

New Data on the Winter Ecology of the Polar Bear (*Ursus maritimus* Phipps) on Wrangel Island

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SUMMARY

Winter ecology of the polar bear was studied in March-April of 1969 and 1970. About 190 maternity dens were found. The dens' distribution is different in different years and it probably depends on the ice conditions of the previous autumn. Dens may be up to 25-27 km from the sea (usually not more than 8-10 km) and are often in groups of 2-5 on a slope, 8-12 m from each other or even closer. The location and structure of dens, and behaviour of female bears and cubs during the denning period and after leaving den, are described. Bear families spend from 0.5 to 7 days in an opened den. Killing and eating of cubs by females have been recorded. The average litter size in 1969 was 1.85 and in 1970, 1.68. Triplets have been extremely rare in recent years. The weight of cubs at the time of den breaking is from 4.5 to 12 kg. The time of den breaking is evidently determined not only by the age of cubs, but by external conditions as well.

A mass emergence from dens took place between 20th March and 5th April one year and at much the same dates in other years. Non-breeding bears are common in waters around Wrangel Island, mainly near Blossom Cape, especially at the time of seasonal movements. Counts of female bears breeding on the Island were carried out; census methods are discussed in detail. The best method is the counting of opened dens from aircraft at the beginning of April, in good weather. The number of female bears breeding on the Wrangel Island in the winter of 1969/70, was estimated to be 180-200.

INTRODUCTION

Biology of the polar bear in winter, when parturition takes place, has been poorly studied up to recently. Only of late have these researches made progress, and papers have appeared dealing with winter ecology of the species in different arctic regions (Uspenski & Chernyavski 1965; Parovshchikov 1967; Harington 1968). Many aspects of the problem are still far from clear.

In the course of field studies on Wrangel Island in March-April, 1969 (by both authors) and March-April, 1970 (by A. A. Kistchinski), new data were collected. We have carried out traverses (by dog team, tractor, light track vehicle and on foot) of a total length of more than 1300 km, in order to find and study polar bear maternity dens. For finding and counting dens, we also used a single-engined AN-2 plane. In the Drem-Head mountains where the number of dens was especially high, fixed stations were established for observation purposes.

BREEDING ECOLOGY

General information

Pregnant female bears come to the land in September-October and make dens in snowdrifts in hilly or mountainous terrain. In these dens they spend winter and, from the end of November to January¹, give birth to cubs. When cubs are 3-4 months old the female digs out an exit from the den, but continues for several days to live with the cubs in the den, although taking them for walks of up to 1-2 km away. At this time, cubs probably acclimatize to the low and unstable outdoor temperatures. Then the family leaves land and goes to the sea ice. By the location and structure of dens one can judge of the way in which females and cubs live through winter.

Location of dens

Some data on polar bear dens on Wrangel Island are presented by A. I. Mineev (1935), S. M. Uspenski & F. B. Chernyavski (1965) and, for dens in other arctic regions, by A. Manniche (1910), P. Freuchen (1935), A. Pedersen (1957), F. Van de Velde (1957), V. J. Parovshchikov (1964), O. Lønø (1970), C. Harington (1968) and others. The paper by C. Harington (1968), in particular, deals with denning habits of bears and is of great interest. Our study of more than 100 dens in 1969-1970 has added considerable data to that which already existed.

As a rule, females den in mountainous terrain no more than 8 km from the sea shore, although dens are sometimes found at a distance of 25-27 km from the coast.²

The distribution of dens in different years varies. For instance, on Wrangel Island many females commonly den in the eastern and northern parts of the East Plateau and on the Hawaii Hills, but there were very few in the winter of 1968/69 (Table 1). A possible explanation is that in the autumn of 1968, on the east coast of the island, water remained free very long (up to December) and there was no ice; bears therefore approached the island mainly from the west. The same irregularity in the distribution of females depending on the ice conditions of the previous autumn was noted by Harington (1968) in the Canadian Arctic and by Lønø (1970) in Svalbard.

