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3

The Status of the Leopard Seal at Heard Island
and Macquarie Island, 1948 - 1950

By

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INTRODUCTION

The Australian National Antarctic Research Expedition has maintained parties at Heard Island and Macquarie Island since the summer of 1947-48. These parties are relieved in February and April each year, when a complete change-over of personnel takes place. The writer was Medical Officer at Macquarie Island with the 1949 party and at Heard Island from August 1950 to February 1951. During these periods full diaries of the natural history of the islands were kept, and from these diaries monthly natural history summaries were compiled by the author. These are the main sources of the present paper, but they have been extensively supplemented from the notes of other observers, and the paper may be said to cover A.N.A.R.E.'s first two years at Macquarie Island and the first three years at Heard Island. The writer would like to acknowledge in particular the value of the very comprehensive records kept by R.G.Chittleborough and E.H.M. Ealey, biologists at Heard Island in 1949. Use has also been made of information supplied by R.Kenny, biologist at Macquarie Island in 1948; of a "Biology Log" kept by Dr.A.Gilchrist during 1948 at Heard Island; and of records kept by L.F.Gibbney and P.S.Young during the first half of 1950. The last mentioned are jointly responsible with the writer for observations made during the second half of that year. N.M.Haysom and T.Manefield assisted in observations at Macquarie Island in 1949.

As the histories and zoo-geographic locations of Heard Island and Macquarie Island are very different, it is necessary to begin by saying something about each separately.

Macquarie Island (Lat. $54\frac{1}{2}^{\circ}$ S., Long. 159° E.) is situated approximately 600 nautical miles from New Zealand, 800 from Tasmania and 800 from Antarctica. It is a narrow island about 21 miles long and 2 miles wide, lying approximately in a North-South direction. Most of the island consists of a plateau about 1,000 feet high covered with tussock grass, moss and other non-arboreal vegetation. No permanent snow exists on the island, although the higher areas are intermittently snow-covered during the winter months.

Information about the past status of the seals is scattered through the accounts of many expeditions and individuals who have visited the island. The best of the

earlier accounts are those of Professor Scott (1882) and of A. Hamilton (1894). In the present century a general account of the island is given by Ainsworth in his chapters on Macquarie Island in "The Home of the Blizzard" (Mawson 1915); and Sir Douglas Mawson (1943) discusses various aspects of the island fauna. Much the best and most complete account of the scientific history of the island is that given by Falla (1937).

Five species of seals, two of eared and three of true seals, have been recorded from Macquarie Island. These are :-

New Zealand Fur Seal (Arctocephalus forsteri, Lesson)

Hooker's Sea Lion (Phocarctos hookeri, Gray)

Elephant Seal (Macrorhinus proboscideus, Peron and Lesueur)

Leopard Seal (Hydrurga leptonyx, de Blainville)

Weddell Seal (Leptonychotes weddelli, Lesson)

Of these, the elephant seal is the only one present at all times of the year, and the only one known to breed there. In the breeding season tens of thousands of this species may be counted on the beaches. Leopard seals visit the island regularly, in small numbers, during the winter months. A small herd of fur seals also arrives each autumn. The Hooker's sea lion and the Weddell seal are casual visitors. The crabeater seal has not yet been recorded from Macquarie Island, but as it seems to occur as a straggler on the New Zealand and Tasmanian coasts (Bertram 1940, p.85) there is every reason to suppose that it will be seen sooner or later at Macquarie Island. However, none of the truly antarctic seals (i.e. leopard, Weddell, and crabeater seals) occurs as frequently at Macquarie as at Heard Island.

Heard Island (Lat. 53°S , Long. $73\frac{1}{2}^{\circ}\text{E}$) is situated almost midway between South Africa and Australia, about 900 miles from Antarctica. The Kerguelen Archipelago lies about 300 miles to the north-west. The island is about 27 miles long and 13 miles wide, the bulk of it comprising the impressive mountain-mass of Big Ben (9005 feet). Permanent ice covers most of the island and glaciers, descending to the sea on all sides of Big Ben,

terminate in 100-foot ice-cliffs. There are no trees and no vegetation with the exception of a little coarse tussock grass, some acaena, a poor variety of Kerguelen cabbage, and various mosses and lichens.

Heard Island differs from Macquarie in that any journey more than a mile or two from the Station is a considerable undertaking, involving the crossing of glaciers and other formidable natural obstacles. For this reason routine observations have so far been confined to the area of the "Four Bays", the area embracing Corinthian Bay, Atlas Cove, West Bay, and South West Bay (See Map). Journeys farther afield can be undertaken only on special occasions. In 1949 and in 1950 parties made the journey to Spit Bay in November to take a census of the elephant seals, and this area had previously been surveyed by Dovers in 1948. The south-west side of the island has only recently been explored. (December, 1951). On account of the heavy surf, rugged coast and uncertain weather the use of small boats as an alternative means of travel is not practicable.

An account of early sealing activities on Heard Island is given in a recent article by Roberts (1950). Little detail is to be found in the reports of the few previous expeditions which visited the island, which are again conveniently summarised by Falla (1937) but it is safe to say that during the last century, the seals of Heard Island were subject to the same ruthless exploitation as elsewhere.

The following seals have been reported from Heard Island :-

- Fur Seal (?Arctocephalus gazella, Peters)
- Elephant Seal (Macrorhinus proboscideus, Peron and Lesueur)
- Leopard Seal (Hydrurga leptonyx, de Blainville)
- Weddell Seal (Leptonvchotes weddelli, Lesson)
- Crabeater Seal (Lobodon carcinophagus, Jacquinot & Pucheron)

As at Macquarie Island, the elephant seals have now reasserted themselves and come ashore to breed

in great numbers. Their rookeries on the Spit at the south-eastern end of the island contain many thousands of animals, but the beaches of the "Four Bays" are comparatively lightly occupied. Fur seals visit the island in small parties in the autumn.

Three of the antarctic seals come to Heard Island as visitors. A few Weddell and crabeater seals have been reported each year, but it is probable that these are wanderers either outside or at the very limit of their normal range. The leopard seal occurs in large numbers as a regular winter visitor to the island.

