other 23 females showed that only 4 were without corpora lutea. Of them, 82% had ovulated and been on heat. Two of the females without corpora lutea were shot early in the mating season, so it is possible they would also have ovulated later.

If we compare the data for the composition of the population in winter with the high percentage of sexually-mature females with corpora lutea in summer, we must conclude that most females give birth every other year. But some of them, probably those who keep together with their young for a longer time, do not give birth again before the third year.

Only one example is known from Svalbard which shows that a female can have cubs with two years in between. Trapper BENGTSSEN (1934) tells that he shot a female outside the den opening and was attacked by 2 two-year-olds when he was going to crawl in and fetch the cubs. After shooting the bigger cubs, he fetched two small ones in the den. This shows that the female may be on heat even though she is together with her approximately 1½-year-old cubs at mating time.

Denning habits

Denning area in Svalbard. – According to the details given about the catching of polar bears in the chapter "The winter trappers' catch in various hunting areas" and information from winter trappers, we now know that female polar bears den in the areas marked with a dashed line in Fig. 4. The density of dens is not the same over the whole area, and in certain years there are a few dens outside it.

Kong Karls Land is always closed in by pack ice early in the winter, and it is assumed that there are many dens there every year.

Even though there are few details from the north and east side of Nordaustlandet, we know that the ice conditions are such that it can be taken for granted that there are a lot of dens.

Kvitøya has never been visited in winter, but it is assumed that females den there every year. PAROVŠČIKOV (1964) tells that there are dens every winter on Victoria Island, 100 km east of Kvitøya; in 1959–60 ten dens were found.

In years when the pack ice closes in early (October–November) round Barentsøya and Edgeøya, there are probably almost as many dens there as in the areas further north. In years when the pack ice comes later round Edgeøya, there are only a few dens on this island. Usually there is quite a number of dens there, see Table 24. The eastern part of Edgeøya seems to have a larger number of dens than the western part.

There are dens every winter in the areas of Nordaustlandet towards Hinlopenstretet and the eastern part of Vestspitsbergen, southwards towards Agardhbukta, but with less density than in the areas mentioned above.

There is no record of dens being found on Vestspitsbergen, apart from the north-eastern areas, which have just been mentioned. It is probable, however, that in certain years there are dens in the area from Sørkapp to Agardhbukta and also on the north coast of Vestspitsbergen.

Two dens have been found on Hopen. Dens are only occasionally found on this island in years when the pack ice comes early.

Only one den is known about from Bjørnøya. Winter hunters have visited Bjørn-

øya from very early times, see Tables 4, 5, and 9, but it was first in 1964 that a female and two cubs were shot and a den found. According to information from SØRENSEN (p. com.), the female probably swam across to Bjørnøya in October 1963, because just at that time bear tracks were seen before any pack ice was observed. There was little ice with scattered floes that autumn, and only one bear was shot before Christmas.

The density of dens from one year to another is, of course, dependent on ice conditions. If there is little ice, there are a lot of dens in Nordaustlandet and Kong Karls Land. If there is a lot of ice, the females and their dens will be found over a much larger area. In years with unusually much ice there will probably be as many dens on Barentsøya and Edgeøya as in Kong Karls Land.

Denning location and structure of dens. — The polar bear's den may be found anywhere in the terrain. It does not look as though the female tries to find any special kind of ground; she finds a suitable snowdrift on land and digs herself in. As most of the snow in Svalbard comes with the east and north-east winds, the dens will usually be found in snowdrifts on ground sheltered from these winds. Dens have never been found on ice in Svalbard. The female is not able to find a suitable place on the ice at the time she is looking for somewhere to den. There is not enough snow on the newly-frozen ice in the fjords and bays. Drifts may be formed on the pack ice where it is hummocked, but conditions would hardly be satisfactory for a bear to have its den there. The enormous pressure and movements would make it very difficult for the bear. It is not easy to know definitely whether the bear dens on the pack ice or not, as the winter hunters never go out on the pack ice. Nor are the sealers ever in the areas around Svalbard which may be of interest at the time when the bear leaves the den. I have detailed descriptions of ten dens found at places varying from about 10 m from the shore to high up in the mountains. The den lying 10 m from the shore was situated in a place where there were avalanches from the mountain behind. After the female had gone into the den, there had been several avalanches. The bear probably had to dig a new opening several times as the tightly-packed snow was not porous enough to provide a sufficient supply of air. Two of the dens were on such steep slopes (40°–50°) that nobody dared go near them for fear of avalanches. One of the dens was found on the low and flat Halvmåneøya.

Trapper OXAAS (p. com.), who found the den on Halvmåneøya on March 27, 1907, tells; "We found the den in a snow drift in the lee of a rock just near one of our traps. There were three openings, two small which only the cubs could get through, and one bigger. Inside, the cave was a metre high. There was a passage across the den at each end. The cubs had been born in one of them as there were traces of blood. The den was clean and without excrements. The roof was no thicker than about a foot, and it was light inside the den." Fig. 18A.

Trapper BJÅEN (p. com.) shot a female in the den-opening on April 10, 1948, on Edgeøya. There was one cub in the den. The opening was 30–40 cm high and 70–80 cm wide. A slanting tunnel led downwards in the snow to a cave which was about 1 m high and 2 m wide, Fig. 18B. The den was perfectly clean. There were two other openings next to the opening which was dug out. It is possible

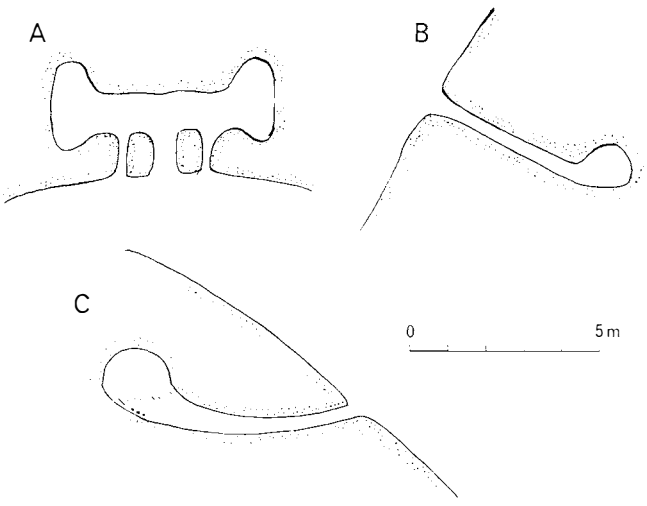

Fig. 18. *Polar bear dens. A top view section, B and C cross sections. Some excreta were found in C.*

that these were two other dens that the female had used, but they were not dug out.

On Hopen on April 17, 1962, a female was shot immediately after she had left the den with two cubs. TORSVIK (p. com.) tells about the excavating: "The den was situated at 200 m a.s.l. The female's resting place furthest in was a little higher than the rest of the cave. The width inside was 2 m, and it decreased outwards towards an opening that was only just big enough for the female to be able to get in and out. There were a few excrements by the side of the female's resting place." See Fig. 18C.

I once looked through the opening to two dens and saw the female moving about in there. The outermost part of the den was not higher than 30–40 cm. It was our intention to dig out these dens, but they were snowed in afterwards, and we could not find them again.

Only females with small cubs have been found in dens in Svalbard, apart from one case referred to earlier, where there was a den with a female and her two small cubs and two two-year olds. Both male and female polar bears of all ages dig themselves a temporary shelter now and again where they rest or wait for the bad weather to pass over. These shelters cannot be called dens as they are only rather shallow hollows in the snow and very seldom cover the bear completely.

It has been observed in Kong Karls Land, though very seldom, that the polar bear digs a den or a resting place in a snow drift in summer (KRÆMER 1940). This probably happens only under very special conditions, as for example when a bear is forced to stay behind on an island because the pack ice has disappeared. LØVENSKIOLD (p. com.) stayed for 12 days in Kong Karls Land in July–August 1960, and he tells: "There were about fifteen bears in the neighbourhood of our hut. They had all dug themselves dens in the snow cushions in the steep terrain. The dens were used daily, and if the temperature rose to over +7°C, all the bears went into the dens. (+7°C is an unusually high temperature for these islands.) One bear had three similar dens which it used in turn. These dens were examined. First there was a tunnel of 1.5 m which went upwards to a round cave with a height of 1.5 m. When the bear was lying in there, it could see down to the shore.

The snow, which was dug out of the caves, made platforms in front of the dens, and the bears would often sit there for a long time, watching. All the bears went backwards into the dens."

Entrance in the den. — The question of when the female polar bear goes into the den has been discussed a great deal by trappers in Svalbard. As far as I know, only trapper B. JOHANSEN (p. com.) has definitely observed a female going into her den. JOHANSEN spent the winter by Heleysundet. There was no snow before the middle of November when deep drifts were left after a heavy blizzard. When the storm had passed over, JOHANSEN went out straight away to have a look at his traps, and he had a dog with him. While he was checking one of the traps, the dog ran up the hillside and started to dig in the snow. He called the dog back as he did not see anything in particular. On February 22, at exactly the same place where the dog had been digging, the head of a bear was seen sticking out. The bear was shot, and the den dug out. The den was about 2 m long with a smaller cave at the side. The female had a very tiny cub. There is no doubt that the female went into the den in the middle of November during the storm, according to JOHANSEN.

According to the observations made of the pack ice, the beginning of polar bear hunting and the catching of cubs at Negerpynten on Edgeøya, it looks as though the females go into the dens in November–December. In the autumns of 1946 and 1947 the pack ice came, together with the bears, in the middle of November. Those two years five dens were found and 16 cubs were caught alive. In 1950 the pack ice came in the last half of December. We only found tracks of 2 females with small cubs. We caught 4 cubs altogether. In 1954–55 the ice came at the beginning of January, and we saw no trace at all of females with their young. Further north in Svalbard, where the ice comes earlier, it is possible that some females den as early as the last half of October.

It will be seen from Table 26, p. 86, which shows the proportion between male and females in the catch, that there are more females only in October and November. The majority of females is greatest in November. It may be that the females that are going to den are very active and therefore go on land more often than the males, and for that reason are more easily killed by the spring-guns. But the reason may also be that the females, more so than the bigger and stronger males, prefer to be on land at that time of the year when there is more movement and pressure on the pack ice, which is more broken up at the beginning of the winter, than later.

Time for parturition. — So far no polar bear with fetus has been shot in Svalbard; nor have any small blind cubs been found in dens, so we have no such material to use. It is possible, however, to calculate the date of birth of some of the cubs included in Table 24. Trapper JOHANSEN, who took a cub out of a den on February 22, has provided us with some information regarding the date of birth of the cub. It was very small and was carried back to the hut inside a jacket. Its eyes were open so it must have been older than 30 days, which is when they open their eyes, according to KOST'JAN (1954). It looks as though the

cub was born at the beginning of January. The twin cubs my fellow-trapper caught on May 1 weighed 16.3 and 15.8 kg respectively on May 6. If their age is calculated according to the weight curve (Fig. 19), they ought to have been between 105 and 110 days old. That means a date of birth around January 20. There are, however, some uncertain factors. The weight curve is for cubs born in captivity. It is probably more steep than it would be for cubs born in natural surroundings, and the cubs may, therefore, be older than the age given. It has been assumed here that cubs that have grown up in captivity grow faster than wild cubs as their mothers have had the best possible nutrition. I should think that these twins were born in the first part of January. The smallest cubs I have caught were found on May 9. They had just come out of their den as they had sand in their fur. They were also easy to handle. They were not weighed, but I do not think the weight was more than 7–8 kg. That would give an age of maximum 80 days, and the date of birth would be approximately February 20. The trappers STRAND and FORFANG (p. com.) caught one cub on April 9, of which they guessed the weight to be 5 kg, and that gives a date of birth around February 20. They caught three other cubs on April 20, twins estimated at about 3 kg each, and one cub estimated at about 4 kg. They do not consider these weights to be too low. If they made a mistake, even though it is rather unlikely, and the cubs were twice as heavy, for example, then all five cubs must have been born in the last half of January or at the beginning of February. On the other hand, the two big cubs I caught on March 28 show that parturition may take place very early. They are undoubtedly the earliest born of all the cubs mentioned in Table 24. They were not weighed, but I calculated they must have been born at the beginning of December. All the others must have been born in the period between the first days of December and the middle of February. Most births appear to take place in the first three weeks of January.