In the north-western part of the island, in the small mountain massif of Drem-Head (8 × 3 km: Fig. 1), which was carefully examined, not less than 60 female bears gave birth in 1968/69, and in 1969/70 not less than 45. On the majority of slopes there were hardly any dens, but in the places where dens were situated their density was often very high. Dens were made close to each other, sometimes as close as 8-12 m (Fig. 2). In one case, six dens were found within 300 sq.m, and three of them—at a distance of 135 and 200 cm from one another. Such 'density of denning' is probably unique in the Arctic³. There even was a case when two family rooms were situated next to each other being connected

¹ Data on the time of birth are scarce; they have been mainly obtained either in Zoos or calculated according to the weight of cubs caught in March-May (Kostyan 1954; Harington 1968; Jacobi 1968; Khutoryanski & Nemov 1969; Lønø 1970)

² Similar data were obtained in the Canadian Arctic (Harington 1968)

³ C. Harington (1968) writes of several cases when dens on the Southampton Island were situated at a distance of 15-30 m from each other. This was considered to be very unusual.

TABLE 1. DISTRIBUTION OF POLAR BEAR DENS IN DIFFERENT PARTS OF WRANGEL ISLAND

Area	The number of dens ¹		
	1964 (according to Uspenski & Chernyavski, 1965)	1969 (our data)	1970
Drem-Head Mts.	21	57	42
Bezmyannye Mts.	28	4	4
West Plateau	4	2	—
Yevstifeyev Mts.	2	—	—
Tundrovaya Mt.	7	2	6
Kitovaya Mt.	7	1	10
East Plateau (north part)	32	—	25
East Plateau (east part)		6	23
Area of Rodgers Bay and Hawaii Hills	15	3	8
Total	116	75	118

¹ As various regions were investigated in different years with variable accuracy, these data do not show the precise distribution of dens, but they do give an idea of relative abundance. In 1969-1970, the Drem-Head Mountains were best investigated while the Bezmyannye Mts. were least studied.

by a passage 50 cm long (see Fig. 4/3). At the time of making dens females are probably quite indifferent to each other.

Dens were built from 0 to 300 m above sea level, in snowbanks with, usually, a 20-40° slope and near the upper part of the slope (Fig. 3), but sometimes at its very foot (Tables 2 and 3). Once a den was found very near the sea, on the gentle (10°) slope of Cape Florence, and once on an equally slightly sloping alluvial fan. Rarely, dens can be found in snowdrifts on steep banks of small rivers within a relatively flat tundra.

In different years dens are made on slopes of different exposure. For instance, in 1964, the majority of dens occurred on the north-east and east slopes, where snow depth was the greatest (Uspenski & Chernyavski 1965). In 1968/69 the thickest snowbanks were still on the eastern and north-eastern slopes, but there were hardly any dens and the majority of females, especially in the Drem-Head mountains, denned on the south-east and south-facing slopes. But in 1969/70—they again denned on the east and north-east ones (Table 4). Denning sites in the Drem-Head mountains in 1968/69 and 1969/70 did not coincide. It is interesting that in the spring of 1969, on the south and south-east slopes, snow cover was not deep; as a rule, the depth of snowbanks did not exceed 2 m.

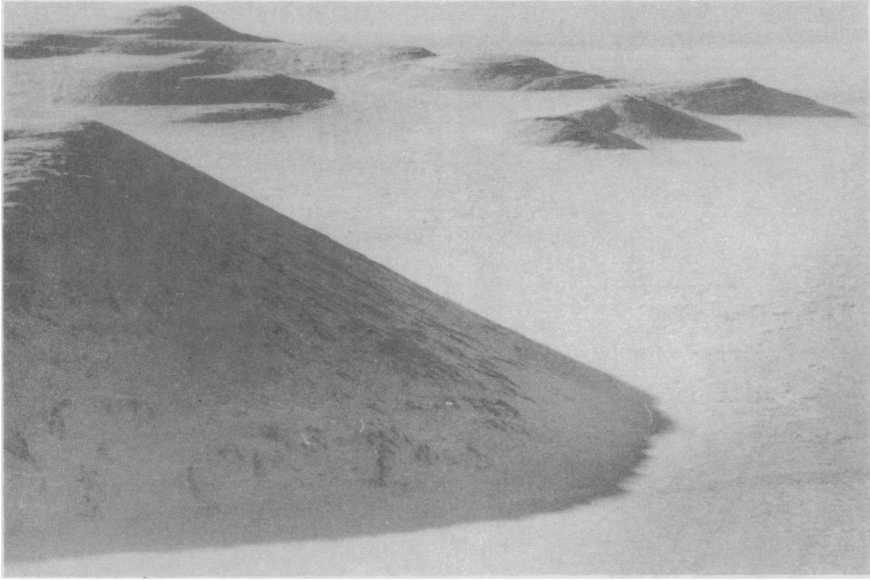


Fig. 1 The Drem-Head mountains, an area of mass denning of breeding female polar bears.

