

The seasonal occurrence and behaviour of Killer whales *Orcinus orca*, at Marion Island

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(With 3 plates and 5 figures in the text)

The paper describes the occurrence of Killer whales at Marion Island (Prince Edward group) in the south Indian Ocean from August 1973 to November 1976. They occur seasonally, being most numerous from October to December. Their occurrence is synchronized with the seasonal haul out of Southern elephant seals, but the seasonality of King, Rockhopper and Macaroni penguins is also likely to influence their occurrence. The largest herds occur in October, the month during which mean group size is also largest. Sex and age composition are given, adult males being significantly more numerous than adult females, while 36.3% of the latter had calves. Hunting activity appears to be greatest between 15.00 and 17.00 hrs, and most Killer whales were seen within 100 m of the shore. Aspects of hunting, attacking, feeding and resting behaviour are discussed. The body measurements of a young male found on a beach are given.

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Introduction

The sub-antarctic Prince Edward Islands, consisting of Marion Island (46°54'S, 37°45'E) and Prince Edward Island (46°38'S, 37°57'E) are situated in the south Indian Ocean. Marion Island (Fig. 1) is the larger of the two with an area of 290 km², while Prince Edward Island 22 km to the north has an area of 44 km². The islands lie north of the Antarctic Convergence, although according to Schulze (1971) this convergence could occasionally come close to Marion. The first record of Killer whales at these islands appears to be that of La Grange (1962), who noted that they were seen throughout the

year, sometimes very close inshore. The present study embraces observations made from August 1973 to November 1976.

Both La Grange (1962) and Rand (1955, 1962) give some details on the seasonal occurrence of Southern elephant seals (*Mirounga leonina*) at Marion Island, and Voisin (1972, 1976) relates the seasonal presence of Killer whales at Possession Island (46°25'S, 51°45'E), and Ile aux Cochons (40°06'S, 50°14'E) in the Crozet Archipelago, to the occurrence of these seals. The object of this study was to determine the seasonal pattern of occurrence of Killer whales at Marion Island, and to examine the relationship between this pattern and the seasonal presence of elephant seals.

The climate of Marion Island is characterized by predominantly strong westerly winds,

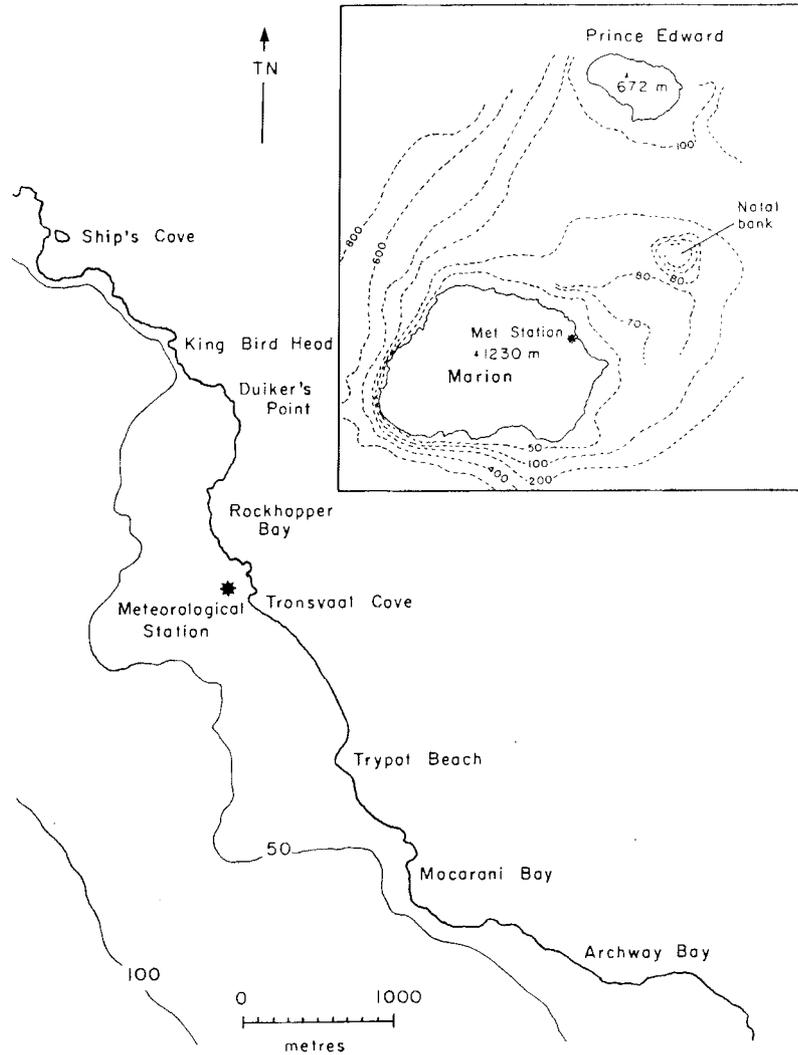


FIG. 1. Marion and Prince Edward Islands (Inset, ocean depth in metres) and the study area (contours in metres).