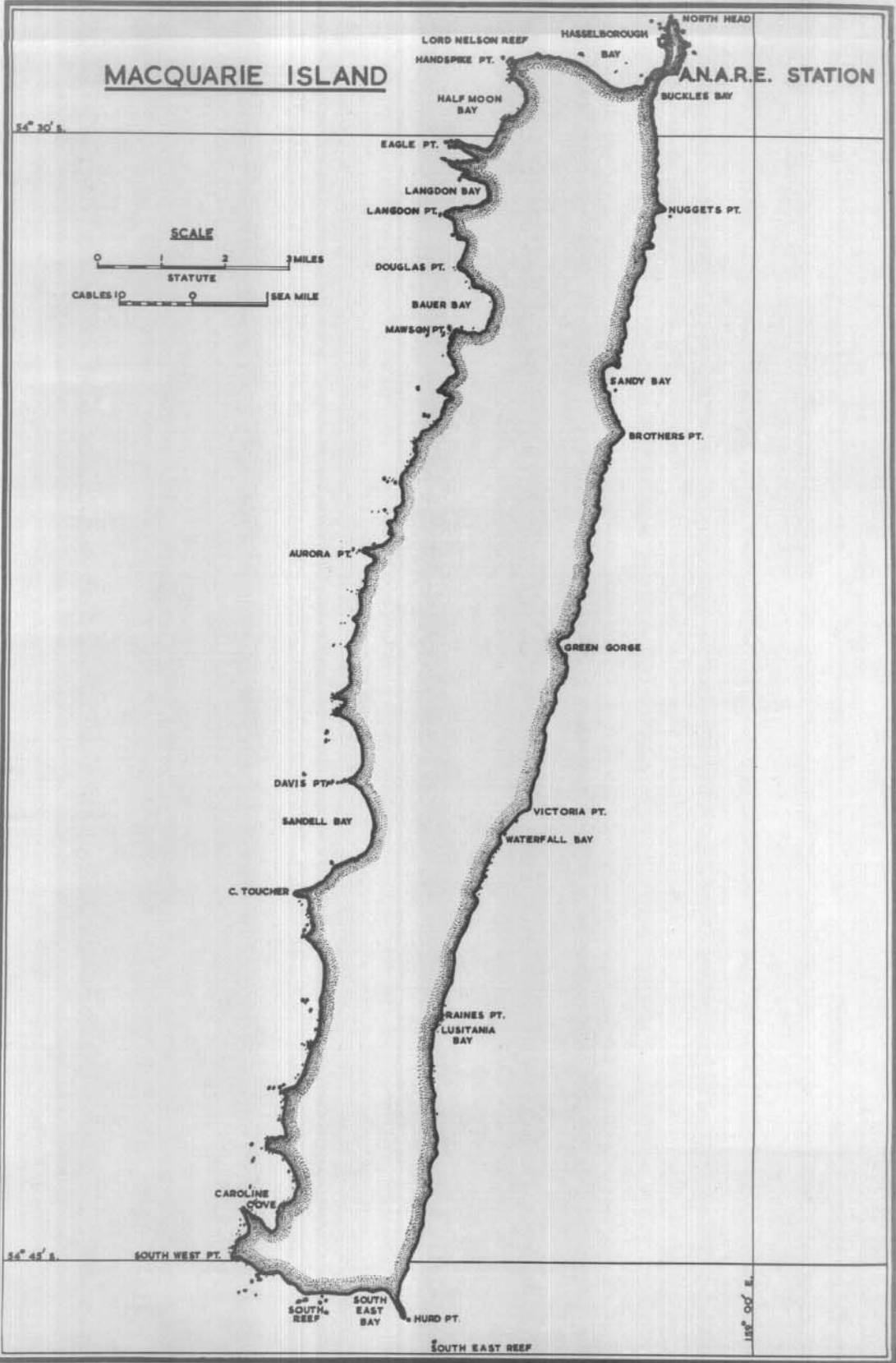
DISTRIBUTION

Although the leopard seal has long been familiar to all visitors to antarctic and subantarctic regions, remarkably little is known about its life-history. J.E. Hamilton (1939) in his interesting paper on the leopard seal collected most of the information available at that time, but his account deals mainly with questions of anatomy and physiology and stresses the paucity of information on the animal's breeding habits.

Hamilton points out that, although the leopard seal is widely distributed, it is a rare species. Its total population appears to be small, a fact which is closely connected with its solitary and predacious habits. He considers that the pupping season extends from September to December and the mating season from January to March, concluding that the gestation period is about eight months. From an examination of seventy-two skulls and other data, Hamilton distinguishes four age groups. He concludes that the males do not reach maturity till their fourth year, but that the females normally produce their first pups when three years old.

The leopard seal is best known as a winter visitor to the antarctic and subantarctic islands which lie beyond the limits of the pack-ice, but it does not breed on them. Reasons are adduced in the present paper for regarding the leopard seal as primarily an animal of the outer fringes of the pack-ice, and for supposing that it is on the pack-ice that the young are born.

MACQUARIE ISLAND



In contrast with the small numbers of leopard seals recorded by most other writers, members of A.N.A.R.E. parties stationed at Heard and Macquarie Islands during the past three years have observed more leopard seals than any other seal except the elephant, and it is possible that at Heard Island leopard seals are to be seen in greater numbers than anywhere else in the world. Certainly no other expedition in the present century has reported more than a small fraction of the numbers recorded in the present paper.

Macquarie Island.

Most accounts of Macquarie Island mention that leopard seals are frequently seen there, but little further detail is given. Ainsworth states that they are chiefly seen "from late winter to early summer". During the stay of the 1949 party on Macquarie Island a record was kept of their appearances, noting size and sex wherever possible.

The first occasion on which a leopard seal was seen by the party was 5 May 1949 and a week later one of the same size (probably the same animal) was shot at the same spot. It was a female 208 cm. long. The next was not seen till 25 June, but after that appearances of leopard seals became frequent. Four, of which two were shot, were seen in the first eight days of July, and from 16 July till 22 September they were seen almost daily. During most of this period a tour of the Isthmus and Aerial Cove always disclosed one or two. They were most abundant on 15 August when nine were seen between the camp and Nuggets Creek, three in Sandy Bay, and two at Green Gorge. From the middle of September their numbers began to decline. On 16 September, during a census of elephant seal bulls from Brothers Point on the east to Eagle Point on the west, only two leopard seals were seen. Only seven were seen during October. In the middle of November, in the course of a census of elephant seal pups covering the entire coast of the island only two leopard seals were seen, though on 18 November, while the party taking the census was away in the south, three came ashore on the Isthmus. On 2 December a small sickly animal was ashore near the Station, and a similar animal was on the rocks near Garden Cove two or three days later. This was the last leopard seal observed up to the time of the party's departure in April.

During this period eighteen were shot, the measurements of which are given in Table I.

TABLE I
MEASUREMENTS OF LEOPARD SEALS KILLED AT MACQUARIE ISLAND,
1949.

<u>Serial No.</u>	<u>Date</u>	<u>Sex</u>	<u>Total Length</u>
M1/49/M1	12.5.49	F	206 cm.
M1/49/M6	6.7.49	F	199 cm.
M1/49/M7	8.7.49	F	215 cm.
M1/49/M8	16.7.49	F	223 cm.
M1/49/M9	28.7.49	M	203 cm.
M1/49/M10	30.7.49	F	240 cm.
M1/49/M11	10.8.49	M	246 cm.
M1/49/M12	13.8.49	M	254 cm.
M1/49/M13	26.8.49	F	224 cm.
M1/49/M14	31.8.49	F	240 cm.
M1/49/M15	11.9.49	M	264 cm.
M1/49/M16	11.9.49	M	239 cm.
M1/49/M19	19.9.49	M	248 cm.
M1/49/M22	29.9.49	M	226 cm.
M1/49/M	21.10.49	M	223 cm.
M1/49/M29	11.11.49	M	197 cm.
M1/49/M32	28.11.49	F	301 cm.
	29.11.49	M	281 cm.

The total length was taken from the tip of the animal's nose to the tip of its tail. (Bertram (1940, p.27) gives

it as his opinion that the measurement of the length of a seal "cannot be more accurate than \pm 2 ins., and the error may very possibly be more". This remark refers to large seals, which may have been dragged some distance. In the case of small seals, measured on the spot, the error is probably very much less).