Yet we sometimes found 2-5 dens together on slopes which in March-April could hardly be considered as convenient for dens, because snow depth was so shallow. One den was found in quite a thin pocket of snow (see Fig. 4/4). There were no dens on such thin snow-slopes in 1970. On the other hand, in several sites where in 1969 there were dens in deep snowbanks, we found denning female bears in 1970 as well. Finally, on some slopes where in the spring of 1969 dens were absent but the snowbanks were very thick, we found maternity dens in the following winter.

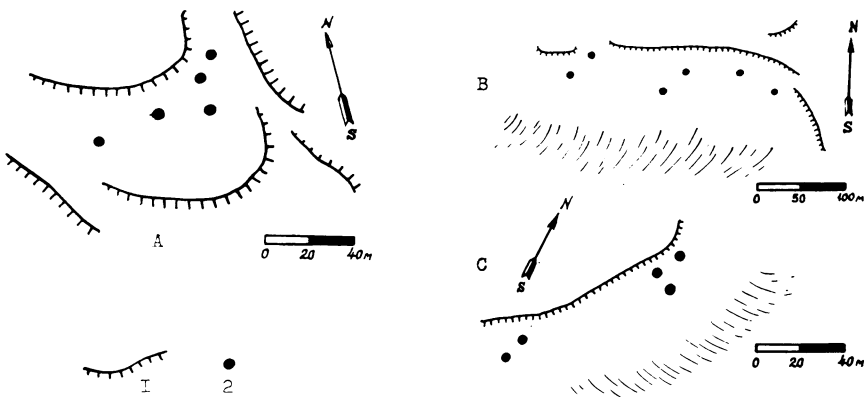


Fig. 2 Positioning of dens in three areas of the mountains. I indicates the upper edges of slopes and 2 the den site.



Fig. 3 The exit of an inhabited den on the Drem-Head mountains. The female's tracks can be seen above and below.

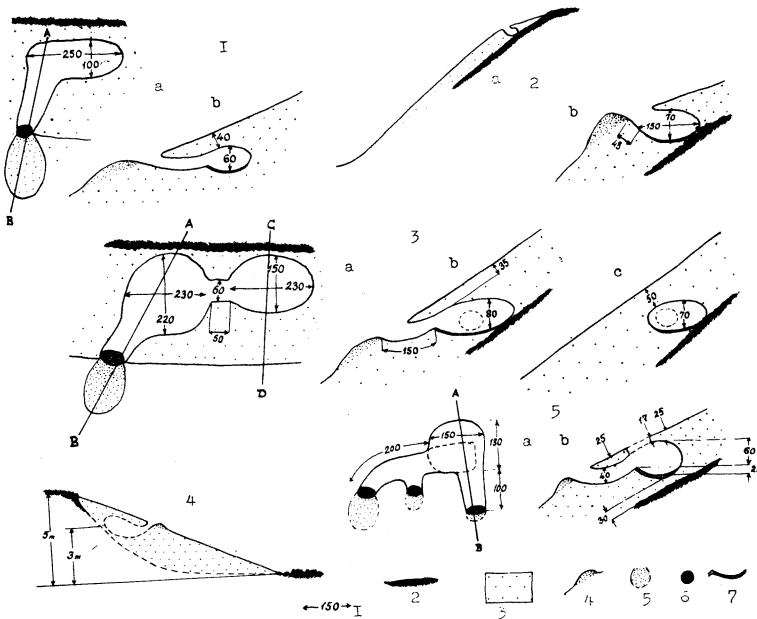


Fig. 4 Structure of 5 dens:

1. (a) plan; (b) vertical section on line AB.
2. (a) section of the snow drift, (b) vertical section of den.
3. (a) plan; (b) vertical section on line AB; and (c) on line CD.
4. Approximate section of snow drift containing a den.
5. (a) plan; (b) vertical section on line AB.

Symbols: 1: measurements in cm; 2: substrate; 3: snow; 4: excavated snow 'doorstep'; 5: excavated snow (plan); 6: exit; 7: ice floor of chamber.