high relative humidity, low mean temperature of approximately 5.0°C showing little annual and diurnal variation, abundant precipitation in the form of rain and snow, and a high degree of cloudiness. Sea temperature is warmest in February–March (6.1°C) and coldest in August–September (4.0°C), with an annual mean of 5.0°C (Schulze, 1971). The coast line in the study area (Fig. 1) is generally irregular with numerous large open bays and smaller coves, deep inlets, and offshore rocks, and is characterized by vertical cliffs 15–30 m high, broken by beaches (Langenegger & Verwoerd, 1971; Verwoerd, 1971), on which elephant seals breed.

Methods

The Base Station on Marion Island is situated on the leeward east coast, and much of the biological field investigations take place within 4 km of this station (Fig. 1). Most Killer whale observations were made along the coast within this area, because of the greater human activity there.

Because of the erratic occurrence of Killer whales no set periods were specifically assigned for observations. Instead, sightings were logged as and when they occurred, taking care not to include repetitive sightings of the same individuals. They could only be watched between dawn and dusk, and whenever they were sighted, were observed for as long as possible, and their behaviour recorded.

At every sighting the following information was recorded: date, time, sex and age (when possible), distance offshore, and herd and group size.

Sex. Only adults could be sexed by the shape and size of their dorsal fin. Adult males are characterized by tall upright fins (Plate I(a)), right angle triangle in shape with the posterior edge perpendicular to the body (Jonsgård & Lyshoel, 1970; Martinez & Klinghammer, 1970; Voisin, 1972). Martinez (pers. comm.) indicated that adult females have a “sickle-shaped” dorsal fin. Hancock (1965) states that while adult males have highly contrasting black and white markings, females have less contrasting markings, their bodies appearing a “grey-brown” rather than black colour with less distinct white patches. Baldrige (1972) describes the colour of the saddle behind the dorsal fin as “grey” in colour in positively identified females. During our observations we noted that positively identified females (i.e. those accompanied by calves) had distinctly sickle-shaped dorsal fins (Plate I(a), (b)), grey rather than clearly demarcated white saddles, and a grey-brown rather than black body colour. We did not notice any dissimilarity in the pattern of markings between the sexes.

Age. Individuals were assigned to one of four classes; adult, subadult, calves, and unidentified. Adults (Plate I(a), (b)) were recognised by the height of their dorsal fin and body size, calves were defined as small individuals, about half the length of adult females, and always in close association with an adult female (Plate I(a), (b)). The rest were classed as subadult. Those moving too fast or too far offshore to be identified were assigned to the unidentified class.

Herd. All individuals visible at one time, or passing a given point within 30 min, or within 1.5 km of each other, were considered to be part of one herd. These conditions were arbitrary but based on practical considerations under the prevailing conditions, and it was considered that individuals within 1.5 km of each other were probably in contact with each other and therefore part of the same herd. Sometimes members of one herd were grouped, at other times fragmented into scattered sub units.