Emerging from the den. – Many observations have been made in Svalbard of females leaving the dens with their cubs. As can be seen from Table 24, by far

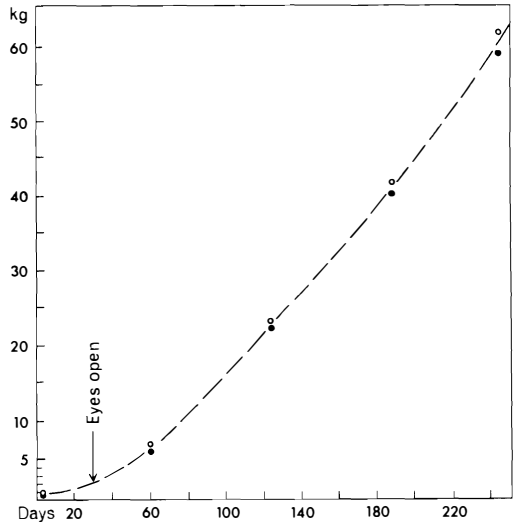

Fig. 19. *Growth rate of 3 male cubs (open circles) and 3 female cubs (dots) born in Leningrad Zoo. From KOST'JAN (1954).*

most of them leave the dens in April. The earliest observed date is March 10. It may be that the female was disturbed in the den and left it earlier than she would normally have done. Eight days before she left the den I peeped in, and we looked at each other with only a metre between us. My fellow-trappers and I also drove by the den several times with the dog-team. The den of the bear shot on March 28 was not found. She had two very big cubs, and it is more than likely that they had been out of the den for a week or two already. The bear shot on May 9 had two very small cubs and, as mentioned earlier, she had just come out of the den.

This shows that the females which leave the dens earliest come out in the middle of March. Those leaving latest come out at the beginning of May. Most of them leave the den in the period between April 10 and 25. I have spoken to several experienced hunters about this, and they all say that the bear leaves the den in April. See Fig. 20.

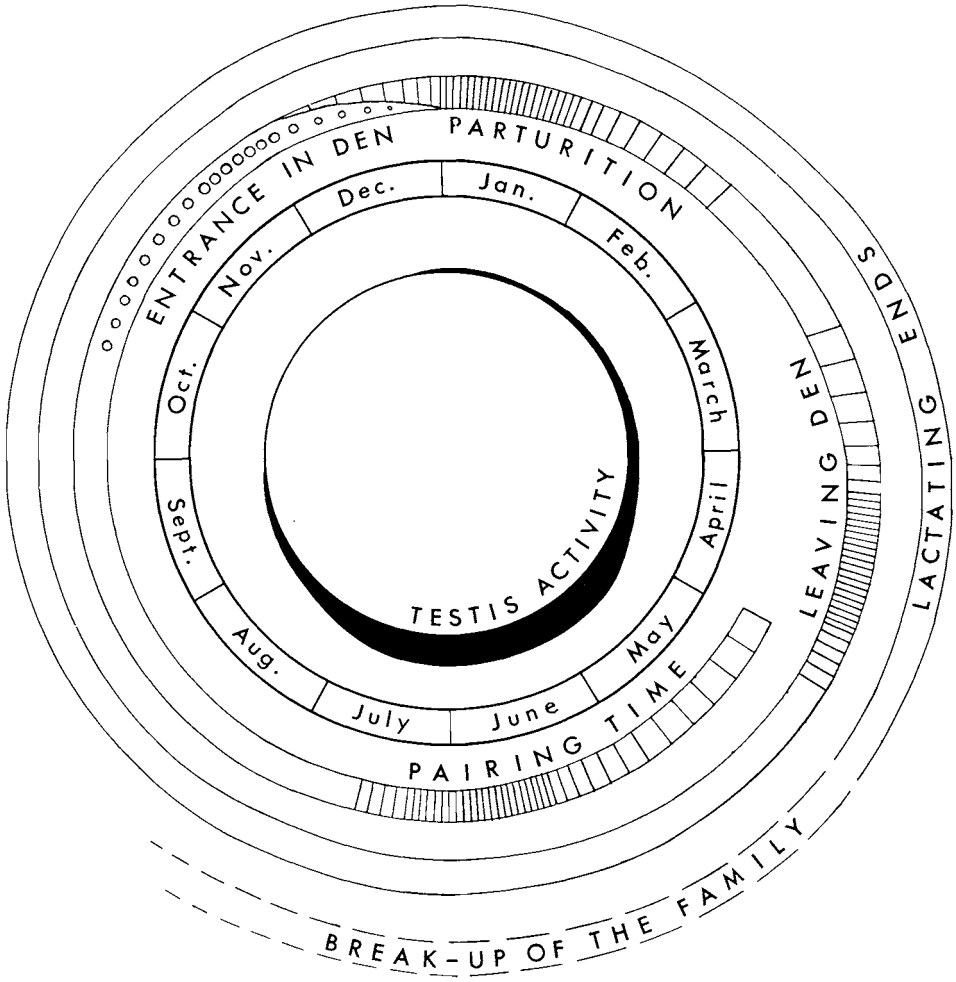

Fig. 20. *The breeding cycle of the polar bear in Svalbard. Inner circle shows the development of the testis. The spiral shows the two years' cycle of the female from pairing time to the time when the mother and the cubs separate.*

If we presume that the usual time for parturition is the first three weeks of January, then the average length of time the female spends in the den with her young, from the peak of parturition to the peak of emerging from the den, will be approximately 100 days. In addition to this, there is the period in the den before birth, which may be as much as 50 days. Altogether the female is in the den for about 150 days.

Activities associated with denning. — No observation have been made in Svalbard of the activity of the female polar bear in or around the den in the dark season. Both BJÅEN's observations (p. com.) and my own, however, show that the bear makes an opening 8–14 days before she leaves the den, and in some cases even earlier. She feels safe in the den as she does not come out even if there is somebody by the opening. In some cases the female, lying 1–2 m inside the den, may look out and snort irritably when she has visitors. In other cases nothing has been seen or heard of the bear even when a shot is fired by the opening. The bear usually takes some short trips outside the den together with her cubs the last 8–10 days before she leaves the den for good. TORSVIK (p. com.) tells that the men at the weather reporting station on Hopen saw a bear make an opening in her den on April 9, 1962. The den could be seen from the houses. The opening was soon filled with snow and was not opened again before April 17. The bear left the den that day with her cubs, and they were all caught.

Lactation and the break-up of the family

The first weeks after leaving the den, the female does not normally go further away from her cubs than 10–15 m. When the cubs are resting or playing, she often lies nearby so that she has a good view over the ice in case there should be any male polar bears around, as they are a danger to the cubs.

Most females stay with their young and defend them when they are pursued. A few may be frightened away from the cubs after a long and hard chase. Trapper SNARBY (p. com.) told that he and a fellow-hunter chased a female in North-East Greenland with a dog-team until she ran away from her cubs. The cubs were kept on board the ice-bound ship for a couple of hours. The bear kept near the ship the whole time and ran to meet her cubs when they were set free.

The few times I have seen a bear feed her cubs she has always been lying on her side or on her back. The cubs are fed until they are over a year old. One bear, No. 56 (Table 23), suckled her 13-month-old cub. There was milk in her glands. This was also the case for bear 62, which was shot on March 6. The latest example of suckling I have seen was in the middle of March, when a bear suckled her two 14-month-old cubs. Females with yearlings, which were examined in August by LARSEN (1968), still had some milk in their nipples.

The family consisting of mother and cubs breaks up in the spring or early summer when the cubs are nearly one and a half years old. During this time they have been almost inseparable, but now they begin to go around alone on the pack ice. Table 28 shows there are very few bears that stay together with their big cubs in the period June–August. Most of the families seem to be broken up either before or during the first part of the mating season. See Fig. 20.

Table 25

Catch and observation of twin-litters (2) and single-litters (1) when the cubs are in their second winter. Information from the trappers MUNKEBYE, BJÅEN, K. JOHANSEN *and the author.*

	Oct		Nov		Dec		Jan		Feb		Mar		Apr		Total	
	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1
Bjørnøya 1962–63					2	1	1	0	0	1	0	1			3	3
Zieglerøyane 1950–51					1	1	0	2	2	1	0	0	1	1	4	5
–»– 1954–55									1	6	2	1	0	1	3	8
–»– 1964–65	1	0	1	2	0	2	0	0	2	2	0	6	0	2	4	14
Halvmåneøya 1946–47	1	0	2	1	0	4	1	0	2	6	2	3	1	1	9	15
–»– 1947–48			2	8	1	2	0	0	2	5	2	1	1	1	8	17
–»– 1964–65	1	1	0	1	0	1	0	1	3	1	2	2	0	1	6	8
Total	3	1	5	12	4	11	2	3	12	22	8	14	3	7	37	70

Litter size frequency: twin cubs 34.6 per cent
single cubs 65.4 per cent
Mean litter-size: 1.34.

During the four winters I spent in Svalbard I only twice saw a young bear, probably two years old, together with a female and her one-year-old cubs. Perhaps it was a chance meeting that lasted only a short time.

Mortality

Table 24 shows that at the time the female leaves the den the size of the litters are 4.2% triplets, 58.3% twins, and 37.5% with only one cub. The mean litter size is 1.67. Observations of litters when the cubs are in their second winter (see Table 25) show that the corresponding figures are 0 triplets, 34.6% twins, and 65.4% with one; the mean litter size being 1.34.

The figures show that some of the cubs die in the first year. The difference between 1.67 and 1.34 suggests a death rate of a minimum of 20%.

If a female dies, her cubs may be adopted by another female with cubs. Trapper RUDI tells (SØRENSEN 1958) that after they had shot a female, her six-month-old cub escaped. It met another female with a cub; the bear licked the new cub, and it was accepted as one of the family. They all got away safely.

The reasons causing death among the cubs may be many. It seems natural that many die from injuries acquired on the pack ice in storms and in the dark. Some cubs are killed by their own kind. Captain G. JACOBSEN (p. com.) tells how in the Jan Mayen area in the month of April he saw a female with two small cubs. One of the cubs was dead and was lying about 25 m away from the mother bear and the other cub. It certainly looked as though the bear had killed the cub. After the female was shot, it turned out that she had no milk. In Nordaustlandet, on May 15, trapper OLSEN (1924) shot a female that had just eaten a little cub. OLSEN was not able to determine whether it was her own cub or not. It is well known among bear trappers that captive bear cubs, whether they are kept tied up or let loose around the hut, are killed if a male bear visits the hut. We were

visited by a male polar bear in the last days of May 1947, and it killed two of the cubs, which were tied up outside the hut, and wounded a third. PAROVŠČIKOV (1964) believes that most of the deaths among the young cubs in Franz Josefs Land are caused by old males tearing them to pieces in the spring.

Older cubs may also be killed by their own kind. NANSEN (1897) tells that he had shot a female which had two cubs on September 27, 1895 in Franz Josefs Land. The cubs escaped. The day after, NANSEN and his comrades shot a big male bear. It had killed the two nine-month-old cubs. Both of them were found with their skulls smashed. The bear had killed them out on the ice, but it had pulled them back to land without doing anything more to them.

It seems to be difficult for polar bear cubs in their second winter to survive if their mother dies. Some observations from Hopen in 1966, however, show that, in a few cases, they can manage for quite a long time and possibly survive. On February 4, a one-year-old cub was shot and another one on April 4. Their mothers had not been killed by spring-guns on Hopen, and as there were no trappers on the east side of Svalbard that winter, the mother bears must have perished on the pack ice. Both cubs were very thin, and their fur was in a poor condition (TORSVIK p. com.).

Adult bears sometimes kill one another. SIVERTSEN (1934) tells that in February in North-East Greenland he found a dead bear, which, as far as he could see, must have been killed by a bigger bear in a fight over a ringed seal.

It must be assumed that a number of bears perish in the open sea. There are several cases known of polar bears swimming over long stretches of open sea and reaching land far away from the districts in which they are usually found. Several polar bears, for example, have reached the Norwegian coast (JOHNSEN 1947). Most bears losing contact with the pack ice, however, probably drown or perish in the sea.