This record shows the interesting fact that the first seals to arrive were all first-year animals born in the previous spring or early summer. These were fairly easily distinguished from medium-sized second-year animals which had noticeably larger heads. The first of these medium-sized animals was the female shot on 16 July. (See Table I). There were two males in this series, 254 cm. and 264 cm. long, which judged by the "os penis" were definitely not adult, though they could have been older than the group measuring about 240 cm. It will be noted that the animals in both groups had smaller length measurements than those given by Hamilton (1939). Fully-grown adults were rarely seen, and then only at the end of the season. Only three animals were recorded which may have been fully adults :

- (i) a large seal seen on rocks off Hurd Point on 17 November;
- (ii) a female shot on 28 November, which measured 301 cm.;
- (iii) an old male, 281 cm. long, shot on 29 November. The latter had very broken and worn teeth, with evidence of gross sepsis. A large bony sequestrum overlay the broken stump of the left upper canine.

However, Ainsworth mentions a seal killed on 11 May 1912 which was a female "about 11 ft. long". This was probably an adult. It is possible that the A.A.E. saw more adults than A.N.A.R.E., for Ainsworth later observes : "We had taken female specimens on several occasions apparently within a few hours of parturition." This obviously refers to females similar to those shot on Heard Island in August and September. He was presumably misled by the activity of the premature foetus into thinking that it was full-term.

Another curious point was that all the early animals were female. Up to the end of July only one male

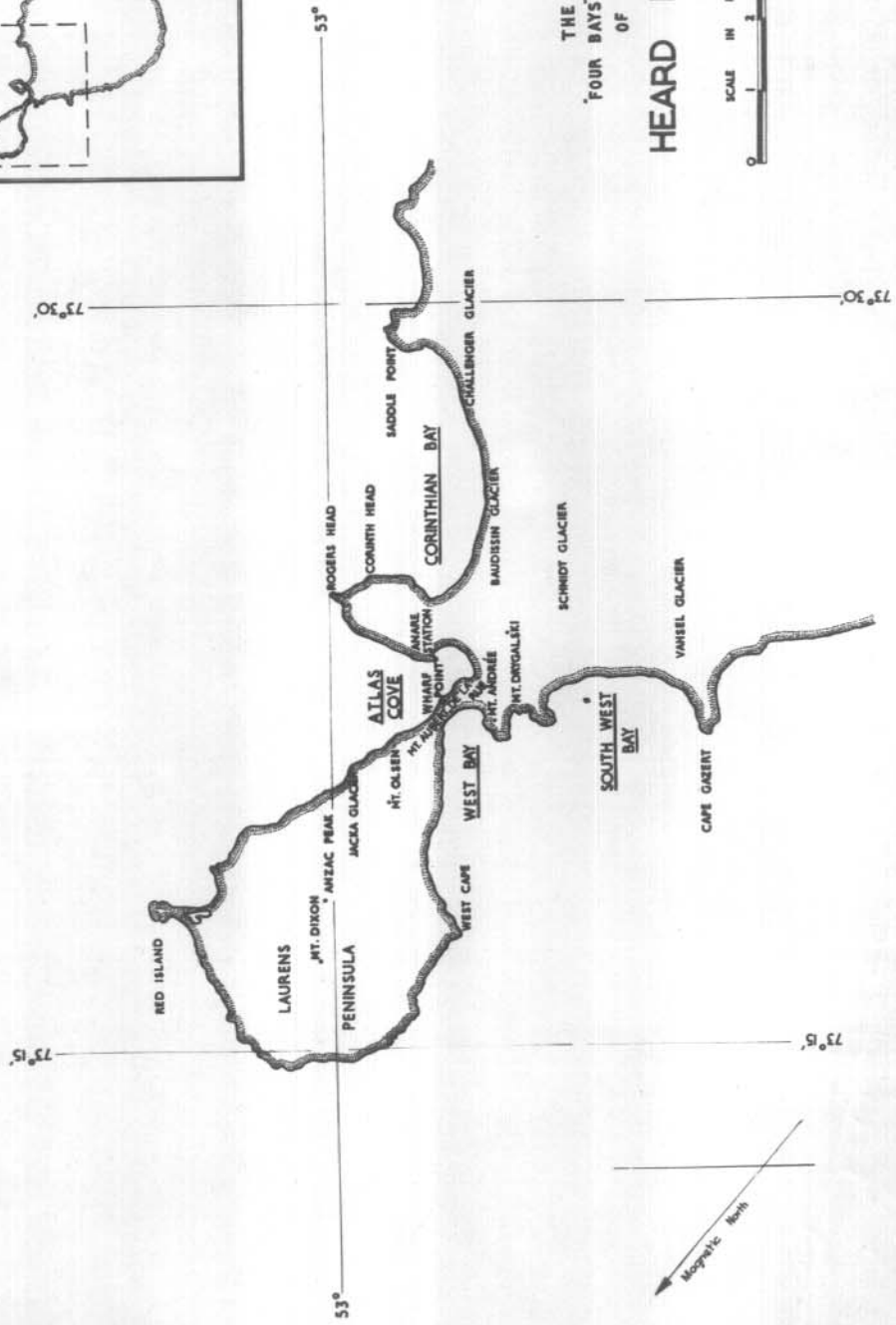
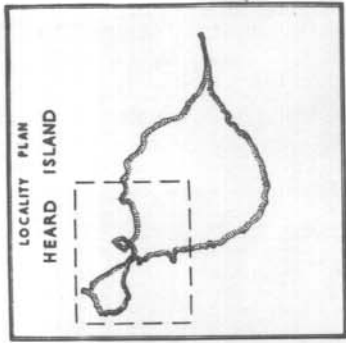
had been seen, a first-year specimen shot on 28 July. In August there was again a large preponderance of females, but this was no longer evident in September. These trends are shown in the following table :-

TABLE II

LEOPARD SEALS RECORDED NORTH OF NUGGETS POINT,
MACQUARIE ISLAND 1949.

Month	Number of Males	Number of Females	Total Sexed	Yearlings	Two-year-olds	Three-year-olds and Adults	Total Recorded
May	-	-	1	1	-	-	1
June	-	-	-	-	-	-	-
July	1	8	9	11	5	-	16
August	6	21	27	7	13	2	ca40
September	7	2	9	8	7	-	21

Totals for subsequent months were: October 7, November 6, December 2. In considering these figures it must be borne in mind that the number of leopard seals on the beaches is not necessarily an index of their numbers in the surrounding waters. The largest numbers were seen on days when the beaches were snow covered, and during October and early November the great herds of elephant seals on the beaches would prevent the leopard seals from hauling out at many of their customary places. Yet their complete absence from the beaches during five months of the year seems to indicate that they do leave Macquarie Island during that period. Those seen in late November and early December were nearly all sickly animals, presumably too ill to undertake the journey south. It is less easy to explain the fact that a large proportion of those seen early in the winter also appeared sickly; possibly they come to land in relatively temperate waters only when they are sick or have been long at sea. However,



the simplest interpretation of the available facts is that, at the approach of winter, the pups scatter northwards, the first (about seven months old) arriving in the vicinity of Macquarie Island in May. For some unexplained reason the first arrivals are all females. The second-year adolescents follow later, again with the females in the van. Adults also take part in this dispersal, but do not travel so far. Few penetrate as far as Macquarie Island, though the 1949 party's experience in this matter evidently differs from that of the A.A.E.

Heard Island

The abundance of leopard seals at Heard Island was not suspected before 1948 since no previous expedition had visited Heard Island in the winter. During 1949 and 1950 a record was kept of the number of leopard seals occurring at the three main beaches near the A.N.A.R.E. Station. These records were compiled in the course of other projects so they are somewhat haphazard. However, the following table gives a fairly adequate picture of the distribution of leopard seals throughout these years. (Figures for West Bay are not given as this is a shingle beach with a heavy surf, and relatively few leopard seals are seen there).