TABLE 2. DISTRIBUTION OF DENS ACCORDING TO HEIGHT OF SLOPES

Height of slope, m	Number of dens		
	1969	1970	Total
0-15	4	1	5
16-30	19	5	24
31-60	15	11	26
61-150	12	14	26
151-350	4	4	8

TABLE 3. DISTRIBUTION OF DENS ACCORDING TO DISTANCE FROM FOOT OF SLOPE

Distance of den from the foot, m	Number of dens		
	1969	1970	Total
0-10	14	8	22
11-20	13	7	20
21-50	22	18	40
51-100	4	3	7
101-300	1	2	3

TABLE 4. DISTRIBUTION OF DENS ACCORDING TO EXPOSURE OF SLOPES

Exposure of slope	Number of dens					
	1964, total (Uspenski & Chernyavski, 1965)	1969		1970		Total
		total	Drem-Head Mts.	total	Drem-Head Mts.	
Northern	14	2	1	7	3	21
North-eastern	36	2	1	19	12	57
Eastern	26	14	12	12	11	52
South-eastern	14	15	15	13	8	42
Southern	8	22	19	2	0	32
South-western	7	2	0	2	1	11
Western	1	3	1	3	3	7
North-western	10	5	3	3	0	18

All the data considered show that the principles according to which pregnant females choose suitable places for denning are not quite clear. There are hardly any direct observations on the actual den making. Judging from spring examination of dens and the tales of aborigines, some students (Mineev 1935; Uspenski & Chernyavski 1965, etc.) have supposed that sows either settle down in autumn in unthawed snowdrifts of the previous year or excavate dens in such snowdrifts, or they excavate dens in new drifts already accumulated in the current autumn. Further snowstorms cover the female bear with snow and make a snowy roof over the den. According to Harington (1968), the den excavated by a female in a newly formed snowdrift is approximately of the same form as it is found to have in the spring.

Another point worth mentioning is that the floor of the den is separated from the ground by a layer of snow usually 10-30 cm thick. However, while in some of the dens small patches of bedrock were observed on the innermost wall (see Fig. 5/2 and 3), in others, the inner wall was separated from the substrate by a very thick bed of packed snow. In the former case it seems that the bear had denned in fresh snow, which later on thawed beneath its body, and that in the latter case it had denned in snow of the previous year.

Harington (1968) wrote that in Canada dens occur more frequently on slopes facing away from the sea. This is also generally true in the Drem-Head mountains, but in some other areas (south-eastern coast of Wrangel Island, northern slopes of the East Plateau, etc.), due to the peculiarities of relief, the majority of dens face the sea. The situation in each area is conditioned by the local relief and also the predominant winds.

Structure of dens

The typical structure of polar bear dens on Wrangel Island has been described by S. M. Uspenski & F. B. Chernyavski (1965). In 1969 and 1970, we surveyed many dens including ones of very simple as well as very complicated structure (Figs. 4, 5 and 6). Usually an active den has a simple oval chamber with a passageway 1-2 m long and outside the exit a deposit of excavated snow up to 70-100 cm high, forming a 'doorstep' which helps one in sighting the den from a distance. However, in the spring of 1969 and 1970, on many slopes where dens were situated, there was little snow; therefore, these doorsteps were small and difficult to distinguish. For the same reason, the roof of some of the dens was very thin (5-15 cm) and the female tended to break it when emerging. In 1970, we often found 'half-open' or completely 'open' dens; they were simply pits in the snow with bear families lying in them (Fig. 5/3 and 4). In such cases, the 'roof' was broken since, even before the den was opened, it was no more than a few centimetres thick. On some slopes winds blew away the snow and uncovered the procumbent female (Fig. 5/3). By contrast, some dens were located in very deep snowbanks. We also found complex dens consisting of several chambers like those described by G. P. Gorbunov (1929), G. Mary-Rousseliere (1957), V. J. Parovshchikov (1964) and others. The structure of the den shown in Fig. 6, as well as that of other complex dens, indicates that the digging activity of the female (i.e. her total activity) does not stop in winter. In this case (the den had 5 chambers), we may presume that while widening the first 'living-room' the female met a rock wall: the presence of this rock aggravated heat conditions in the den and she began to dig other tunnels and chambers but, again encountering the rock wall, abandoned each in turn until she reached and managed to dig a big chamber in continuous thick snow. The fact that the walls and ceilings of dens often have claw marks confirms digging activity in the dens. Dimensions of dens are shown in Table 5.