The walrus attacks, kills or wounds polar bears in the sea. KRÆMER (1940) saw a fight between a bear and a walrus which ended by the bear saving itself on an ice floe. The walrus had torn open the bear's thigh with its tusks.

Even the hooded seal can kill the polar bear. One of the crew on a sealer in the Jan Mayen area made the following observation (MOBERG 1960): A bear entered an ice flow from the water and struck at a male hooded seal. The furious fight ended in the sea. When the boat arrived at the arena both of them lay dead in the water. The throat of the bear was bitten through to the spine and the seal had all its ribs broken.

Population composition

In Table 26 nine winter catches are divided according to the proportion of males and females. None of the bears were selected and most of them were caught by spring-guns. Altogether, 701 polar bears were caught in these nine catches, and the sex of 605 was determined. The bears with no sex determination are cubs and yearlings and some adults. Males are in the majority from December until April. This is because the pregnant females are in the den. The proportion 34% males and 66% females in November is interesting. It looks as though the females are caught when they go onto land to find a place to den. The composition

Table 26

Sex composition of 605 polar bears caught in winter in Svalbard.

		Sep		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		Sum	
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Zieglerøyane	1954/55					4	2	2	0	5	3	16	4	8	8	1	0	0	1	36	18
–»–	1964/65			5	4	5	7	6	5	10	2	8	7	9	4	3	4	1	2	47	35
Bjørnøya	1962/63							1	0	3	3	5	1	2	2					11	6
Hornsund	1962/63	1	0	2	0	1	0	17	9	3	1	5	0	13	3	0	5			42	18
Halvmåneøya	1963/64			3	1	5	12	16	9	12	2	15	8	4	5	3	1	0	1	58	39
–»–	1964/65			4	5	10	28	3	9	12	11	11	5	9	3	2	0			51	61
–»–	1966/67			4	6	8	3	2	2	6	6	5	3	9	5	9	9	2	1	45	35
Hopen	1963/64					5	10	4	6	2	3	1	5	4	2	1	0	2	0	19	26
–»–	1965/66					4	7	1	5	8	5	4	4	6	7	6	3			29	31
Sum		1	0	18	16	42	69	52	45	61	36	70	37	64	37	25	22	5	5	338	267
Per cent		100	0	47	53	37	63	54	46	63	37	65	35	63	37	53	47	50	50	56	44

of my catch in 1964–65, however, does not support this theory. There were no pregnant females in the catch. The explanation may be that the younger and smaller females prefer to be on land at the time of the year when storms and bad weather cause great pressure and movements on the pack ice.

Table 27 shows the composition of my winter catch in 1964–65. There is nothing to suggest that certain categories are more easily caught than others. There was no selection of the catch. Two females with three cubs, which were caught at the end of April and the beginning of May, are not included in the table. It is most likely, therefore, that the composition of the population given here is a correct picture of the winter period while the female is in the den. Sexually mature females, four years old or more and without cubs, constitute 10% of the population. Males, 2½ years old or more, constitute 51.3% of the population.

The composition of the population is different in the summer. The female with her small cubs roam around on the pack ice, and some of them still have their 1½-year-old cubs with them. Table 28 is compiled from the catch and observations from M/S «Havella» in the summers from 1961 to 1967, when the ship was used

Table 27

Composition of the polar bear population in winter (pregnant females are in their dens), based on the catch on Edgeøya 1964–65. For further information, consult text.

Category	No.	Per cent of total population
Cubs 10 to 14 months old	12	15.0
Females accompanied by cubs	7	8.8
Males	41	51.3
Females about two and three years old	12	15.0
–»– about four years old	4	5.0
–»– 4+ years old	4	5.0

Table 28

Population composition in summer (June 1 to September 1) based on catch and observations from M/S «Havella» operating east and north of Spitsbergen.

Category	No.	Per cent of total population
Cubs 6 to 9 months old	30	14.5
Females with cubs	18	8.7
Yearlings accompanied by their mother	3	1.4
Females accompanied by yearlings	2	1.0
Males (catch)	57	27.5
Females (catch)	40	18.8
Other bears	58	28.0

for the trophy hunting of polar bears. The catch is partly selective as tourists prefer big male bears as trophies. Even so, there is no great majority of males. Time is often short on these tourist trips, and it is not always possible to choose the prey. All the bears which were shot were sexually mature except seven.

Size and weight

The growth of males and females in their first years is shown in Fig. 15. The female is fully grown about two years before the male. The heaviest weight in the winter catch 1964–65, which is shown in Table 29, is the male bear 49, which weighed 371 kg. Not all the bears were weighed, and it is possible that bear 22 was somewhat heavier. In the winter 1954–55, I caught three males which weighed 452, 441, and 486 kg respectively. Norwegian hunters always use the total length of the hide with the blubber removed when comparing the size of bears. The largest polar bear I have caught had a hide 292 cm long, but according to the reliable measurements of the trappers BJÅEN and RUDI, hides may be as long as 305 cm. These are very rare specimens, and if the bear is fat as well, the weight may be as much as 550 kg.

The heaviest female in the winter catch 1964–65 was bear 19, which weighed 225 kg. In the winter 1954–55 I caught a female which weighed 293 kg. As the trappers only remember the biggest males, there is no information about how big a female can be. LARSEN (1968) gives the weight of a female, weighed in the summer, as 350 kg.

Two big bears, in very good condition, were shot in Franz Josefs Land in September 1929. They were weighed by IVERSEN (1941). The male weighed 463.5 kg and the female 251.5 kg.

There is no good correlation between the measurements' total length, hide length, and hide size. Inaccuracy of the total length is caused by difficulties in placing the frozen or partly frozen bear in the right position for measuring. The hide size of two bears of the same total length will not be identical if one is fat and the other thin. The hide size will be larger if there is little blubber left on the

Table 29. *Size and weight of 83 polar bears caught winter 1964-65 on Edge-*

Bear No.	Date	Sex	Total length in cm	Total weight kg	Weight of blubber kg	Per cent blubber of total weight	Hide length in cm	Hide size		Estimated age	
								Foot	Inch	Year	Month
1	Oct. 16	♂	186	–	–	–	220	14	1	2	9
2	» 16	♀	175	147	40	27	212	12	9	1	9
3	» 21	♂	230	–	–	–	275	17	11	6+	
4	» 23	♂	203	251	50	20	245	15	4	3	9
5	» 23	♂	222	–	–	–	265	15	10	4	9
6	» 24	♂	204	222	53	24	230	14	0	3	9
7	» 24	♀	183	154	38	25	220	13	5	1	9
8	» 31	♀	174	–	–	–	–	–	–	2	9
9	» 31	♀	180	–	–	–	220	13	2	1	9
10	Nov. 8	♀	195	168	36	21	225	14	1	4+	
11	» 8	♀	128	56	10	18	155	9	11	0	10
12	» 22	♂	–	–	–	–	–	–	–	1	10
13	» 22	♀	188	181	44	24	235	13	10	4+	
14	» 22	♀	183	143	39	27	210	12	2	1	10
15	» 22	♀	176	–	–	–	–	–	–	2	10
16	» 23	♂	240	332	70	21	275	16	9	5	10
17	» 25	♂	239	364	97	27	280	18	0	6+	
18	» 25	♀	129	69	18	12	155	8	9	0	10
19	» 26	♀	192	225	76	33	245	14	6	4+	
20	» 26	♂	148	117	39	33	185	11	2	0	10
21	» 26	♂	148	105	43	41	185	11	8	0	10
22	» 27	♂	235	–	–	–	290	17	1	6+	
23	Dec. 1	♂	215	–	–	–	260	16	0	3	11
24	» 4	♂	217	282	22	8	250	16	3	6+	
25	» 4	♀	179	–	–	–	225	13	11	3	11
26	» 4	♂	185	–	–	–	–	–	–	1	11
27	» 5	♂	175	–	–	–	215	13	2	1	11
28	» 11	♀	192	177	47	27	220	13	7	2	11
29	» 11	♂	217	–	–	–	225	15	7	4	11
30	» 23	♂	226	309	71	23	260	15	11	4	11
31	» 29	♀	194	206	52	25	238	13	11	4+	
32	» 29	♀	190	–	–	–	220	–	–	4+	
33	» 29	♀	127	57	14	25	160	9	5	0	11
34	Jan. 4	♂	146	117	33	28	180	11	0	1	0
35	» 6	♂	185	–	–	–	215	13	0	2	0
36	» 6	♀	188	–	–	–	235	14	5	4	0
37	» 6	♂	208	–	–	–	240	14	3	3	0
38	» 14	♂	190	175	39	22	230	13	10	3	0
39	» 23	♂	216	–	–	–	250	15	4	4	0
40	» 23	♀	164	115	20	17	185	12	1	2	0
41	» 24	♂	233	–	–	–	270	16	9	5	0
42	» 27	♂	235	–	–	–	260	16	3	6+	
43	» 27	♂	235	–	–	–	265	16	2	6+	

hide when skinned. In Table 29 the bears were skinned with all the subcutaneous blubber on the hide.

A thick layer of blubber is usually found under the skin of the polar bear (see column 6, Table 29). This layer is thickest at the bottom of the back, by the tail, and behind the thighs. It is thinnest on the legs and throat.

Apart from this, the bear often has a lot of fat around the intestines – the most I have weighed is 28 kg. There are also fat deposits between the muscles. There is, therefore, a great difference in the deposits of body fat in the polar bear compared with seals and whales, which have most of the fat under the skin. As the border between skin and fat is not so definite in the polar bear as in the seal, a correct examination of the fat under the skin of the polar bear will depend on the

*øya and 2 hunted on the pack ice north of Svalbard in the summer 1960.**

Bear No.	Date	Sex	Total length in cm	Total weight kg	Weight of blubber kg	Per cent blubber of total weight	Hide length in cm	Hide size		Estimated age	
								Foot	Inch	Year	Month
44	Jan. 27	♂	237	–	–	–	270	16	5	6+	
45	» 30	♂	235	–	–	–	275	16	5	6+	
46	Febr. 5	♀	168	112	25	22	200	12	3	2	1
47	» 5	♀	188	167	45	27	230	14	0	3	1
48	» 5	♂	200	–	–	–	230	14	0	4	1
49	» 8	♂	235	371	93	25	285	16	6	6+	
50	» 14	♂	232	–	–	–	280	16	7	5	1
51	» 15	♂	237	–	–	–	285	–	–	6+	
52	» 15	♀	186	181	39	22	232	14	6	4	1
53	» 17	♀	190	137	34	25	228	12	11	3	1
54	» 18	♀	150	88	10	13	187	11	8	1	1
55	» 18	♂	205	–	–	–	245	14	7	4	1
56	» 18	♀	190	196	52	27	245	14	4	4+	
57	» 18	♀	144	91	26	29	180	10	11	1	1
58	» 22	♂	203	212	54	25	245	14	10	4	1
59	» 22	♂	143	90	16	18	176	11	3	1	1
60	» 25	♂	236	368	44	12	280	16	10	6	1
61	March 1	♂	219	–	–	–	245	15	8	5	2
62	» 6	♀	192	159	38	24	226	14	6	4+	
63	» 6	♂	–	66	12	18	158	9	8	1	2
64	» 6	♀	190	176	47	27	230	14	1	4+	
65	» 7	♂	235	–	–	–	270	17	4	6+	
66	» 9	♂	220	–	–	–	270	16	11	6+	
67	» 9	♂	178	160	50	31	215	12	6	2	2
68	» 11	♀	200	164	31	19	235	14	2	4+	
69	» 16	♂	230	331	62	19	275	16	6	6	2
70	» 26	♂	230	–	–	–	270	16	2	6+	
71	» 26	♀	190	185	39	21	245	14	3	4+	
72	» 26	♂	216	–	–	–	250	16	0	6+	
73	» 31	♂	230	–	–	–	275	16	7	6+	
74	April 1	♀	182	–	–	–	225	14	1	4+	
75	» 1	♀	151	95	20	21	190	11	8	1	2
76	» 6	♀	186	–	–	–	230	14	0	3	2
77	» 10	♀	142	68	12	18	180	10	9	1	2
78	» 27	♀	190	133	12	9	235	13	10	4	2
79	» 29	♀	197	207	36	17	242	14	0	4+	
80	May 1	♀	192	161	30	18	235	13	11	4+	
81	Sep. 9	♂	133	87	21	24	–	–	–	0	8
82	» 9	♂	125	70	16	23	–	–	–	0	8
83	» 9	♂	125	70	16	23	–	–	–	0	8
	July 19	♂	–	373	77	21	280	–	–	–	
	» 19	♂	–	270	64	24	255	–	–	–	

* Total length = straight line from tip of nose to end of tail when laid on side.
Hide length = from tip of nose to end of tail after blubber is removed, hide laid out flat.
Hide size = length from tip of nose to middle of anus plus width from claw tip to claw tip of front feet before blubber removed, when hide laid out flat.

person skinning the animal. In this investigation all the animals were skinned in exactly the same way, and the fat was removed very carefully from the meat. The results are, therefore, comparable. The heaviest weight of blubber in the catch 1964–65 was bear 17 with 97 kg. A bear I shot in January 1955 had 175 kg of fat under the skin. The female's layer of fat is just as well developed, and the heaviest weight is 76 kg.