TABLE III

MAXIMUM COUNTS IN EACH MONTH, HEARD ISLAND, 1949 & 1950

Month	Atlas Cove		Corinthian Bay		South West Bay		Totals	
	1949	1950	1949	1950	1949	1950	1949	1950
March	-	.5.	-	18(3)	-	11(3)	-	34
April	7(1)	.6.	30(2)	21(2)	8(2)	9(3)	45	36
May	18(2)	25.	28(2)	6(2)	-	1(2)	(46)	32
June	78(4)	32(2)	9(3)	90(3)	6(3)	7(2)	93	129
July	65	7(3)	39(2)	6(2)	5(2)	1(2)	109	14
August	85	67.	160(3)	143	10(2)	32(4)	255	242

Month	Atlas Cove		Corinthian Bay		South West Bay		Totals	
	1949	1950	1949	1950	1949	1950	1949	1950
September	46 ...	50 ...	124(3)	155 ...	57(3)	36	227	241
October	36(2)	22(4)	74(2)	26 ...	22(3)	8(3)	132	56
November	2(1)	3	3(2)	5 ...	6(1)	12	11	20
December	7	.4.	6(2)	11 ...	12(2)	16 ...	25	31
	<u>1950</u>	<u>1951</u>	<u>1950</u>	<u>1951</u>	<u>1950</u>	<u>1951</u>	<u>1950</u>	<u>1951</u>
January	3	.8.	15(2)	11 ...	29(2)	31(3)	47	50

Few February records are available in either year.

Figures in brackets show the number of counts in each month. Figures underlined thus are the maximum out of at least five counts.

Figures underlined thus are the maximum out of at least ten counts.

All maximum counts in December 1950 refer to 27 December.

The small total for July 1950 is due to the fact that the few counts in that month were done on days unfavourable to big haul-outs. On 16 July 1948 Gilchrist recorded 118 at Corinthian Bay and a glance at Table IV shows that the figures for this month in Table III are misleading.

Chittleborough and Ealey, biologists at Heard Island in 1949 kept a daily record of the number of leopard seals in Atlas Cove, (a) during the period of maximum numbers and (b) from 15 December to 31 January. These figures provide very interesting information on leopard seal fluctuations :-

TABLE IV

LEOPARD SEALS ASHORE AT ATLAS COVE, HEARD ISLAND,
DURING PERIODS OF MAXIMUM AND MINIMUM ABUNDANCE

Period	Total No. of Counts Made	No. of Nil Counts	No. of Counts Below 10	No. of Counts Above 30	Min. No. of Seals in One Count	Max. No. of Seals in One Count	Average No. of Seals in One Count
<u>1949</u>							
1-15 July	15	-	4	3	5	54	23.8
17-31 July	15	-	5	2	5	65	20.5
1-15 Aug.	12	1	5	4	0	75	27.0
17-31 Aug.	11	1	5	2	0	85	20.6
1-15 Sept.	7	-	2	1	4	34	16.0
17-31 Dec.	12	4	12	-	0	7	2.2
<u>1950</u>							
1-15 Jan.	13	3	13	-	0	3	1.7
20-31 Jan.	12	8	12	-	0	2	0.7

The trend in the average column for the last three periods is misleading. Other evidence indicates that the number coming ashore was increasing at this time, but few were seen in Atlas Cove (See Table VI).

Unlike the elephant seals, whose numbers on any beach show a steady trend from week to week, the number of leopard seals fluctuates wildly from day to day. The population of a beach which on one day may be crowded with over a hundred seals, may two days later be reduced to four or five stragglers. This fluctuation is due to weather conditions, and during the winter a big haul-out can be predicted with some certainty, the two important factors being calm weather and snow-covered beaches. "Dead calm,

after two days little wind; beaches covered with soft snow," is a typical entry on such occasions. It might be argued that under these conditions the beaches in the Heard Island winter would very often be snow-covered. But at Macquarie Island in 1949, by far the largest number ever recorded on one day came ashore on one of the very few days on which the beaches were thickly snow-covered, and at Heard Island exceptional numbers early in the winter nearly always coincided with a thick cover of snow on the ground. There is therefore some evidence to suggest that the sight of snow-covered ground near the water's edge is one of the factors which tempt leopard seals ashore.

For these reasons the maximum number recorded during any given period is probably a better index of their abundance at that time than the average of a number of counts.

Another point which may be seen from Table III, but which was even more obvious at the time, is that different beaches are preferred at different times of the year. During the winter it was rare to see any large number on the steep, storm-swept beach at South West Bay; but in January this was the place where they were to be seen in greatest numbers, while their chief winter resort, at Corinthian Bay, was relatively deserted. Both beaches are sandy, but the former is much more exposed to the prevailing gales.

No matter how many are ashore each still keeps a discrete distance from its neighbours; they never huddle together as other seals do. Leopard seals nearly always come and go by night. Stragglers coming ashore in daylight generally do so before 10 a.m., and they seldom leave by day unless disturbed.

It appears that leopard seals spend most of their lives at sea, coming ashore only for short periods. However, no exact observations have been made on the time individual seals remain ashore nor the extent to which the same individuals frequent the same beaches.

COMPOSITION OF POPULATION

It may well be asked what evidence there is that the leopard seals leave the vicinity of Heard Island during the summer, and whether their absence from the beaches is not due simply to climatic conditions. It is difficult to furnish positive proof of their absence, but from daily experience of these seals from the time of their greatest abundance in August, until January, when they are beginning to return after their breeding season, the writer is of the opinion that when in the vicinity of land leopard seals do haul out for a rest at regular intervals, and that the number seen ashore over a reasonable period is a good index of their abundance at that time in the surrounding seas.

The fact that individual seals which were recognisable by scars or other peculiarities were often noted to return repeatedly to the same beach lends some support to this view. But perhaps the best evidence is in the pronounced changes in the composition of the leopard seal population, which can be correlated with the exigencies of their breeding cycle.

The following notes summarise the changes observed from month to month. Apart from some sex ratios* all the detail concerning the composition of the population was collected during the second half of 1950.

August. The composition of the winter population was not studied at its peak. In contrast to Macquarie Island it consisted very largely of big seals, with a considerable proportion of second and third year animals. On 12 August 1949, out of 52 leopard seals in Corinthian Bay, 27 were males, 19 females, 6 were not sexed.

* The sex was recorded only when a clear view of the belly was obtained. This is open to the objection that one sex may tend to lie on its belly more than the other. This point was considered at the time but no indication was found that this might be so, except perhaps in the case of pregnant females; these were absent at the season when the preponderance of males was most marked.

September. The drop in numbers for the first half of September 1949 in Table IV was probably fortuitous. In 1950 the greatest haul-out recorded was on 29-30 September, a calm moonlit night; at 1 a.m. 162 seals were counted on the half-mile beach at Corinthian Bay. Pregnant females, common during August, were becoming increasingly rare towards the end of September. In the haul-out of 29 September only 3 or 4 were noted, though there were almost certainly several more present. When relatively small numbers were ashore they included a large proportion of immature animals and there was a tendency towards a large preponderance of males. When large numbers were ashore the proportion of large seals appeared to be much higher, suggesting that the young seals spend more time ashore than the adults.