TABLE 5. MEASUREMENTS IN CM OF MATERNITY CHAMBER OF DENS

Dimension	min	mean	max
Length of the room	110	165	250
Width of the room	100	140	220
Height of the room	55	80	120
Minimum thickness of the roof*	5	32	100 [†]

* Dens of 'open' type were not taken into account

† Some dens, not measured, undoubtedly had even thicker roofs: they were too difficult to dig up.

Sometimes dens have ventilation holes which may help to disclose dens that have not yet been opened.

As already stated, the floor of the den is separated from the ground by a layer of snow.

The passageway leading from the den outside is from 1 to 6 m long (usually 1-2 m): the height is 50-60 cm, the width 70-110 cm. The exit is round or rectangular, 50-60 cm in diameter. Sometimes the floor of the tunnel near the chamber is icy and even its roof may have a crust of ice; the ceiling and walls, including those of the den itself, tend to have claw marks and fragments of hoar-frosted bear hair hanging from them (Fig. 7).

This indicates that in these cases part of the tunnel has been dug in autumn and, being closed by a snow 'plug', the signs of excavation last through the winter. In spring, the female lengthens the tunnel, digging up towards the snow surface. Sometimes (Figs. 4/5 and 5/1) a den has 2 or 3 exits. Faeces of cubs can be found in the tunnels.

In spite of the differences in the length of the tunnels, the number of chambers, etc., there are certain common features in the structure of all dens. In almost all cases the passageway slants downwards. This feature is shared with the Eskimo 'igloo' and no doubt similarly serves for conserving warm air.¹

Occasionally, however, the tunnel slants upward or, when the chamber is close to the snow surface, may not follow the shortest line (perpendicular to the slope) but travel parallel to the surface to left or right for distances up to 6 m; the thickness of the snow roof over the tunnel is kept more or less constant and approximately equals that of the den's roof. We believe that when digging such a long corridor (which also helps to conserve warmth in the den) the female is guided by the intensity of light penetrating through the snow 'ceiling'.

¹ The temperature recorded in one opened den (-17.8°C) was higher than the outdoor temperature by 7.8°C; Harington (1968) recorded a temperature of -9.9°C in a closed den, higher than the outside temperature by 21°C.



Fig. 7 Interior of den, showing claw marks in the walls and ceiling and some bear hair covered with hoar frost hanging from the roof.

The tunnel is separated from the living-room by a sill, the floor of the chamber being cup-shaped. Sills and floors of dens consist of strongly iced snow. No female bear excreta are found in the chamber but sometimes small amounts of cub faeces. There are often traces of urine in the snow. We have never found any additional spaces set aside as lavatories. Evidently the female licks up most of the cub droppings; in the intestines of one or two female bears that have been dissected we have found hair of cubs and a liquid gruel-like mass with a characteristic smell. Droppings of adult females can be found only outdoors, usually 10-50 m from the dens. There are many tracks around the dens and often excavations resembling den exits can be observed. In some of these females probably spend the night after leaving dens; their floors are often strongly iced.

Behaviour of female bears and cubs

We never met any bears in dens except females with cubs. We could see into one den with a broken roof quite well and kept it under observation from 26 to 29 March 1969. The female was lying on her side so that her hind- and forelegs were touching (Fig. 8). The cubs were always near her head and belly, inside the circle made by her paws. They crawled over their mother, under her paws, and very often reached for the nipples. In windy cold weather the female turned her back towards the hole in the den so as to protect the cubs against the wind. The den was deserted on 29 March, but contained one dead cub, badly damaged, and there was evidence that the female and the second cub had left shortly before we came. In 1970, in one of the dens we also found the half-eaten remains of a cub frozen into the icy floor to a depth of 2-5 cm. The cub had probably been killed long before the den was opened. Similar cases are also known to occur in zoos.