In Table 29, column 7, the layer of fat is given as a percentage of the total weight of the animal. This varies somewhat from one individual to the other and

is somewhere between 8 and 41%. On an average it is 20% for males over one year of age and 23% for females older than one year.

There are only two weights of mine from the summer (Table 29). They were two males shot in 1960. They had 21% and 24% fat. The two examples of weighing by IVERSEN (1941), mentioned earlier, give information about the weight of the blubber, and I have calculated that the male had 27% and the female 30% fat.

These data confirm the information given by several experienced summer and winter hunters that there is no definite rhythm during the year for the fat deposit. Both well-covered and lean bears of both sexes are found all through the year. This is in great contrast to many other Arctic animals. Fig. 21 shows the blubber weight as a percentage of the total weight of the polar bear's most important prey, the ringed seal. The figure is based on the weighing of 75 adult ringed seals caught near Edgeøya.

Even though I did not weigh so many of the bears caught in the winter 1954–55, it is obvious that the bears in that catch were fatter. In the winter of 1954–55 there was little ice, and in the winter of 1964–65 there was a lot of ice. (See information regarding pack ice near Hopen, Table 15.) It is not possible to say whether there is any connection between the amount of ice and the bear's ability to catch its prey.

Big male bears seem to be amongst the fattest. This is probably because the most powerful individuals get hold of food more easily, and they can also take food from weaker individuals. I once saw a big male bear chase away a smaller male in order to take the prey it had just caught.

The two female bears, 79 and 80, which had both just come out of their dens with their cubs, had 17% and 18% fat, respectively. I have skinned six other females just after they have come out of the den. All of them were in good condition, and hardly less fat than those mentioned above. One of them probably had 25% fat. This shows that the female bear manages to survive the long time in the den very well, with the birth and feeding the cubs. Strangely enough, there does not seem to be any difference between the condition of the females coming out of the dens and other bears that do not den. USPENSKIJ and ČERNJAVSKIJ (1965) also point to the fact that the females leaving the dens on Wrangel Island had a lot of fat under the skin, and that their reserve of fat was far from used up in the den.

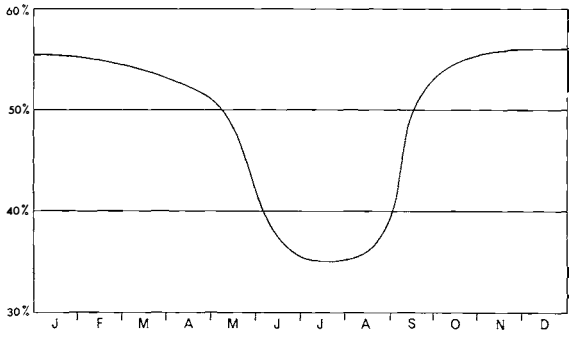

Fig. 21. *Per cent blubber of total weight in ringed seal (in Spitsbergen waters) as a function of season.*

DISCUSSION

This study shows that the male polar bear has a long pre-breeding season with a low spermia production that lasts from the last part of January to the middle of April. Even though there are few specimens from April and May, we must assume that the time of full-breeding condition in the male starts at the end of April and continues until the end of July. The time of complete gonadal rest lasts a couple of months – October and November.

On account of there being too little material, it is not possible to say at which time of the year the testes are heaviest, but it will either be immediately before the mating season begins in April or during the beginning of the mating season in May. This corresponds exactly with what ERICKSON and NELLOR (1964) found out regarding the black bear, whose testes are heaviest close to the breeding season.

The sperm production exceeds by many months the length of female receptivity. There is a difference between the polar bear and the black bear whose sperm production was only observed for two months (ERICKSON and NELLOR 1964). From this point of view, the polar bear is more like the brown bear which has a potential breeding season slightly exceeding half a year (ERICKSON et al. 1968).

The histological investigation showed that two 3½-year-old male polar bears were sexually mature. It is possible that there is some individual variation in young bears, but we must assume that most of the males are sexually mature from 3½ years, and all of them from 4½ years. In the younger bears, 1½ and 2½ years old, there is a marked change in the tissue of the testis in the mating season, but it is not fully developed with sperms. This seasonal development of the polar bear is also seen in the Leydig cells and the epididymis. ERICKSON et al. (1968) prove that the epididymis of the black and the brown bear has a development typical of the state attained by the sexually mature animal two years in advance of any spermatogenic activity. An examination of the three 2½ years old bears shows that the epididymis is completely developed in the polar bear one year before sexual maturity. Further, the examination of the one cub 3922, 1½ years old, caught before mating time began, makes it look highly probably that the polar bear is like the black bear and the brown bear regarding the development of the epididymis two years before sexual maturity.

The histological examination indicates that the female polar bear has induced ovulation following mating. The breeding activity, therefore, is comparable to that of the black bear (ERICKSON and NELLOR 1964), the ferret (MARSHALL 1904), and the mink (HANSSON 1947).

It is not possible to say definitely when mating time starts as there is not enough material to do so, but it is most likely that it starts at the end of April or beginning of May and lasts until the middle of July, with a peak period of three weeks from the middle of June. The males begin to show an interest in the females in March and April, and attempts to mate have been observed at the end of April and beginning of May.

PAROVŠČIKOV (1964) gives mating time in Franz Josefs Land as from the end of April until the middle of July, probably based on observations in the field. It corresponds exactly with this histological examination which has been carried out

on polar bears from Svalbard. HARINGTON (1964) gives mating time in Canada as usually in April. Observations from zoological gardens show that mating time there is even earlier. In Moscow Zoo observations of two females during several years showed that their earliest mating took place from 3rd to 12th March, and the latest in the last days of April (AFONSKAJA and KRUMINA 1958). In Prague Zoo mating was in the period from 11th February to 10th May (VOLF 1963), and in Leningrad Zoo from 15th March until the end of April (KOST'JAN 1954).

How long oestrus lasts is only known from zoos. In Moscow Zoo, where four females were observed, it lasted from 4—13 days (AFONSKAJA and KRUMINA 1958), and in Prague Zoo from 3—8 days (VOLF 1963).

No blastocyst or fetus was found[1] and, therefore, the investigation cannot prove whether the polar bear has delayed implantation or whether the blastocyst is implanted and does not show any development in the first months after mating. But it is assumed, all the same, that the polar bear, like the black bear and the brown bear, has a delayed implantation (DITTRICH and KRONBERGER 1963, and WIMSATT 1963). As fetuses have never been found in polar bears by trappers in Svalbard, even though a reward has been promised, it looks as though the fetus is implanted (or is developed) immediately before the female bear goes into the den, or while she is lying in the den. The time for implantation is probably very like that which DITTRICH and KRONBERGER (1963) found regarding the black bear and the brown bear, where the blastocyst is implanted 8—10 weeks before parturition. HARINGTON (1968) has information from the Arctic parts of Canada regarding fetuses in polar bears as early as 1st October. Five females had seven fetuses with lengths varying from 10 to 20 cm in the first days of October. Such large fetuses would hardly have escaped the notice of Norwegian hunters, and it makes it look as though they develop earlier in the year in the polar bear in Canada than they do in Svalbard and North-East Greenland where Norwegians have never found a fetus. PEDERSEN (1957) also mentions that a female with a fetus has never been found in Greenland.

In the material examined, some corpora lutea were found in the period between June 6 and September 1. No change in size of the corpora lutea was registered as both smaller and larger ones were equally characteristic of the polar bears killed during that period. Owing to the lack of material, the development of corpora lutea could not be followed during the interesting period up to parturition.

The investigation shows that the female suckles her young until February—March, when the cubs are 13—15 months old. It is possible that some feed their young until they are nearly 1½ years old. BAKER et al. (1963) examined a female accompanied by a 16—17 month-old cub. She had very little milk; 20 grammes were squeezed out of the mammary glands. There was no evidence that the cub was still suckling. In Moscow Zoo a bear suckled her cub until it was 10 months old, but then she started to protest. No one knows how long the suckling would have lasted as the mother and cub were separated (AFONSKAJA and KRUMINA 1958). KOST'JAN (1954) reports from Leningrad Zoo that the cubs were suckled until they were one year old. The amount of milk decreased after 7—8 months, and the

[1] See note p. 71.

female did not want to feed her cubs after that time. In Prague Zoo a cub was 20 months old before it finished being suckled. All these observations show that the period of suckling may vary from one to one and a half years. It is likely that a period of 13–15 months is usual in Svalbard.

In Svalbard the female bear goes into the den sometime in the period from the end of October to the middle of December. This is later than in Canada where, according to HARINGTON (1968), they go into the den in October. According to PAROVŠČIKOV (1964) the time is October–November in Franz Josefs Land. According to USPENSKIJ and ČERNJAVSKIJ (1965) on Wrangel Island, when ice conditions are normal, the female goes into the den in October.

Only pregnant females den in Svalbard. This has been confirmed by all the different hunters. Other bears will only den in Svalbard on account of extraordinary circumstances. The most recent investigations in Franz Josefs Land (PAROVŠČIKOV 1964) and on Wrangel Island (USPENSKIJ and ČERNJAVSKIJ 1965) seem to confirm this. HARINGTON (1968) has come to a completely different result in Canada, where both sexes of all ages have been found in dens.

Individual bears of both sexes and of all ages may dig themselves a hole in a snowdrift in the summer and use it as a resting place for a short period. This seems to happen mostly when the polar bears are forced to stay behind on an island when the pack ice has disappeared. DOUTT (1967) has described some dens from Twin Island, James Bay, Canada, which I believe he has mistaken for dens which had been used in winter. The dens had been dug in sand in sloping ground. They had been newly dug there, and traces of many old dens showed that dens had been dug there from many years earlier. Many polar bears were shot on the islands at the time the newly-dug dens were found. It is probable that bears dig these holes in summer in order to find a cool place to rest. LØVENSKIOLD (p.com.) was sure this was one of the reasons why polar bears used the dens the summer he saw them in Kong Karls Land. Twin Islands, which are situated between 53° and 54°N, and are near the southernmost area for the polar bear, have much hotter summers than Kong Karls Land (79°N). It would, therefore, be quite natural for the polar bear to seek a place to rest in a cool hollow of sand when there is no snow. The sand hollows on Twin Islands are of the same shape and size as the snow hollows described from Kong Karls Land in summer.

It has been possible to calculate the date of birth of cubs that have just come out of den from the information about the growth of bear cubs born in zoological gardens (KOST'JAN 1954) (Fig. 19). According to these calculations, female polar bears in Svalbard bear their young from the first days of December until the middle of February, the majority of births being in the first three weeks of January. PAROVŠČIKOV (1964) gives the date of birth in Franz Josefs Land as January–March. This does not seem to agree with his information about the weight of 23 bear cubs which were taken out of their dens. If calculated in the same way as above, the births in Franz Josefs Land would appear to take place at the same time as in Svalbard, or a little earlier.

In Canada the females give birth earlier. HARINGTON (1968) states: "Data on embryos from females shot between 1st October and mid-December, and information on recently-born cubs in dens suggest that, in nature, cubs are born in

November or December." Fig. 22 is taken from HARINGTON (1968). It is based on 124 births in zoos. This graph agrees completely with the data HARINGTON gives from Canada.