About the end of August occasional very small seals were observed; the first noted by the writer were two, a male and a female, on 12 September. These looked so small compared with the large seals that it was first supposed that they might be the first of the current season's pups. To settle the matter, a male and female (perhaps the same as the two seen on 12 September) were shot on 20 September and were found to measure 216 and 207 cm. respectively. From this, and from an examination of their skulls, it is clear that they were animals about a year old, comparable with the small animals seen at Macquarie Island.

October. No big haul-outs were recorded, and the numbers to be seen on the beaches appeared to be diminishing toward the end of the month. The most striking change was the complete absence of pregnant females except for one possible record on 9 October. A few adult males were noted, but most of the leopard seals seen in October were two or three-year-old adolescents, of which the large majority were males. Several small yearlings were again seen, seven being observed on 9 October. One shot on 21 October measured 203 cm.

November. In this month the number of leopard seals at Heard Island reached its lowest ebb. In the first half of the month two-thirds of the leopard seals seen were young seals of the size regarded as two-year-olds, and nearly all of these were males. During the second half of the month as many females as males were recorded, and many of both sexes were large. The follow-

ing table shows that the difference is entirely due to the disappearance of the younger seals, though at the time there appeared to be an absolute increase in the number of large seals hauling out.

TABLE V

LEOPARD SEALS ASSESSED FOR SIZE AT HEARD ISLAND DURING NOVEMBER, 1950

Date	Yearlings	Two-year-olds	Three-year-olds and Adults
November 1-15	4	41	20
November 16-20	1	7	17

The yearlings in the first half of the month were all at Corinthian Bay, and it is likely that only two individuals were concerned. Where two or more records obviously refer to the same individual they are counted as one, but in only a few cases can one be certain of such duplication.

It is difficult to generalise from the limited figures available, but it seems that the young seals are the last to leave and that a number of them, chiefly males, remain during the first half of November. In the second half of the month even these have gone, leaving only a miscellaneous assortment of seals which for one reason or another fail to go south. Some are obviously sickly, others may simply be aberrant in their behaviour, preferring to remain all the year round in their winter quarters; and it is possible that a few adults or near-adults are already returning from the south.

December and January. In the first half of December numbers are still very small, but there is a substantial increase before the end of the month. This trend is best illustrated by the figures for South West Bay which was visited on 23 days during November and the first ten days of December. Only four visits were made from then till the end of January.

TABLE VI

LEOPARD SEALS AT SOUTH WEST BAY, HEARD ISLAND,
NOVEMBER-JANUARY, 1950-51.

Date	Average	Maximum	Minimum	No. of Counts
November 1-10	4.5	12	0	8
November 18-30	3.4	6	2	8
December 1-10	2.0	7	0	6
December 16	-	9		1
December 27	-	16		1
January 15	-	31		1
January 26	-	24		1

The great majority of seals seen in December and January were large, probably adults. About two-thirds were males, including a few of medium size, probably two or three-year-olds. The females on the other hand were practically all very large. Many of these were non-breeding animals, but on 16 December a long, very lean leopard seal was seen, with pouting nipples; there is no doubt that this was an animal which had recently left its pup. This was first clear evidence of the return of females after breeding. Subsequently, similar females were noted on various occasions.

The finding of a half-moulted pup on 7 January in two different years, and the onset of the moult of the older seals in January are noted below. One very small seal in the clean coat of a recently-moulted animal, was seen on 15 January. It was estimated to be 7 ft. long, so it is doubtful whether it was a small yearling (the first noted since 20 November) or a three-month-old pup. Another, or possibly the same animal, was seen on the same beach on 14 February.

March to July. Apart from absolute numbers, little detail is available for this period. The small numbers sexed show a slight preponderance of males :-

TABLE VII

LEOPARD SEALS AT CORINTHIAN BAY & ATLAS COVE, HEARD ISLAND

Period	No. of Counts	Locality	Totals of Counts		
			Males	Females	Unsexed
<u>1949</u> April 20-July 16	6	Corinthian Bay	32	26	30
<u>1950</u> May 30-July 17	5	Atlas Cove	34	26	18
<u>1950</u> June 12	1	Corinthian Bay	24	27	23

The last is the only count indicating the ratio for a big haul-out.

A dead female examined on 6 June 1949 was found to contain a 410 mm. embryo. Another seen 30 June 1949 was noted as "obviously pregnant".

Occasional large haul-outs early in the winter indicated that considerable numbers had returned to Heard Island by May. Eighteen were observed in Atlas Cove on 5 May 1949; 25 on 30 May; 78 on 14 June and 74 in Corinthian Bay on 12 June. The really big haul-outs however all occurred in August or September.

ESTIMATE OF AGE.

Considerable attention was paid to the question of assessing the age of leopard seals, and with constant practice it was thought possible to distinguish four

different age-groups among the females, mainly on the basis of size, but in males a satisfactory distinction between live three-year-olds and adults is probably not possible. The small yearlings seen from September to November were fairly easy to distinguish by their small size and small heads. The two-year-olds in turn were very much smaller than the adults, and among females there appeared to be a fairly distinct intermediate class between these last two. This three-year-old class was further distinguished by their narrow hips, giving them a long, slim figure as compared with the much more massively built adults, which they approached in length. In the spring this distinction was further emphasized by the fact that most of the adults were pregnant. Later, as already noted, the pouting nipples of females which had been suckling pups readily distinguished them from non-breeding animals, whose "virgin" nipples were sunk in their hair coat. (This distinction probably disappears after their moult). The existence of a class of virgin three-year-old seals conflicts with Hamilton's conclusion that leopard seals become pregnant at the beginning of their third year, and suggests that at least among the females, he has one age group too few. It must however be admitted that size is notoriously difficult to judge, and the validity of this grouping can be substantiated only by examination of an adequate series of shot specimens which have been assessed while still alive.

PREGNANT FEMALES.

In August it became obvious that many of the large females were carrying pups. Three such were shot and examined by Gibbney, who supplied the following details :-

TABLE VIII

SIZES OF FOETUSES

Date	Length of Mother Seal	Length of Foetus	Weight of Foetus	Sex of Foetus
<u>1950</u>	-			
August 19	300 cm.	109 cm.	29 $\frac{1}{2}$ lbs.	Female
August 29	323 cm.	111 cm.	28 lbs.	Male
September 13	333 cm.	109 cm.	36 lbs.	Female

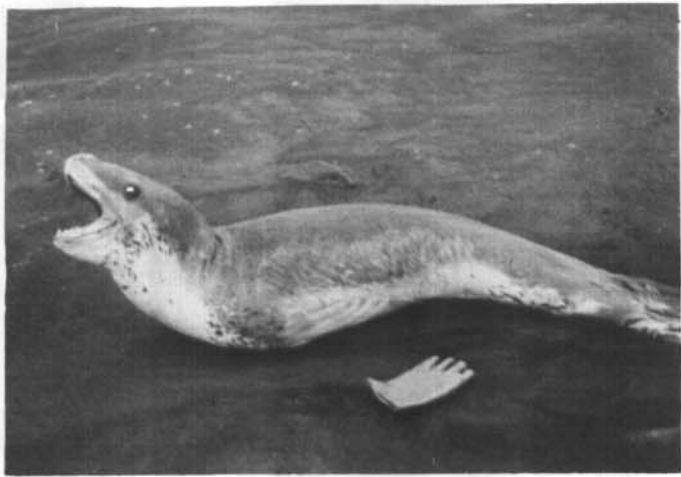


PLATE 1. LEOPARD SEAL PUP
ATLAS COVE, HEARD ISLAND, 1951.