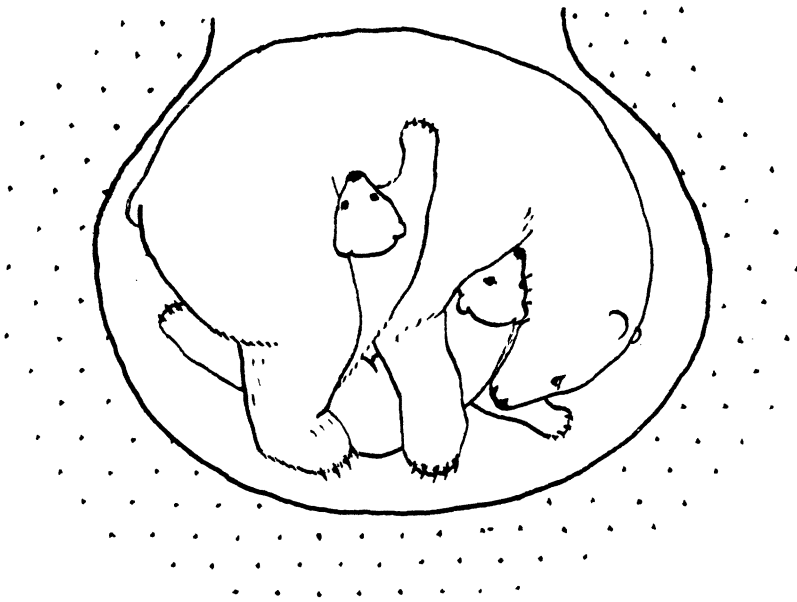


Fig. 8 Drawing of a female and two cubs in a den on the Drem-Head mountains, 27 March 1969.

After opening the den, the family continues to use it for several days. In 1969, the weather at the end of March was cold (near -30°C) and windy. Bear families remained in the opened dens for 3-7 days. In 1970, this period was warmer, and in days without strong winds and frosts females met after breaking out of dens left the latter quite quickly, sometimes in 0.5-1 day. For example, on the 5th of April, the first fine day after a five-day snowstorm, we found a den which had been opened that very morning and was already abandoned. The amount of time for which a family stays in an opened den thus ranges from 0.5 to 7 days. O. Lønø (1970) states that in Svalbard the period is longer, 8-14 days.

When the den has been opened the female hardly ever leaves her cubs. If a man approaches the den she sometimes puts out her head and snorts, after which she hides herself again. More often, especially in deep dens, she does not show herself at all. She retreats as far as possible into the den and keeps silent, and it is rather difficult to make her even show her head.

In the morning, the female bear takes her cubs for a walk up to 1-2 km from the den and during the walk she keeps close to them. Only once, on a warm day, we found two cubs of about 8-9 kg in a den; having examined the tracks, we saw that their mother had gone to the sea ice. After being away for several hours, she returned and took the cubs. However, on first opening a den, the female goes out alone, usually not more than 50-100 m from the den.

At the beginning of the lactation (in the den), the milk is secreted in small amounts and the cubs probably suck very often. We did not manage to extract more than 5-10 drops from an immobilized lactating female. Captive cubs required to be fed very often throughout the day and night. At 3-4 months old cubs in captivity must drink up to 6 times a day (Kostyan 1954). The duration of sucking at the age of 2.5 months is 15 min. (Meyer-Holzappel 1957).

We were lucky to observe three times how cubs sucked outside the den, standing on their hind legs under the mother's belly. Once both cubs sucked simultaneously, one from the front nipple and the other from the back one.

Three females killed in 1969 when leaving dens, weighed 150-180 kg. They had little fat; even on the sacrum and the buttocks its thickness did not exceed 35-50 mm. In 1964 (Uspenski & Chernyavski 1965) females which left dens were fatter.

Number and weight of cubs

The data on litter size are given in Table 6. Small but reliable differences in the number of young were observed in different years.

TABLE 6. NUMBER OF CUBS PER LITTER

Year	Litter size			Mean litter size	Number of litters
	1	2	3		
1964 (Uspenski & Chernyavski, 1965)	7	7	0	1.50	14
1969	3	17	0	1.85	20
1970	11	19	1	1.68	31
Total	21	43	1	1.69	65

Based on his observations in the 1920s to 1930s, A. I. Mineyev (1935) wrote: 'the female bear gives birth to three cubs as often as to one'. More recently records of three cubs have been very rare. V. A. Starchenko, who has taken part in the capture of cubs over the last 13 years, told us that he met families with 3 cubs only four times.

The majority of female bears, which had one cub each in 1970 (8 out of 11), left dens later than the rest, after 5 April. The same phenomenon was observed in 1964 (Uspenski & Chernyavski 1965) but not in 1969.

The weight of a female cub taken from a still closed den on 31 March 1969, was 5.0 kg. The weight of cubs from opened dens is shown in Table 7. Sex differences in weight at this age were not established. The male-female ratio was 14:8.