With a peak period of mating in June and a calculated peak period of births in the beginning of January, the length of pregnancy for the polar bear in Svalbard should be 7 months (about 210 days). This does not agree with the data given for four births in Moscow Zoo. According to AFONSKAJA and KRUMINA (1958), the period of pregnancy was 228–236 days for one bear, whilst another bear had three pregnancies in three successive years which lasted 236–239, 254–260, and 258–262 days, respectively. The time is given according to the first and last mating. This is a variation of minimum 22 days and maximum 34 days. In Prague Zoo, VOLF (1963) gives the period of pregnancy as varying from 228–303 days, giving an average of 8 months. In Leningrad Zoo, KOST'JAN (1954) gives a period of 230–250 days. Everything seems to point to the fact that polar bears in Svalbard have a shorter pregnancy than those in zoos.

In Svalbard most female bears leave the den somewhere between April 10 and 25. This is a week or two later than in Franz Josefs Land. According to information from PAROVŠČIKOV (1964) about catches of 23 cubs from 13 dens in 1960 and 1963, the females left the dens between the middle of March and the first days of April. On Wrangel Island the females leave the dens at the same time as in Franz Josefs Land. According to USPENSKIJ (1965), most of them leave the dens on Wrangel Island between March 10 and 25. In Canada it happens in March or April (HARINGTON 1964). According to PEDERSEN (1957), the bears in East Greenland leave the dens at the end of March or beginning of April, seldom earlier.

The date of birth for polar bears in captivity seems to be the same as for polar bears in Canada. According to information from HARINGTON (1964 and 1968) about mating and parturition, the period of pregnancy for the polar bear in Canada is about 8 months. This period seems to be about a month shorter for polar bears in Svalbard than those born in captivity or in Canada. The reason for this cannot be that there are several subspecies of polar bears, as those in the zoos come from many different areas. In fact, a large number of polar bear cubs from Svalbard have gone to zoos all over the world. An explanation of the different

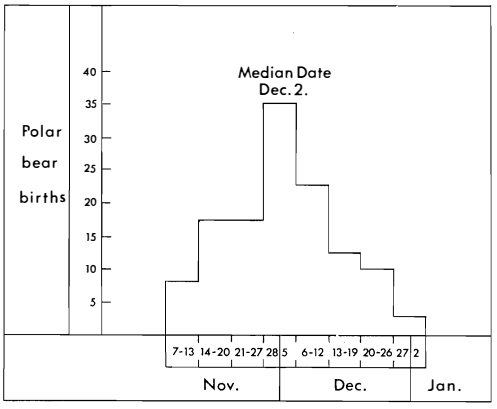

Fig. 22. *Dates of parturition of captive polar bears (grouped by weeks). Based on 124 dates. The parturition period is centred on December 2. From* HARINGTON *(1968).*

mating time and period of pregnancy among polar bears in Canada and in captivity on the one side and polar bears in Svalbard on the other, may be the different daylight conditions. The material of fetuses and new-born cubs, which HARINGTON (1968) collected, was from between 55° and 75°N, whereas the material from Svalbard was collected from 77°20′N. The polar bear wanders over great distances but only a few of those in the Svalbard area will come south of 75°N. In summer they all move northwards, and a great number of them are found north of 80°N. I have no information about the polar bear's wandering in Canada, but they will always be further south than in Svalbard. In Svalbard (on 77°N), the dark season lasts about three and half months, and the period with the midnight sun is of the same length. On the other hand, there is no dark season, or only a very short one, and only a short period with the midnight sun in those parts of Canada where HARINGTON's material was collected. The zoos that have been mentioned all lie on latitudes where there is no dark season and no midnight sun. It is possible that this difference in daylight conditions is the explanation of the earlier start of mating time in zoos and in Canada.

The biology of reproduction seems to be similar in the polar bear and the mink. Experiments with mink have proved that if the animals are exposed to more than the natural amount of light per day, the time of breeding is moved forward (AULERICH et al. 1963, HANSSON 1947). The same is the case with the ferret (BISSONNETTE 1935). The period of pregnancy also seems to be shorter in Svalbard than in zoos. The intense reflection of light from the midnight sun on the snow-white pack ice, which the pregnant females are subject to after breeding, may have the same effect as with mink, where the gestation period is shortened when the animals get additional illumination per day after mating (AULERICH et al. 1963). PEARSON and ENDERS (1944) have proved that the period of pregnancy in the American marten is shortened by three months if the amount of daylight is increased by artificial light.

The great difference in size of the cubs in the month of April shows that the time for parturition in the polar bear in Svalbard stretches over a period of more than two months. PAROVŠČIKOV's (1964) investigations in Franz Josefs Land show that there, too, the female bears give birth over a similar period of time. This is a difference between the reproduction biology of the polar bear and the brown bear. The brown bear, which also has a very varied period of pregnancy, varying from 194 to 278 days (DITTRICH and KRONBERGER 1963), all the same gives birth during a shorter period, regularly in late January and early February (ERICKSON et al. 1968). In this way the brown bear is very much like the mink, which has a great variation in the pregnancy period, but where the females give birth during a short period (HANSSON 1947).

When the polar bear leaves the den in Svalbard, the size of the litter is on an average 1.67 with the variation of 1 to 3. Triplets are certainly much more rare than 4.2%, as the observations in Table 24 show. Of all the winter hunters I have spoken to, who have caught bears both in Svalbard and North-East Greenland, none of them ever saw a polar bear litter of triplets. On the other hand, during the last two years female bears have been seen with triplets on the east side of Svalbard, later on in the summer. As it has been proved that bears may adopt

Table 30

Litter size in polar bears in natural dens in various areas and in captivity.

Location	References	No. of litters	Litter-size frequency per cent				Mean litter size
			1	2	3	4	
Canada	HARINGTON (1968)	99	31.3	59.6	8.1	1.0	1.79
Franz Josefs Land	PAROVŠŠIKOV (1964)	141	22.7	77.3	0.0	0.0	1.77
Svalbard (Edgeøya)	Consult Table 24	24	37.5	58.3	4.2	0.0	1.67
N. E. Greenland	MANNICHE (1910)	35	28.6	71.4	0.0	0.0	1.72
Wrangel Island	USPENSKIJ & ČERNJAVSKIJ (1965)	14	50	50	0.0	0.0	1.50
Various zoos	HARINGTON (1968), AFONSKAJA and KRUMINA (1958)	62	38.7	59.7	1.6	0.0	1.65

other cubs, it is possible, though slightly, that one of them was an adopted cub. It is obvious that triplets are very rare because several experienced captains on sealers are of the opinion that polar bear triplets do not exist. Table 30 shows the size of polar bear litters in the different areas where they live and also of captive polar bears from 9 different zoos. The average size of the litter shows a difference from 1.50 on Wrangel Island to 1.79 in Canada. One triplet birth is known from Moscow Zoo (AFONSKAJA and KRUMINA 1958), whereas triplets and even quadruplets are known from Canada (HARINGTON 1968).

This investigation shows that the polar bear female hardly reaches sexual maturity at an age of 2½ years. As with the black bear and the brown bear, it must be assumed that sexual maturity is dependent on growth and development, and that all individuals do not reach it at the same age. Brown bears have been observed in Leipzig Zoo, and a few become sexually mature when they are 1½ years old, while the others reach this stage at an age of 2½ or 3½ years (DITTRICH and KRONBERGER 1963). The black bear, in captivity, has reached sexual maturity at an age of 3½ years (BAKER 1912, quoted by RAUSCH 1961). In Prague Zoo polar bear females reached this stage first after 5 years (VOLF 1963). In Leningrad Zoo the corresponding age was 4½ years (KOST'JAN 1954). NOVIKOV (1962) states that polar bear cubs attain sexual maturity at the age of 3 to 4 years in nature, and the age of 5 years in captivity. The general physical development and the development of the reproduction organs give the impression that the polar bear female reaches sexual maturity from an age of 3½ years, but according to the number of observations now available from different zoos, one must take into account that a certain number of females first reach sexual maturity when they are 4½ years old.

An analysis of the composition of the polar bear population, summer and winter in Svalbard, shows that most sexually mature females give birth every other year. Observations from zoos give a more varied picture. In Leningrad Zoo the bears gave birth regularly every other year. If a bear lost her young after one or two months she gave birth again the next year (KOST'JAN 1954). In Prague Zoo the sexually mature females were not on heat the following year after they had given birth, and they suckled their cubs up to an age of 20 months. There,

too, another female that had lost her young was not on heat the year after parturition (VOLF 1963). In Moscow Zoo a bear gave birth to three litters in three years (AFONSKAJA and KRUMINA 1958). Probably the bear was separated from her young each time when they were 10 months old.

Summary and conclusion

This survey is based, first and foremost, on material from 85 bears shot in Svalbard during the winter of 1964–65, and 95 bears shot on the pack ice in the Svalbard waters in the summers of 1961–67. In addition, observations have been included from three earlier winters, the first in 1946–47.

The results are summarized here under headings which correspond with the sections in the survey.

Hunting methods. – In the summer, all hunting takes place on the pack ice. The bear is hunted by boat, and is shot either in the water or on the ice. Trappers who have spent the winter in Svalbard have used various kinds of hunting devices, but now only the spring-gun is used. Earlier, poison was also used. Traps for catching the bear alive have been tried out, but without success.

Statistics. – Norwegian Arctic hunting began in Spitsbergen in 1795, and Norwegians have expanded their hunting areas over the years so that today, Norwegian boats hunt in the pack ice from Newfoundland in the west to Novaja Zemlja in the east. These sealing boats have always caught polar bears, but the hunting of bears has always been of less importance than sealing.

Norwegians have also carried out winter hunting in North-east Greenland (though this ended in 1959) and in Svalbard, and these hunters have caught a certain number of bears. But it is only in the hunting grounds in the eastern part of Spitsbergen that the hunting of bears has been the basis of hunting activity.

Statistics have been made of all Norwegian bear catches from 1871 up to today. These figures show that the total catch increased because of an increase in the activity of the industry up to 1907 when figures show that 888 bears were shot. Since then, the catch figures have remained high with large variations from year to year – 901 bears were shot in 1924, which was a record year. However, if one looks at the period from 1907 to today as a whole, one can see a slight decrease in the catches because the number of sealing boats in Nordisen has declined – this is the hunting ground where most bears have been shot. From 1945 to 1968, the average number of bears shot per year is 311.

Living cubs have made up roughly 10% of the total catch since 1958 – since then, the hunting of cubs has almost come to an end.

It is most probable that there has been a decrease in the bear population in Svalbard from 1900 up to today, although this decrease is probably no greater than 25%.

The bear follows the pack ice southwards in the winter, and wanders north-

wards again in the summer when the ice recedes. There is nothing to show that the bear wanders into or out of the Svalbard area – the catch figures show that the bear is just as numerous in the summer in Svalbard as it is in the winter.

Laws. – The first law, which came into operation in 1927, prohibited the use of poison. In 1939, all bear hunting was prohibited in the group of islands known as Kong Karls Land, and in 1967, bear hunting from motor vehicles and planes was forbidden. The ban which has been of most protection for the bear population is the prohibition of the capture of living cubs.

Food. – The result, based mainly on stomach contents, shows that in winter the polar bear around Svalbard lives almost entirely on ringed seal. In summer, the ringed seal is also the most important prey, but the polar bear also feeds more on bearded seal and harp seal than it does in winter.

It eats some quantity of seaweed too, if it has the opportunity. Grass, moss, and birds are of very little importance as food, even though they are found in the stomachs of bears now and again. The polar bear shows no interest in reindeer whatsoever.

Age determination. – The males are not fully grown until they are 5–6 years old, and because of this, the male can be classified into more yearly age groups than the females, which are fully grown two years earlier.

Useful criteria for the classifying of the first 3 to 4 years are provided by the bacula and the testes, but it is not possible to group the females on information provided by the ovaries and uterus.

Four cranial measurements, viz. coronoid height, interorbital breadth, condylobasal length, zygomatic width, and the sum of the last two measurements, have proved to be useful in the classification of the first few years. The closing of cranial sutures have been examined – the basioccipital-basisphenoid suture closes in the males at an age of about 4½ years, and in the females at about 3½ years.

The femur ceases to grow in length in the males at an age of about 5½ years, and in the females at about 3½ years.