PLATE 2. LEOPARD SEAL EATING ELEPHANT
SEAL PUP - HEARD ISLAND, 1950.



PLATE 3. HEAD OF LEOPARD SEAL.
HEARD ISLAND, 1951.

In all three cases the foetus was alive when the animal was opened and, in the last two, attempts were made to keep the young animals alive in an incubator (in the first case successfully, for 15 hours, with the help of respiratory stimulants).

The weight of a Weddell seal pup at birth is 50 to 78 lbs. (Lindsey, 1937) and it may be assumed that a full-term new-born leopard seal pup is at least as big.

On 26 September a very pregnant female, with a huge healing wound across its loins, was seen on the beach near the Station. Next morning a dead, new-born pup was found on the same spot; nearby was the stain of the placenta; the mother had gone. Unfortunately skuas and giant petrels had already been at the body, so it was not possible to obtain satisfactory measurements. This is probably typical of the circumstances under which leopard seal pups are occasionally born at subantarctic islands.

During September pregnant females became increasingly rare and it was assumed that they were departing for their breeding grounds. Except for a large adult lying on its belly, seen on 9 October and noted as "probably pregnant", none was seen during October. Occasional large females seen at this time were three-year-olds or other non-breeders.

PUPS

On 7 January 1949 a leopard seal pup, with some of its puppy coat still attached, was observed on the beach in Atlas Cove. By a remarkable coincidence, on 7 January 1951 the writer found a leopard seal pup in precisely the same condition on Corinthian Beach. Gibbney and the writer secured and prepared the specimen; its length was 168 cm.. As can be seen from Plate 1 the remaining fur is attached mainly along the sides of the back and above the axillae. The flippers and head looked disproportionately large for the rest of the body. The skin is now in the Sydney Museum, and apart from Vallentin's skin (See p.26) is probably the youngest leopard seal skin in existence. That the animal had been independent for some time was evidenced by the fact that the intestine was crammed with tapeworms, up to 3 or 4 inches long. Some of these were massed into boli in the gut. The stomach contained three feathers, but no

nematodes. Apart from the tapeworms, the animal seemed in good condition. It is possible that these two were pups which had been forced to fend for themselves prematurely, and were consequently stunted in growth. They could not have been much more than two months old, and were probably less. (The moult of a Weddell seal pup may be completed at any age from 27 to 70 days (Bertram 1940).)

MOULT.

In January nearly all the leopard seals had very dingy coats, and towards the end of the month many were beginning to moult around the base of the hind flippers. On 28 January a large female was seen which had nearly completed its moult, patches of loose hairs along the back and on the fore flippers being all that was left of the old coat. (The seal was asleep, and a tuft of loose hairs was removed without waking it). Its silvery new coat was in marked contrast to the dingy yellowish coats of other seals on the same beach. On 2 February what was probably the same seal was seen again, having now completed its moult, and on another beach several others were observed in half moult. It is clear from this that in the leopard seal the annual moult is less drastic than in the elephant seal, which comes ashore to lie up for the period of its moult. In the leopard seal the hairs come out singly, not embedded in a sheet of epidermis as in the elephant seal, and the process does not seem to involve any interference with its normal activities.

PLAY

Sea leopards ashore have very rarely been seen to engage in any activity apart from sleep, so it was with particular interest that Young and the writer observed two leopard seals on the night of 29 September 1950 (about 9 p.m.) engaged in a "play" on the snow. The first, a stoutly built seal (adult male?) was trying to rest its head on the body (usually hind quarters) of the second, a smaller animal, which continually eluded the first by turning towards it, the pair therefore tending to go round in circles. At intervals the second would break away, always followed by the first. This performance continued for some time, and they were still at it half-an-hour later. They paid little attention to the

writer's presence, and made no noise. A very similar performance was seen again on 8 October (about 7 a.m.) in driving snow. One, which appeared to be the aggressor, was seen sniffing at the penile orifice of the second, which was then lying on its side. Unfortunately it was not possible to establish the sex of the former before they both disappeared into the sea. The impression was that they were both immature seals, and they were probably the same as two seen lying close to each other at the same spot on the previous evening. Usually a leopard seal will not allow itself to be touched by another of its own kind, and even in the biggest haul-outs they are well spaced out over the beach. However, about this time (early October), a definite tendency was noted for them to be grouped along the beaches in twos and threes, though still lying at a discrete distance from one another. It is perhaps significant that this occurs at a time when the bulk of the population is leaving, presumably for the south.

CROONING

The curious crooning noise made by leopard seals at times is probably familiar to many people, but its significance is completely obscure. It can sometimes be heard from a considerable distance. On one occasion the writer was much puzzled by its origin until he saw two leopard seals on a flat reef some distance off-shore. It is at least sometimes made by sleeping animals, and on two occasions on which the sex of the animals was noted they were young males.

On the occasion of the biggest haul-out in 1949 Chittleborough and Ealey noted:—"During the night of 18 and 19 (August) there was much trumpeting by leopard seals in Atlas Cove", and the following morning there were 85 on the beach. However, during the night of the great haul-out on 29-30 September, 1950, there was no unusual noise. The only "crooner" noted on this occasion, a sleeping seal, was making "a resonant booming noise as well". These noises are made by a vibration in the throat, with the mouth shut (also noted by Chittleborough and Ealey, 1949).

FOOD

There is little to add to previous observations on the subject. Stomachs of animals killed were usually found to be more or less empty; in many cases a few penguin feathers were the only indication of previous meals. At Macquarie Island, out of 18 examinations (1949 and 1950), cephalopod remains were found on five occasions, fish only once.

On 19 December, Young and the writer found a young (probably two-year-old) leopard seal lying in the surf, holding in its jaws the half-eaten body of an elephant seal pup, at intervals releasing its grip to threaten the crowd of skuas which were edging in for their share. (See Plate 2). The leopard was apparently sated, but was unwilling to relinquish its prey, which had been stripped of skin and blubber down to a line round the middle of the body, but did not seem to have been torn open to expose the viscera. It was presumed that the leopard had taken the pup in shallow water, and had then drifted ashore. A few days earlier, two other members of the party had seen a leopard seal tearing at a body floating out at sea on a different part of the coast. This is the first conclusive evidence of leopards preying on young elephant seals, though it is well known that they attack Weddell and crabeater seals in the antarctic. Leopard seals have never been seen attempting to catch prey, or to feed, on shore.

It is an interesting fact that leopard seals are most numerous around the shores of Heard and Macquarie during the time when the most numerous penguin species, i.e. rockhoppers, macaronis, and royal penguins, are away on their winter wanderings. It is clear that at Heard Island at least, the remaining gentoo penguins could not support the large population of leopard seals which exists in the surrounding seas during winter. At Heard Island elephant seals also are largely absent during the winter.

The leopard seal's habit of following small boats is probably due to curiosity, rather than to any hostile intent. At Heard Island it could possibly have been attracted by the noise of the outboard motor.

INJURIES AND DISEASE.

There is good evidence that leopard seals sometimes fall a victim to animals larger than themselves, presumably killer whales. At Macquarie Island one was seen with two deep parallel gashes six inches apart on its shoulder. This type of injury has been noted several times on elephant seals, and was believed to be caused by killer whales, since nothing smaller has wide enough jaws. However this type of wound was not seen at Heard Island, and does not appear to be the same as the wound which is reported on crabeaters in the Antarctic as due to attack by killers, for in these the wound is stated to be parallel gashes about two inches apart. At Heard Island however, other major wounds were seen - at least one leopard with a hind flipper torn off, and apparently none the worse; the female noted on p.19 with a huge piece torn out of its back; and at least two different seals each with a single deep, clean gash almost encircling the neck. It is difficult to imagine how this last wound could have been inflicted. Chittleborough and Ealey also record several with major wounds, including three with deep neck wounds, one a huge gash, two inches wide and half encircling the neck" (this seal also had smaller gashes on the head). Other minor scars were common, but could have been caused by seals fighting among themselves.