Observations show that the weight of cubs at the time of leaving dens differs considerably (Table 7). As we can hardly suppose such marked differences in the rate of growth, we believe that the dates of den-opening do not strictly correlate with the age of cubs. It is interesting that the smallest cubs were found in dens of an 'open' type or in those with a very thin roof. Probably the opening of the den is also stimulated by the conditions outdoors; thus, the blowing away of snow from the roof and thinning of it (at the end of the passageway) may make the female leave the den earlier.

TABLE 7. WEIGHTS IN KILOGRAMS
OF CUBS IN OPENED DENS

Date	♂♂	00?	♀♀
March 24	12		
March 24	11		11
March 24*		4-5	
March 25	8; 8		8
March 25	4 ¹ / ₂		
March 26*		8; 8	
March 26		12; 12	
March 26		8-9	
March 30	9; 9		
April 2	8		
April 6*			10
April 7	9		9
April 8	9 ¹ / ₂		11
April 8	10; 10		
April 9	8 ¹ / ₄		8 ¹ / ₄
April 10	8		8

* weight estimated by sight

Departure from dens

The first female was encountered out of the den on 11 March in 1969, and on 7 March in 1970. A mass opening of dens took place in 1969, between 20 March and 5 April, followed by departure from dens by bear families between 25 March and 8 April. In 1970, bears left their dens a little earlier. A mass departure occurred on 20-25 March and from 23-26 March we often saw polar bear families moving across the tundra and onto the sea ice. We met with such families in 1970 up till 10 April and in 1969 we found dens recently deserted on 15 April. Following the tracks of departing families, we observed, in places with thin snow, shoots of dwarf willows which had been dug up and gnawed by females.

The directions which bear families take when going to the sea ice vary. Usually they chose the shortest way or moved from the mountains into the nearest valley and along the latter directly to the sea. However, this was not always the case. On the 19-21 March 1969, we observed near Mt. Tundrovaya fresh family tracks moving straight from west to east over a great distance. There was no doubt that their dens were situated westwards of the area. Instead of heading for the sea by the shortest way they were going in the opposite direction with at least 70 km to cover to the sea. It well may be that the bears somehow oriented themselves by the presence of free water: at that very time there were large pools of free water off the east side of the Wrangel Island.

In the upper reaches of the Neozhidannaya river, separated from the sea by a steep and rocky ridge 5-10 km wide, V. A. Paponov saw a family which had just left the den, and kept watch on its movements for 20 km. The animals were moving in the direction opposite to the sea, down the river, which meant that they would have to travel not less than 40 km before reaching sea. It is possible that the female was leading her cubs the same way by which she had come in autumn.

Some families after leaving dens wandered in the mountains for one or two days. Once a family, frightened out of a small den-like shelter, ran away and hid themselves in a real maternity den. Probably this family had left the den shortly before and had spent only one night in the shelter.

NON-BREEDING PART OF THE POPULATION

Polar bears are common in waters around Wrangel Island. Very often they visit Cape Blossom where thousands of walruses are landing in autumn. There are great numbers of dead walruses and remains of others that have been killed, which provide abundant food for bears. When moving between the East Siberian Sea and the De-Long Strait in autumn and spring, bears pass the Blossom Cape and stay there for some time. According to inquiries, a great number of bears were there in the springs of 1954, 1955, 1956, 1964 and 1967, and in autumns of 1966 and 1968. In the autumn of 1968, 15-20 animals were observed simultaneously. As a rule, single bears moves across Cape Blossom; females with cubs are uncommon there.

On 12-13 April 1969, in 16 hours, S. M. Uspenski saw near the Cape 6 single bears moving along the coast to the north (including a male following a female). At the same place, from 20 April to 6 May, V. A. Paponov observed four bears, one of which stayed for two days. The animals fed on the walrus corpses and rested the greater part of the day among ice hummocks.

During the air survey (15 April 1969) we saw many bear tracks between Wrangel and Gerald Islands and around the latter. There were many leads and cracks; on the ice we saw seals. Some of the tracks were those of couples; it was the rutting time.

From time to time tracks of single bears were observed even in the central parts of the Wrangel Island. These tracks were usually going in one direction, following a straight line for many kilometers. Probably animals having found themselves on land where there is no food, cross it without stopping. Excreta of these passage animals contained much seal hair.