The males have been classified into 7 different age groups, the first four groups corresponding to the first four years. Many criteria have been used in the classification of the fifth group (the 5 year olds), which is thought to be reliable, but the sixth group is uncertain. The seventh group covers bears which are thought to be 7 years and older.

The females have been classified into 5 age groups – the first three groups corresponding to the first three years. The fourth group is considered to consist of 4 year olds, but this is uncertain. The fifth group covers bears of 5 years and older.

An attempt was made to assess age by counting layers in the tooth cement, as the number of layers increase with age. Most probably, two layers are formed each year during the first four years. Nothing certain can be said about how many layers are formed later. The layers are difficult to count, and this method is not at all satisfactory where exact age determination is concerned.

Biology. – The polar bear is a seasonal breeder. The testicles undergo great changes in the course of the year – from gonadal rest in October–November until April, there is a weight increase of about 50%.

The polar bear has a potential breeding season of about half a year starting in late January. The time of high spermatogenic activity lasts from late April to the last part of July.

The males are sexually mature from 3½ years onwards – some females are probably also sexually mature at the same age, but most of them are not so until 4½ years.

Because we have not got very much information about females, it is impossible to state with certainty when the mating season begins, but it probably does so at the end of April or the beginning of May. It lasts until the middle of July, culminating in three weeks which begin in the middle of June. The first corporea lutea has been found as early as June 6.

The polar bear probably has induced ovulation following mating. Embryos have not been found in Svalbard, and it is most probable that the embryo does not begin to develop until, or just before, the female goes into her den. It has not been possible to prove that the female has delayed implantation, but this is probable.

The females have their dens in the east and north-east of Spitsbergen. They go into their dens between the end of October and the middle of December, and leave them again between the middle of March and the beginning of May – most females leave their dens between April 10 and 25. The time of birth has been estimated from the weight of cubs born in captivity. Birth takes place some time between the beginning of December and the beginning of February, although most births take place in the first three weeks in January.

In Svalbard, only the females that are going to have young go into their dens, and only one case is known of where both newly born and two year old cubs were found together in the same den.

The cubs are usually suckled until they are 13–14 months old, although some continue to be suckled for another 4 months or so. The females and cubs part company between April and August – that is to say, when the cubs are from 15 to 19 months old. The males always roam alone on the pack ice, except for a short period during the mating season.

The average litter consists of 1.67 cubs, with a variation of from 1 to 3, although a litter of 3 cubs is very rare. The minimum mortality rate during the first year is 20%.

The largest males usually reach a weight of 350–400 kg, the largest recorded is 486 kg. In record cases, the weight will probably be about 550 kg. The females reach a weight of about 250–300 kg, the largest weighing about 350 kg. Both males and females have a considerable layer of fat under the skin, varying from 8% to 41% of the total weight. The layer of fat does not vary with the seasons, and well-covered as well as lean bears can be found in both summer and winter.

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Vestvik, Per
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Ytreland, Ivar
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PLATE I

Fig. 1. *Bear 36, female, January 6. Transverse section of first molar in lower jaw. The picture is taken from the part lying close to the second molar. In the cementum 5 growth layers are seen. The first layer is very indistinct (arrow) and the third and fourth are almost merging. Estimated age 4 years.* $\times 27$.

Fig. 2. *Picture of the same section as in fig. 1, but taken on the lingual side, middle of tooth where it narrows. The layers, as seen in fig. 1, have been divided in many layers and are difficult to count.* $\times 70$.

Fig. 3. *Bear 52, female, February 15. Median section of first incisor in lower jaw. Eight layers are seen. The first one is seen in only one place (arrow). The four outer layers in pairs. Estimated age 4 years.* $\times 27$.

Fig. 4. *Bear 31, female, December 29. Median section of first incisor. Ten layers are seen. The layers tend to lie in pairs. Estimated age 5 years.* $\times 27$.

Fig. 5. *Bear 74, female, March 1. Median section of first incisor. Eleven layers are seen. The female was accompanied by a cub one year and three months old. Estimated 4+ years.* $\times 70$

Fig. 6. *Bear 24, male, December 4. Median section of first incisor. Nineteen layers are seen. By adjusting the microscope, traces of three more layers can be seen, near the dentine.* $\times 27$.

Fig. 7. *Bear 59, male, February 22. Median section of first incisor. Two layers are seen on a small area. Estimated age one year and one month.* $\times 70$.

Fig. 8. *Bear 27, male, December 5. Median section of first incisor. The first, third and fourth layers can clearly be seen. By adjusting the microscope, the second layer can also be seen (arrow). Estimated age one year and 11 months.* $\times 70$.

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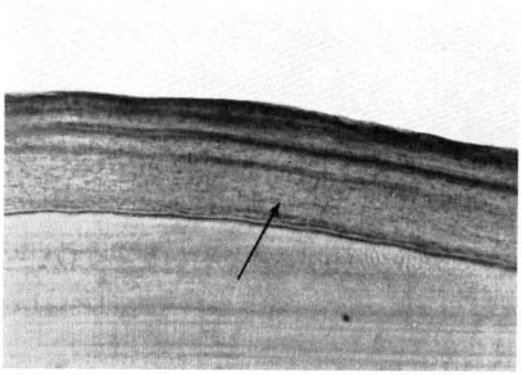

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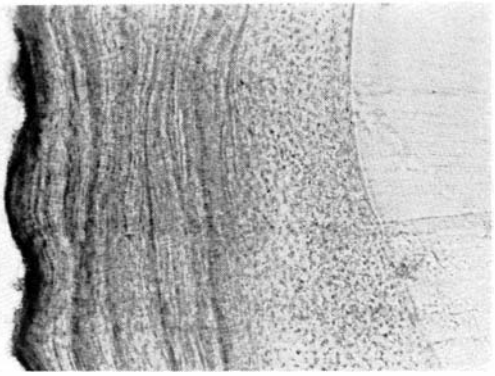

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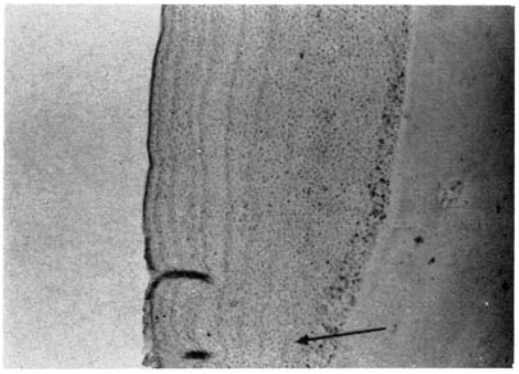

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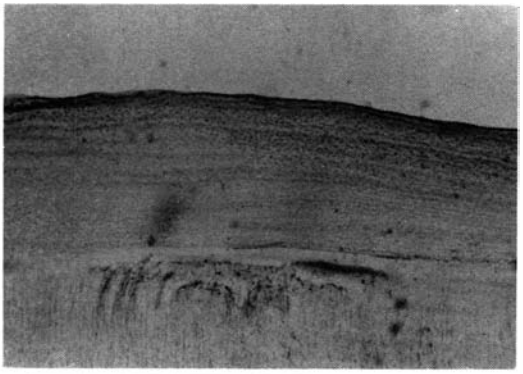

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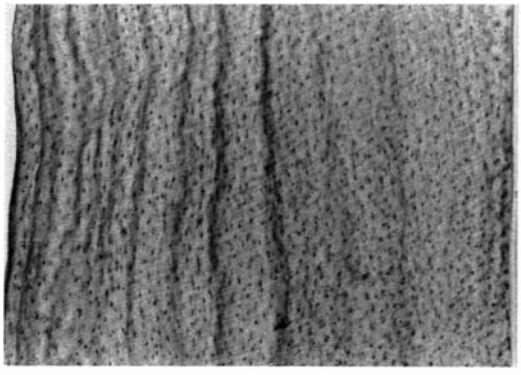

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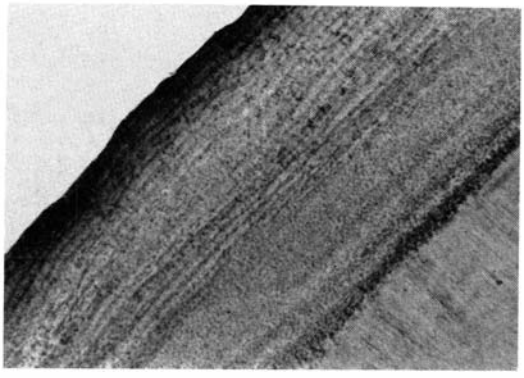

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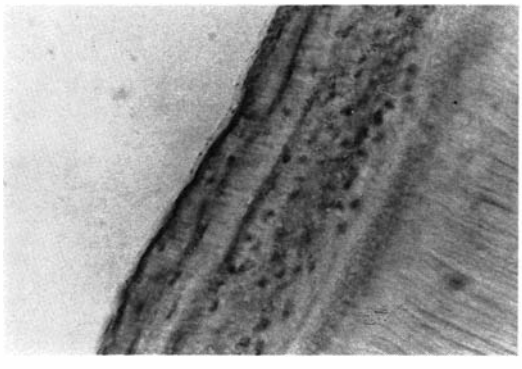

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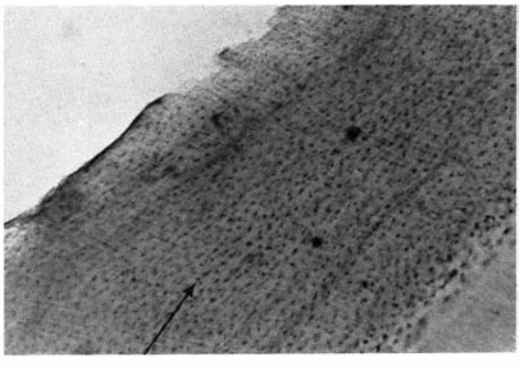

PLATE II

Fig. 9. *Bear 17, Nov. 25, mature. Complete degeneration of the seminiferous tubules. Loose connective tissue occupying most of the testis mass.* $\times 70$.

Fig. 10. *Bear 41, Jan. 24, mature. Early pre-breeding season. Marked enlargement of the seminiferous tubules since the rest stage.* $\times 70$.

Fig. 11. *Bear 41, Jan. 24, mature. High magnification of fig. 10. Spermiogenesia awakening in about one third of the closed tubules.* $\times 270$.

Fig. 12. *Bear 41, Jan. 24, mature. Epididymal epithelium repairing. Lumen with spermatozoa and abnormal and immature germinal elements.* $\times 173$.

Fig. 13. *Bear 69, March 16, mature. Pre-breeding. The seminiferous tubules occupy about half of the testis mass. Spermatozoa seen in most of the closed tubules.* $\times 70$.

Fig. 14. *Bear 3920, April 27, mature. Start of the breeding season. Spermatogenesis complete in almost all tubules.* $\times 70$.

Fig. 15. *Bear 3920, April 27, mature. All stages of the spermatogenesis easily observed in the tubules.* $\times 270$.

Fig. 16. *Bear A3, June 8, mature. Height of breeding season. Seminiferous tubules with lumina lying compressed together.* $\times 70$.