Chittleborough and Ealey noted several with extensive skin disease; this affliction was also noted by the writer, and in some cases was extremely severe. In appearance this was similar to mange in dogs. Usually the head and flippers were chiefly affected, though one seal seen by the writer had lost all the hair off the greater part of its body, and appeared weak and ill. Chittleborough and Ealey noted one with "head and flippers almost devoid of hair and very raw", and another "most emaciated..... sores and pock marks all over the body". It is possible that more than one condition was involved.

Leopard seals were occasionally found dead on the beaches, with no external injury. In May and June 1949, Dr. Allison assisted Chittleborough and Ealey in carrying out post-mortems on two such animals. One had a malignant tumour obstructing one bronchus, with secondary pneumonia and a blood-stained pleural effusion. The other was an adult female carrying a 410 mm. foetus. There were a number of dark red lumps in the wall of the lesser curvature of the stomach, from which there had been considerable haemor-

rhage. The cause of death was diagnosed as carcinoma of the stomach with secondary deposits in the intestine.

The stomachs of leopard seals are often heavily infested with nematodes, though there is some evidence that adults are less infested than young animals. For example, the stomachs of the three female seals mentioned in Table VIII were empty and contained few nematodes. The intestines also are usually infested with tapeworms of various sizes. In some the upper regions of the small intestine are completely filled with a growth of small tapeworms. These infestations do not appear to interfere with the general health of the animal. Hamilton (1939) publishes a list of the internal parasites which have been recorded from this seal.

MIGRATION AND BREEDING GROUNDS.

Perhaps the most interesting point which emerges from the facts presented is the evidence on the migratory habits of the leopard seal. Hamilton (1939) remarks, "there is some evidence that there is a movement ... towards the north in winter." In the light of the additional evidence collected it may fairly be claimed that the leopard seal is as clearly migratory as any of the antarctic seals.* But first it is necessary to consider what should be regarded as the true home of the leopard seal, since the islands outside the pack-ice serve only as his winter quarters..

All available evidence points to the conclusion that the leopard seal is primarily an animal of the pack-ice and that it is there, in the least known region of the Antarctic, that it normally brings forth its young, sharing this habitat with the crabeater and the little-known Ross seal. The reasons for maintaining this are :- First, all seals must come out of the water to give birth (Bertram 1940, p.122). There is no known exception to this

* Bertram (1940, pp.85-87) discusses the summer movements of the crabeater, which seem to amount to a true migration, in this case from the pack-ice toward the continental shore. The Weddell seal is normally a very sedentary species. Nothing is known about the movements of the Ross seal.

rule, and there is no reason to suppose that the leopard seal has developed some special adaptation to enable it to give birth in the water. Second, the leopard seal has no known breeding grounds elsewhere. There is no evidence that it breeds on the shores of the Antarctic Continent,^{*} where in fact it is seldom seen (except for parts of Graham Land, where conditions are more comparable to those of the antarctic islands). Finally, in its later stages, the leopard seal is well-known from the reports of numerous expeditions as a characteristic species of the pack-ice. The fact that leopard seal pups have never been seen in the pack-ice is of little significance. The leopard seal is a scarce and solitary species compared with the abundant crabeater, yet the young pups of the latter have been seen on only three occasions (Bertram 1940, p.97).

The records from those antarctic islands which are surrounded by pack-ice for much of the year suggest that here one is nearest to the breeding places of the leopard seal. At the South Orkneys, on 21 November 1902, Dr. Bruce records in the "Log of the Scotia" that he saw a young leopard seal on pack-ice near the shore. His party was unable to reach it and presently it took to the water, so nothing definite is known about it; but the implication is that it was not more than a few weeks old. Two years later Valette (1906) secured two in December, 189 and 194 cm. in length, evidently young animals about 3 months old.

The other two records of pups mentioned by Hamilton (1939, p.262) are both plainly abnormal:-

* Borchgrevink (1901, p.170) gives an account of a leopard seal pup removed from a pregnant female killed on 11 September at Robertson Bay. This pup survived and was kept for some time on condensed milk. Though by no means improbable, one cannot feel quite satisfied that this record should not really refer to the Weddell seal. In his book Borchgrevink gives the impression that sea-leopards were encountered commonly; but other accounts of this expedition make it clear that this was not so (Bernacchi, 1901, p.206; Wilson 1902, p.71). Bernacchi makes no mention of this incident, nor is it referred to in Hanson's diary, though the latter does record living pups being taken from Weddell seals about this time (September 3 and September 13). Hanson's untimely death a month later makes it impossible to settle this point conclusively.

^ probably the only account of a leopard seal pup (not a newly born pup as stated by Hamilton) seen in normal surroundings.

Matthews found one at South Georgia in September, "3 $\frac{1}{2}$ feet long" (Matthews 1929) but this was very weak and feeble, and was unattended by its parent.

Vallentin secured a skin at the Falkland Islands which is now in the British Museum. Unfortunately, he does not refer to the incident in any of his papers about the Falkland Islands, but the Museum label reads :

Date: "Xmas". Locality: "Shallow Bay, West Falkland"

"Found on shore with mother by native".

From this there can be no doubt that the pup was born under natural, if exceptional, conditions. The date, however, is approximate and may refer to the date on which Vallentin acquired the skin, rather than that on which the pup was killed, and does not justify the extension of the pupping season to so late in the year. In any case the fact that the pup was born in the Falkland Islands is evidence that the circumstances were unusual. The writer has examined the skin and cannot altogether agree with Hamilton's account of it. The yellowish tinge which he mentions is probably the natural colour, since the foetal skins obtained (but not preserved) at Heard Island had a similar colouration. The fur is firmly attached, and there is no evidence of moult; the "second coat" referred to by Hamilton is merely an area where the longer hairs have been removed by moth, singeing, or some such agency. The pup must therefore have been killed when it was still very young.

Even in the pack-ice, leopard seals are met with only in small numbers. Hamilton (1939 p.242) tells us that "during the period 23 December, 1941, to April, 1946, thirty-seven leopard seals were recorded by Mr. F. Worsley in his own diary" and adds: "This is an unusually large number". Andersson (1908) makes the point that they were found only in the more open parts of the pack-ice, a fact also mentioned by Bruce (1893).

Rudmose Brown (1913) quotes Bruce's observations on the sea leopards seen during the cruise of the "Balaena", 1892-93, in a manner which suggests numbers so improbable that they have been ignored by subsequent writers. However, if one turns to Bruce's own writings the matter appears in a different light. In a brief report before the British Association, Bruce (1893) states simply:- "The sea leopard was on the outermost streams [of the pack-ice], and was most

frequently found singly, though two or three might be on one piece of ice, but seldom more." In a further paper (1894) he repeats this statement, but further on also writes:- "On the last day of sealing we were among a great host of the large sea leopards.....they were moaning loudly. This was said to be a sign that they were about to start on a long journey". It is a pity that this observation is not more detailed, for this rather colourful statement seems to mask an observation of very great interest. It seems that the "Balaena" did encounter exceptional numbers of leopard seals, but this second observation refers to a very extraordinary incident. It is possible that they did witness a remarkable gathering of leopard seals, and further that we have here a fragment of old sealers' lore. It suggests that the old sealers were aware of the leopard seals' migrations, and that such gatherings may actually take place as a preliminary to their northward movement. The loud moaning mentioned can only refer to leopard seals (See p.21) for the crabeater, the only other seal commonly encountered, is a very silent animal (Bertram 1940, p.92).