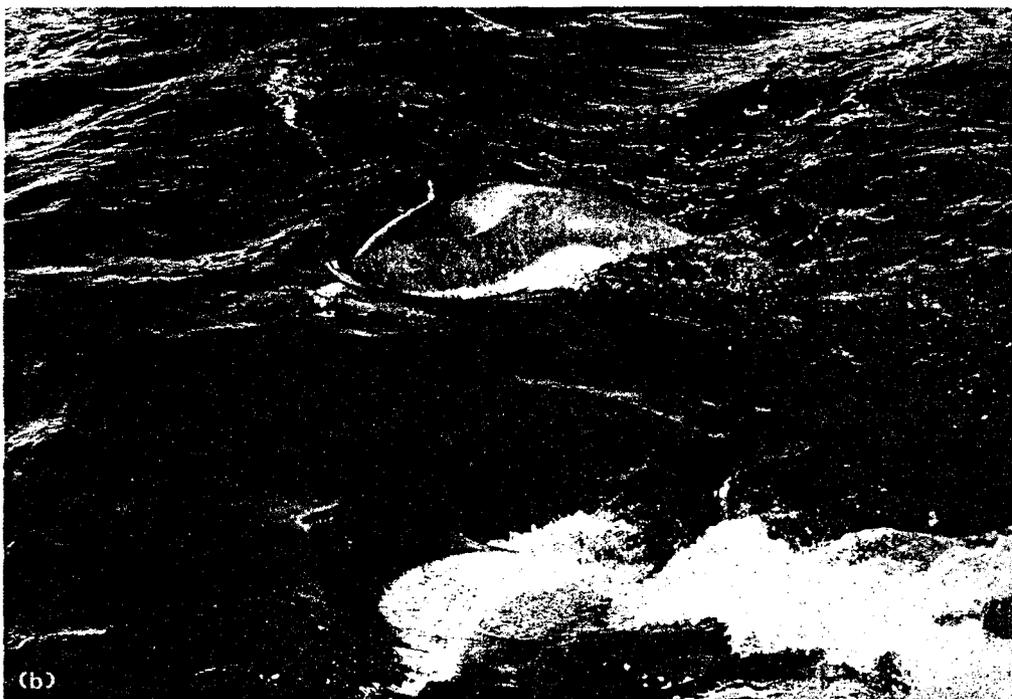


PLATE I. (a) A group of Killer whales. Note (i) the tall upright dorsal fin of the adult male (centre), (ii) the shorter sickle-shaped dorsal fin of the adult female (below the adult male) and (iii) the smaller fins of subadults. (b) An adult female (foreground) accompanied by a calf. The adult's sickle-shaped dorsal fin is distinctive.

Group. These sub units were called groups, consisting of one or more individuals. When a herd was tightly grouped or consisted of one solitary animal only, herd and group size were equal.

Distance offshore. Four zones were chosen; Zone 1—within 5 m of the shore; Zone 2—5 m to approximately 100 m offshore, extending up to the first belt of kelp (*Macrocystis* spp.); Zone 3—from 100 m to 500 m offshore, extending up to the second belt of kelp; and Zone 4—beyond 500 m offshore.

Since August 1973 elephant seal censuses have been carried out once a week on two breeding beaches (Transvaal Cove and Trypot beach) near the Base Station. In an attempt to understand the timing of the Killer whale appearances, their monthly occurrence is related to the combined census results of elephant seals occurring on these two beaches using a standard linear regression of the form $Y = A_y + B_{yx} X$, where A_y and B_{yx} are the Y intercept and slope respectively of the straight line relating Y to X , Y being the dependent and X the independent variable. Correlation coefficients were calculated to test the accuracy of the regressions.

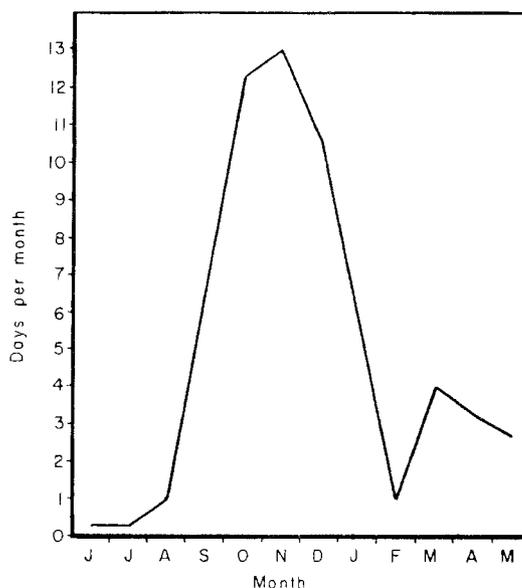


FIG. 2. Mean numbers of days per month on which Killer whales were observed between October 1973 and November 1976.

Results and discussion

Pattern of occurrence

Although no correction for the repeated sightings of the same individuals is made in the data presented, care was taken at the time of recording the observations to avoid repetitions. Only one adult male could be recognised with certainty and was seen in all three summers of the study period.

The data in Fig. 2 clearly indicates a seasonal pattern of occurrence, the frequency of observations reaching a maximum in October, November and December. At Possession Island in the Crozet Archipelago, Voisin (1972) also notes a seasonal occurrence from September to November on the one hand, and from March to May on the other hand.