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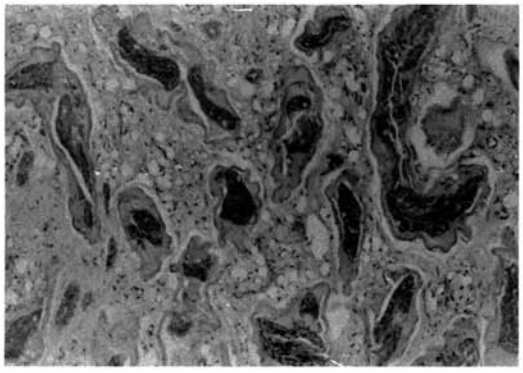

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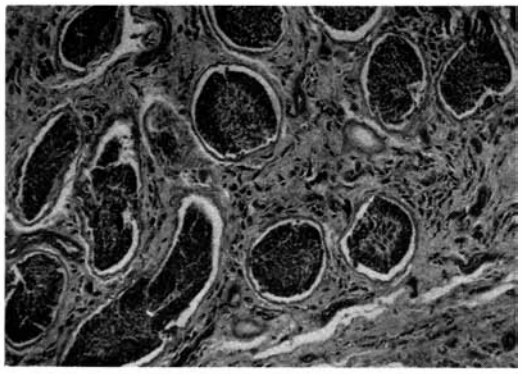

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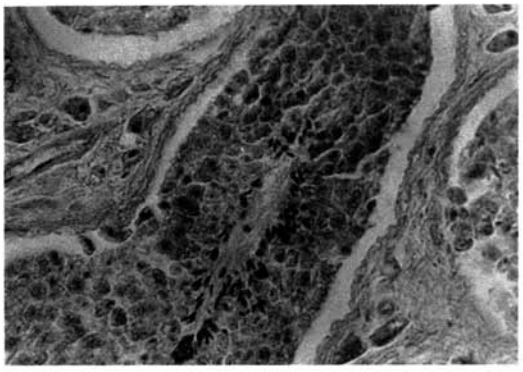

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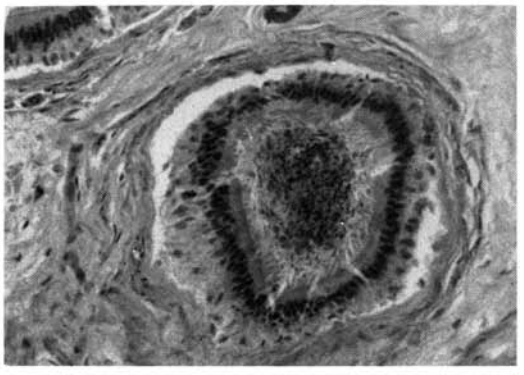

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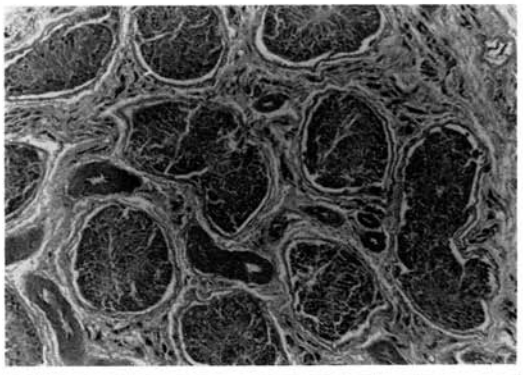

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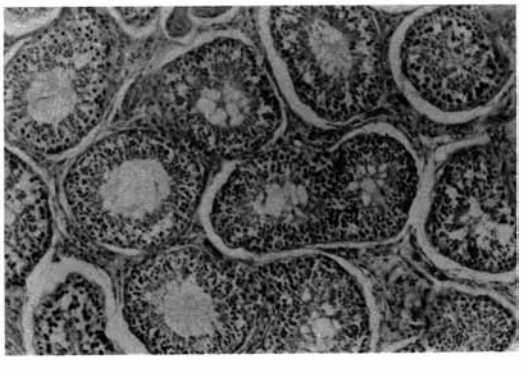

PLATE III

Fig. 17. *Bear A3, June 8, mature. Height of breeding season. Active Leydig cells numerous in the small intertubular areas. ×173.*

Fig. 18. *Bear A3, June 8, mature. Vacuolated Leydig cells with vesicular nuclei and fat cells in the intertubular areas. ×700.*

Fig. 19. *Bear A3, June 8, mature. Height of breeding season. Epididymal tubules compressed together, and filled with spermatozoa. ×70.*

Fig. 20. *Bear A3, June 8, mature. High magnification of fig. 19. Epididymal epithelium steriociliated and highly secretory. The tubules surrounded by a thin layer of muscles. ×173.*

Fig. 21. *Bear 1961–9, July 20, mature. Post-breeding season. First sign of seminiferous tubules degeneration. Spermatogenesis ceased. In most of the tubules extrusion of cytoplasmic droplets and abnormal cell forms. ×173.*

Fig. 22. *Bear C8, Aug. 8, mature. Post-breeding season. This bear still shows an active spermatogenic state. ×70.*

Fig. 23. *Bear A19, Aug. 22, mature. Post-breeding season. Tail of the epididymis. The tubular epithelium shrinks and groups of cells are pressed up and form a wave-like appearance. ×70.*

Fig. 24. *Bear 3, Oct. 21, mature. Non-breeding season. Complete degeneration of the epididymis. ×70.*

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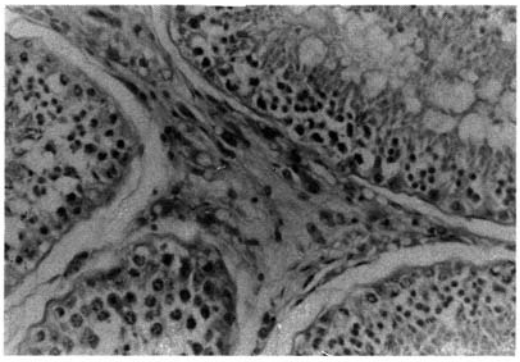

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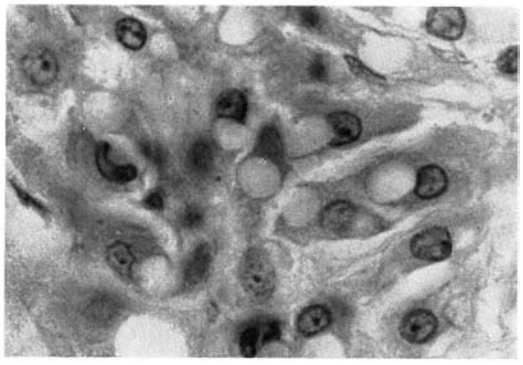

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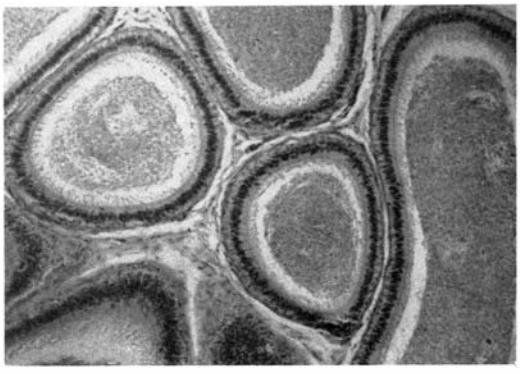

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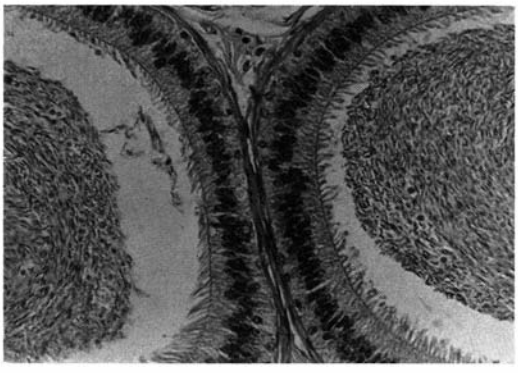

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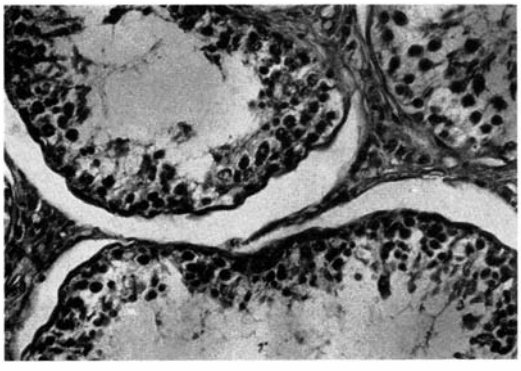

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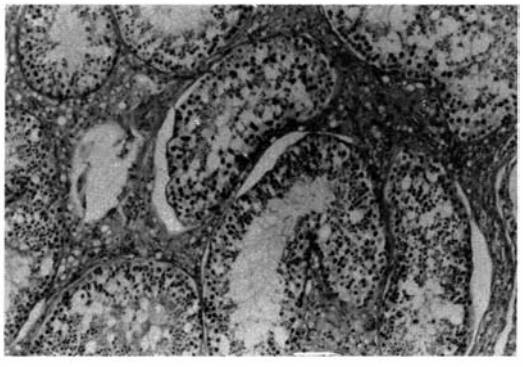

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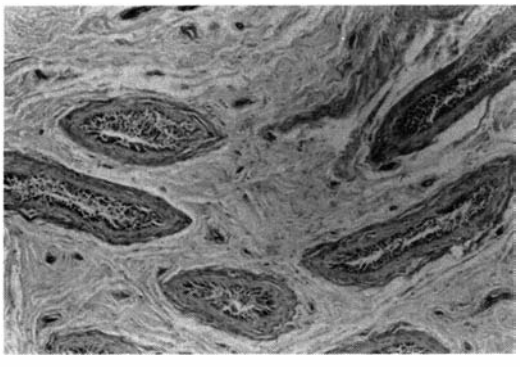

PLATE IV

Fig. 25. *Bear 17, Nov. 25, mature. Non-breeding season. Epididymal tubule surrounded by heavy, fibrous connective tissue, the epithelium disorganized.* ×*173.*

Fig. 26. *Bear C2, June 21, 2½ years, immature. Markedly enlarged seminiferous tubules. Spermatogenesis at the secondary spermatocyte and spermatid stage.* ×*270.*

Fig. 27. *Bear A2, June 7, 3½ years. Height of breeding season. Presumed first-year of adult age. Seminiferous tubules with distinct lumina and complete spermatogenesis.* ×*270.*

Fig. 28. *Bear A2, June 7. 3½ years. Epididymal tubules compressed together. The tubules filled with spermatozoa and few abnormal elements.* ×*70.*

Fig. 29. *Bear 40, Jan. 23, immature, 2 years. Ovarium mostly made up of loose connective tissue. No evidence of follicular development. The condition found both in immature and mature bears.* ×*27.*

Fig. 30. *Bear 64, March 6, mature. Stroma, the cells inactive. This condition found from October to April.* ×*270.*

Fig. 31. *Bear 74, April 1, mature. Pre-seasonal repair of ovarian tissue. The stromal cells of the anestrous bear are replaced by larger and round nucleated cells.* ×*270.*

Fig. 32. *Bear 1962–1, June 4, mature. Breeding season. Small Graafian follicles.* ×*173.*

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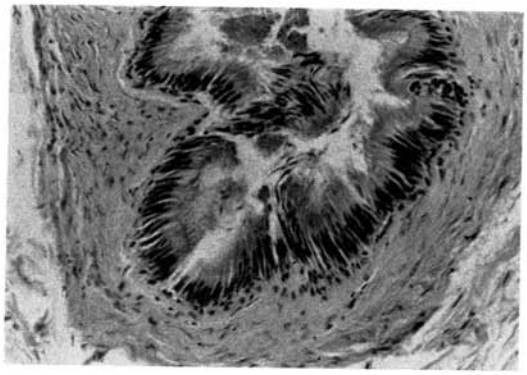

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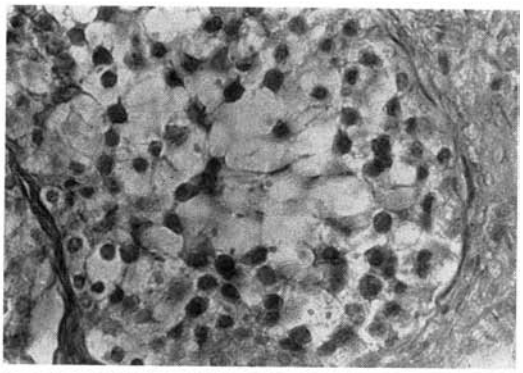

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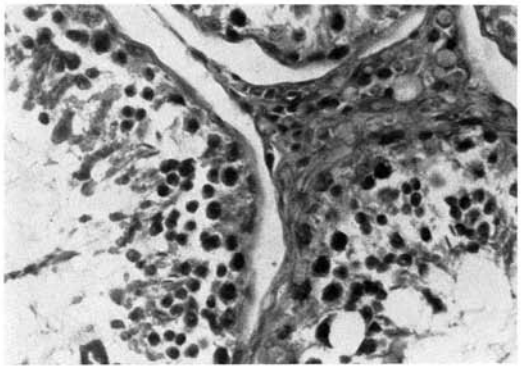