Rudmose Brown's other statement, that "Dr. Bruce estimates that the crew of the "Balaena" killed fully a thousand leopard seals during December, January and February" does not appear in any of Bruce's published accounts of the voyage, and cannot be taken too literally. This figure may have been hazarded in conversation ten years after the event.*

Several parties report the absence of leopard seals during winter from islands within the limits of the pack-ice. Thus Andersson records that they were absent from Paulet Island from 11 April till the following October, and that only one was seen during the winter at Hope Bay, on 19 August. At South Orkneys Rudmose Brown

* This point was referred to Professor Rudmose Brown, who wrote : "It does seem an exaggeration but was verified by Bruce himself when I wrote the paper.....seals of one kind or another were in extraordinary numbers in the pack, that is unusual. "Balaena" sealed in the open pack; rarely on the coasts". In his published accounts Bruce makes it clear that Weddell seals were seldom seen, and that he distinguished correctly between them and the leopard seals.

states that during the winter the "Scotia" party saw three only, (in August) and observes "Dr. Charcot notes their disappearance from Petermann Island in mid-winter." The position at the more southerly islands is thus the reverse of experience at Heard and other islands outside the limits of the pack-ice, although their winter absence from high latitude islands, when these are closely hemmed in by pack-ice, does not prove that the leopards leave the pack-ice during the winter. Many of them may go no further than its more open fringes. This is suggested by the fact that some are seen again in August, presumably as soon as the ice begins to open.

However the evidence for the northward migration of a substantial part of the population comes from their appearance in considerable numbers at all the outer antarctic and subantarctic islands during the winter. Reports from numerous observers make it clear that leopard seals are not uncommon in South Georgia. Matthews states that they are much more common in the winter, though odd ones are to be found all the year round. This is similar to the position at Heard Island. However he adds "during November and December young ones from 6-7 feet long are frequently to be seen on the beaches" and he regards them as the current season's pups. This is by no means certain, if one considers the occurrence of small yearlings at Heard Island in September and October, for these were also about 7 feet long. Farther from the pack-ice, at the Falkland Islands, Hamilton states that they are "most plentiful in spring and early summer". An examination of his Table I, however, shows that 14 out of his 15 specimens collected there were killed in September or October. Even so, it is rather surprising that in October they should be abundant so far north. The four females which he obtained in this month were all immature, but the series included four adult males. As already seen, at

* In September and October the pack-ice reaches its greatest extent, and then approaches nearer to South Georgia than to any of the other islands considered, and some distance to the east actually reaches a latitude further north than South Georgia (Mackintosh and Herdman 1940).

Macquarie Island they are commonest from July to September, and by the end of November the only ones left are a few sick animals. Macquarie Island seems to occupy a position just within the limit of their normal winter dispersal. The records from this island suggest that it is the young animals which go first and travel farthest, so that here there is a clearly defined sequence, animals in their first year beginning to arrive in May and June, followed in July and August by second year animals. Few older seals appear to wander so far, and these were all towards the end of the winter. Records from other low latitude subantarctic islands also suggest a preponderance of immature seals, but the details are inadequate. It is possible that a large proportion of the adult population never leaves the pack-ice.

Accounts from islands other than Heard and Macquarie are not sufficiently detailed to permit a full comparison, but it is clear that sea leopards occurring at the different islands vary in the age groups involved, and in their sex ratios, as well as in total numbers and seasons of occurrence. Thus the preponderance of females among young animals at Macquarie contrasts with the predominance of males later in the year at Heard Island, while seals collected by Bertram in Graham Land were all adult females (Hamilton 1939, p.244). The significance of these variations cannot be explained till more complete data is obtained.

When the numbers recorded at the subantarctic islands are compared with the small numbers recorded at any one place in the pack-ice, it seems clear that there is a tendency for the seals to concentrate in the neighbourhood of these islands. However, they can hardly be dependant on them, for over vast areas there are no such islands. It is almost certain that leopard seals are to be found at the edges of the pack-ice around the entire circumference of Antarctica, though it by no means follows that they are everywhere equally numerous. Thus we are left with a picture of a large scale northward movement in the autumn from everywhere on this periphery. We have little guide as to how far north this zone of winter dispersal extends, but wherever islands occur in this zone, the leopard seals tend to congregate, attracted either by food or by the desire to rest ashore. Their status at each island evidently depends on its position in this zone, or more simply, on

its distance from the pack-ice. Those islands nearer the pack-ice receive the full brunt of the winter invasion, and some leopard seals remain all the year round, while the waters of those near the periphery of the zone of dispersal are invaded only during the winter months, and then only by those sections of the population which travel farthest afield.

SUMMARY

A brief account is given of Heard Island and Macquarie Island with special reference to the seals occurring at each.

The occurrence of leopard seals at Macquarie Island is shown to be mainly restricted to the months from July to November. The great majority are young animals in their first or second years, and there is a well marked sequence, the first to arrive being females in their first year.

Tables III and IV summarise numbers seen at Heard Island from April 1949 to January 1951. Here they are present all the year round, being most abundant from July to September. Numbers are lowest during November and early December.

The changes in population from month to month are noted, points of special interest being the occurrence of pregnant females in August and September, and two records of young pups with some natal fur still attached in January.

It is concluded that pregnant females leave the vicinity of Heard Island about a month before their pups are due to be born, and that the pups are born in the pack-ice during the months September, October and November. There is no satisfactory evidence for extending the pupping season to include December.

Leopard seals in their first year can be distinguished by their small size. At Macquarie Island in 1949 the first of these was seen on 11 May but no more were seen from then till early July. It is not known when they first begin to appear in any numbers at Heard Island but they are not uncommon there during September and October.

With practice it is thought possible to distinguish in life two age-groups between first-year seals and adults, at least in the case of females. Neither of these groups was observed to be pregnant. This conflicts with Hamilton's statement that leopard seals become pregnant for the first time at the beginning of their third year.

The moult of the older seals begins in January, and does not seem to interfere with their normal activities.

A curious "play" was observed on two occasions in the spring between pairs of seals, apparently adolescents. This is the first time that any kind of social behaviour on land has been recorded for this species.

Reasons are given for regarding the leopard seal as primarily an animal of the pack-ice, and its status there and at various antarctic and subantarctic islands is discussed. Attention is drawn to Bruce's remarkable account of leopard seals seen during the cruise of the "Balaena" in 1893, and a new account is given of Vallentin's skin of a young leopard seal pup, the only one in existence known.

The leopard seal is concluded to be a truly migratory species, though it may be that some remain in the fringes of the pack-ice all the year round. In the winter they disappear from the shores of those islands which are then surrounded by pack-ice, and arrive in variable numbers at those islands lying outside the pack-ice. There is evidence that different age-groups behave differently in this respect, the young seals tending to travel farthest. There is also a striking variation in the sex ratios observed at different seasons and at different localities, suggesting that there is a difference in migratory behaviour between the sexes, even in their first year.

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