ESTIMATES OF POLAR BEAR NUMBERS

More or less accurate estimation of polar bear numbers is extremely difficult, primarily because of the bear's migratory habits. The only part of a population which is static for a certain amount of time consists of breeding females spending winter in their maternity dens. However, their ratio to the population can be found by observation, so that the enumeration of breeding females by more or less accurate spring counts of opened dens may be used for evaluation of total bear numbers.

Such a count was carried out on the ground by terrestrial techniques in 1964 on Wrangel Island by Uspenski & Chernyavski (1965). They discovered 116 dens and estimated the total number of females breeding on the island to be about

150. In 1969, we repeated the count by similar techniques but on a smaller scale, with special attention to the Drem-Head mountains. In 1970, we again surveyed the Drem-Head mountains in detail, visited some adjacent areas, and then made an aerial den survey.

This work has helped to clarify some aspects of the techniques of searching for and counting dens. In the spring of 1969 and 1970, we often found dens on slopes relatively poor in snow. The snow 'doorsteps' near the exits which usually help to locate dens, were small; in the majority of cases, dens were difficult to detect from afar. From a distance of 200-500 m we could usually spot only 30-40% of dens, while the majority of them (especially those already deserted) could be found only at a distance of 20-50 m, after careful examination on foot. Special surveys have shown that of dens deserted before a severe (up to 5 days) snowstorm, 75% could not be found after the snowstorm. In short, reduced visibility of the deposits or mats of snow at den exits together with snowstorms, tend essentially to cause underestimates of den numbers.

A second problem was that female bears often made dens next to each other, 2-5 dens on a small slope. Therefore, to ascertain their real number the census-maker had to approach closely. Sometimes, having located an open den from afar, we examined the site carefully and then discovered other dens, one or two, occupied or deserted. More often, we could mistake temporary bear diggings, heaps of stones covered with snow or ice, some forms of 'snow relief', etc., for dens. Sometimes even a very experienced man can only distinguish dens from the other formations mentioned (especially in a diffuse light) at a distance of 10-20 m.

We conclude, therefore, that, when carrying out land counts of polar bear dens by going around foothills with a dog team, tractor or light track vehicle, one can make serious errors both underestimating or overestimating data. In such springs as those of 1969 and 1970, the errors may be so great that the count cannot be considered reliable. There is no time to define correction factors, as the opening of dens lasts for not more than one month, and extrapolations from this count are impossible. In short, such land surveys may give only a general picture of distribution and relative abundance of dens in a given year; full counts are possible only by careful and repeated examination on foot. Such examination is naturally very laborious and time-consuming and it cannot be undertaken everywhere, so it must be carried out in sample areas where there is maximum density of dens.

Altogether, in 1969, 77 dens were found on Wrangel Island, but for the reasons mentioned above we do not believe that this figure can be used as a firm basis for judging the change of numbers of breeding females since 1964. During an air survey of Gerald Island we did not discover any dens; the island is hardly suitable for them.

An aircraft allows good opportunities for counting polar bear dens. On the 10 April 1970, we made an aerial census of dens on the whole eastern part of Wrangel Island. We chose the route in such a way that we could inspect nearly all the places where dens were numerous. We surveyed the area from an AN-2 plane at a height of 100 m and at a speed of 150 km per hour. The weather was sunny, with excellent visibility. All dens were time-registered and afterwards approximately plotted onto a map; when possible, dens were mapped during the flight. Fresh tracks of families going from the mountains to the sea, at right angles to the route, were also registered as 'dens' if they occurred not less than 1-2 km from dens observed earlier. Altogether we registered from the air 57 dens and 8 such tracks.

In good weather, opened dens with snow doorsteps and tracks of females and cubs, can be easily seen from a height of 100-150 m at a distance of 0.5-1 km. The count is especially efficient if in the previous 10-12 days there have been no strong winds. Sometimes even dens which are deserted and covered with snow can be observed and correctly identified. However, the majority of the dens which have been deserted long before are impossible to discover after heavy storms, so that anyhow some underestimation is inevitable. On the other hand, to mistake a den for something else from the air is impossible.

Summing up the results of the complete count in the Drem-Head mountains, observations in the adjacent areas, aerial and other data (Table 1) and making approximate allowances for the incompleteness of the counts and the areas which could not be examined, we estimate the true number of female bears breeding on Wrangel Island in 1969/70 to be between 180 and 200.

Aerial survey makes it possible to get reliable data quickly and with minimum error. Its technique has to be developed, but we believe it to be the best method for den counting.

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