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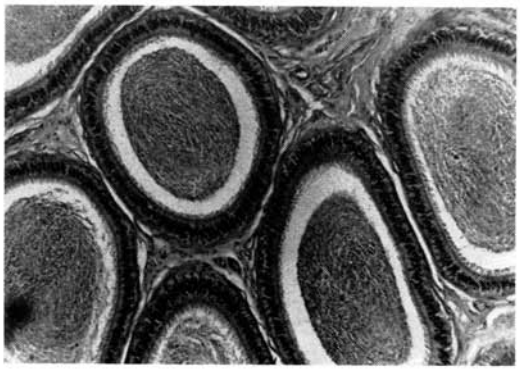

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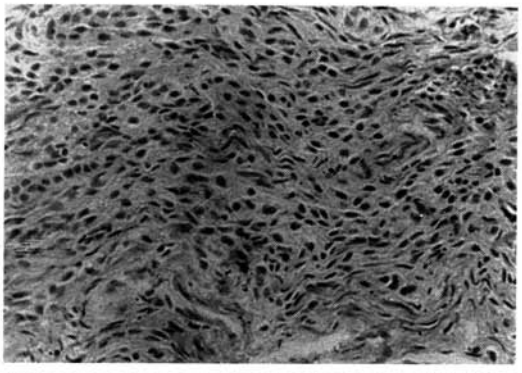

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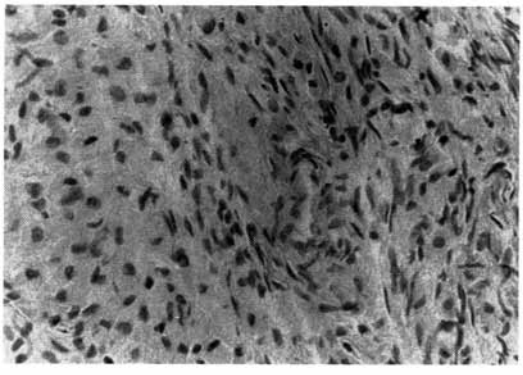

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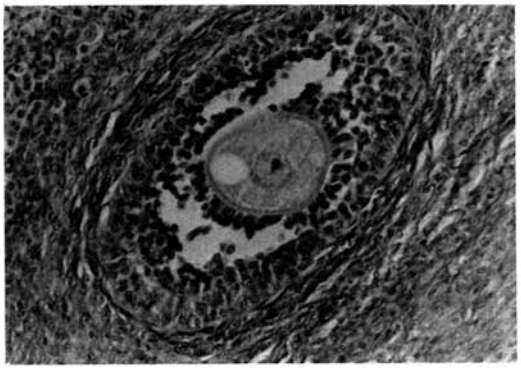

PLATE V

Fig. 33. *Bear 1965–1, June 18, mature. The wall between two large atretic follicles (10 mm in diameter). Ingrowing of theca cells.* × *27.*

Fig. 34. *Bear 1965–1, June 18. High magnification of the theca cells in fig. 33.* × *270.*

Fig. 35. *Bear 1965–1, June 18. Height of breeding season. A small Graafian follicle.* × *70.*

Fig. 36. *Bear 1963–5, June 27, mature. A small follicle replaced by theca cells.* × *70.*

Fig. 37. *Bear 1963–5, June 27. High magnification of the tissue in fig. 36. The cells highly active.* × *700.*

Fig. 38. *Bear 1963–3, June 9, mature. Breeding season. Highly active cells in stroma. Compare to Pl. IV, figs. 30 and 31.* × *700.*

Fig. 39. *Bear 1962–3, June 28. Early functional corpora lutea.* × *270.*

Fig. 40. *Bear 1962–3, June 28. Corpora lutea. High magnification of fig. 39. Cytoplasm showing granules and vacuoles, appears highly active.* × *700.*

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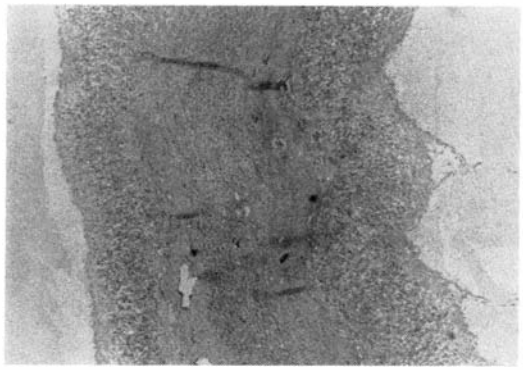

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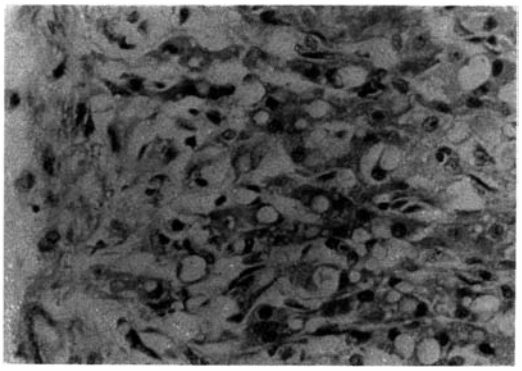

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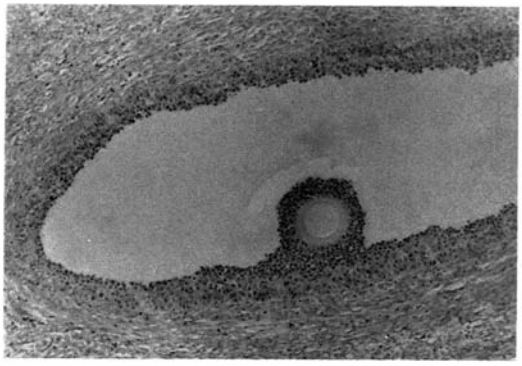

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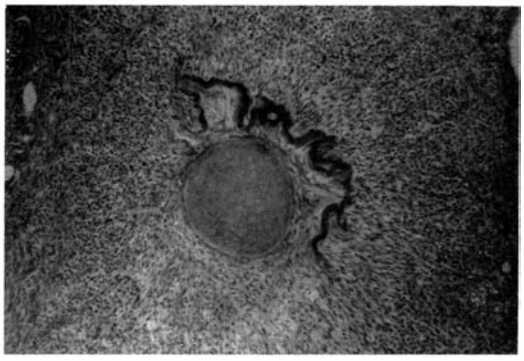

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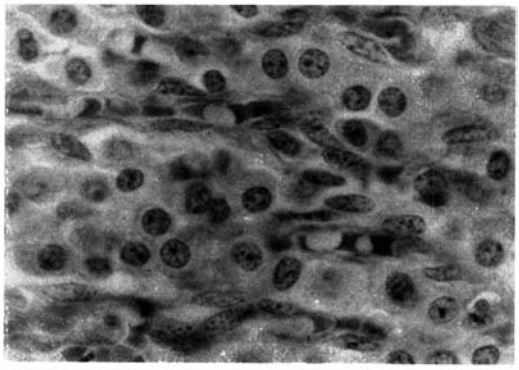

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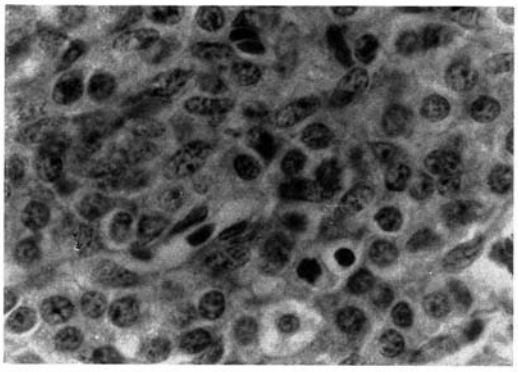

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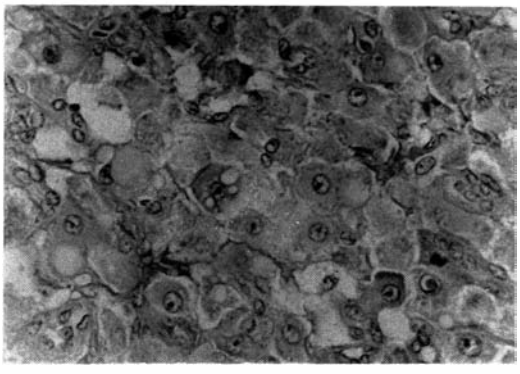

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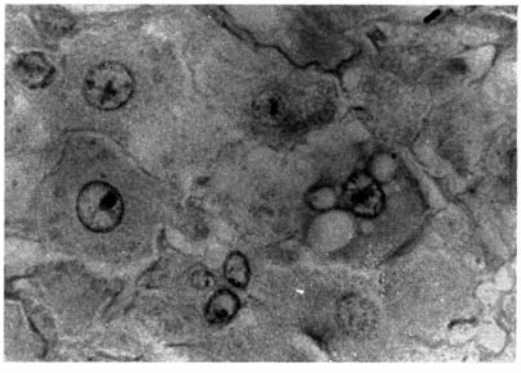

PLATE VI

Fig. 41. *Bear 1964–22, Sept. 1. Corpus luteum. Less gross vacuolation than earlier in the season.* × *270.*

Fig. 42. *Bear 1964–22, Sept. 1. Stroma in ovary containing corpus luteum, appear highly active.* × *700.*

Fig. 43. *Bear 1963–18, Aug. 30. An accessory corpus luteum, about 1 mm · 1.5 mm, on ovary not containing corpora lutea.* × *70.*

Fig. 44. *Bear 80, May 1. Lactating bear with two four-month-old cubs. The whole ovary appears to consist of endocrine type tissue.* × *270.*

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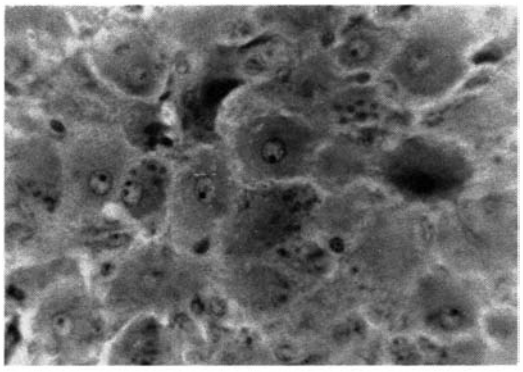

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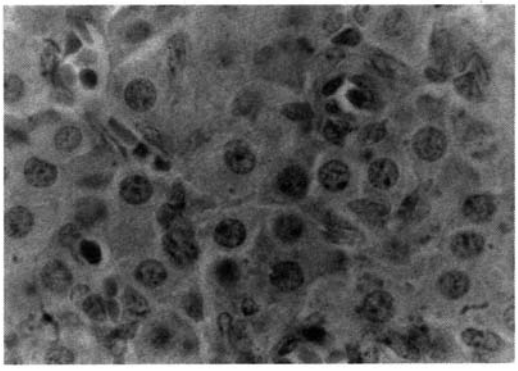

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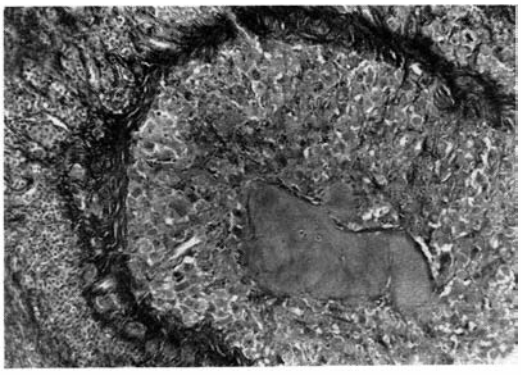

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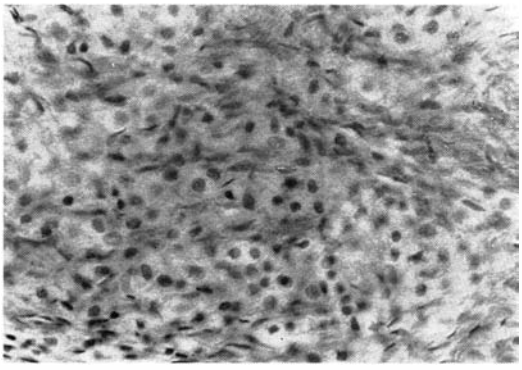

A.W. BRØGGERS BOKTRYKKERI A/S - OSLO