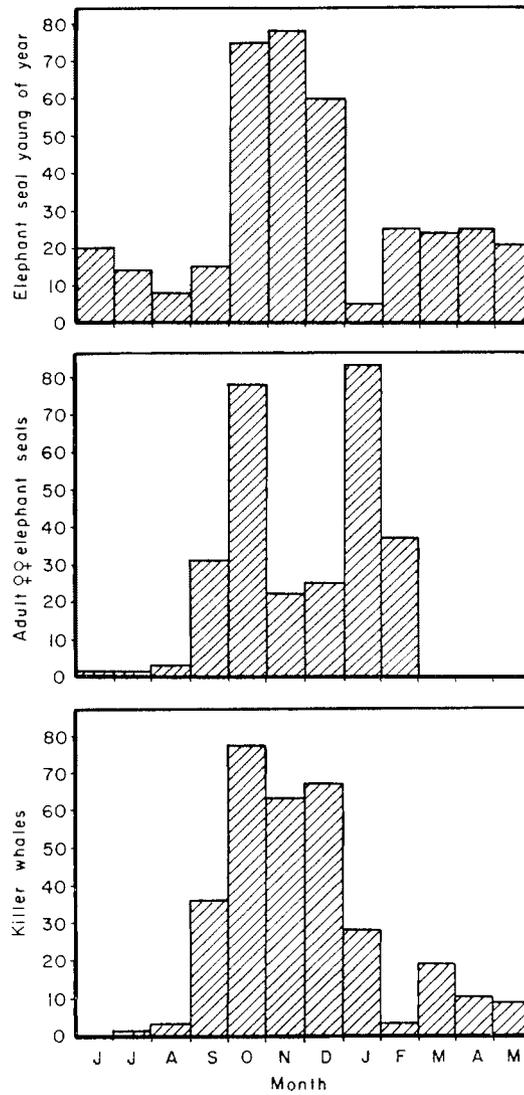


FIG. 3. Mean number of Killer whales, adult female elephant seals and elephant seal yearlings (<1 year old), counted per month between October 1973 and November 1976.

The occurrence of Killer whales, and the number of elephant seals hauled out on the beach in Transvaal Cove and on Trypot beach are illustrated in Fig. 3. The linear relationship between number of Killer whales observed per month and the number of (a) adult female elephant seals hauled out, and (b) elephant seals less than one year old is;

$$(a) Y = 7.53 + 0.599X \quad r_{yx} = 0.568 (P < 0.05)$$

$$(b) Y = 10.81 + 0.756Z \quad r_{yz} = 0.849 (P < 0.01)$$

where Y = number of killer whales, X = number of adult female elephant seals, and Z =

number of elephant seals less than one year old. The correlation coefficients indicate a good degree of association between the abundance of Killer whales and elephant seals.

In September when parturient elephant seals start hauling out, the number of Killer whales begins to increase. At the same time virtually all the 10–12-month-old seals that overwintered on the island depart. There is therefore considerable movement of elephant seals from the sea onto the beaches, and vice versa. During October most of the elephant seal females arrive, give birth, wean their pups, and begin to depart. Some of these pups hence forth referred to as yearlings when older than one month, begin to feed themselves during late October, staying close inshore. Killer whales reach a peak in numbers during this month, and is undoubtedly due to the large number of elephant seals moving about the coast. By November most of the female elephant seals have departed, and there is an 18% decrease in the number of Killer whales. In December the adult females return to haul out for the annual moult. By this time the yearlings are feeding themselves (i.e. they are leaving the beaches), and there is an increase in the number of Killer whales as the movement of elephant seals increases. In January the number of Killer whales observed declines. By this time very few elephant seal yearlings occur on the beaches and most of the females are hauled-out for the moult. The decrease in Killer whale observations appears to be related to the decrease in elephant seal movements.

During February the decline in numbers of Killer whales to almost zero is difficult to explain, but Voisin (1972) also indicates a decline in the number of Killer whales at Possession Island in February. The moulted female elephant seals start departing, and the yearlings start hauling out again. There is therefore no substantial decline in seal movements, and even if the Killer whales turned their attention to penguins they would still be evident.

However, in March when all remaining moulting adult female elephant seals depart, and the number of yearlings (now about five months old) hauled out remains almost constant, there is a large increase in the number of Killer whales. Although the number of yearlings hauled out remains similar to the previous month, there is considerable local movement about the island. The yearlings move from one beach to another and to and from Prince Edward Island, hauling out for rest periods of a few hours to a few days between movements, and undoubtedly attract the attention of Killer whales. As the winter season approaches (April–August) the Killer whales leave the island, although many of the elephant seal yearlings overwinter.

It is probable that the seasonal occurrence of Killer whales is also related to the seasonal presence of the migratory Macaroni penguins (*Eudyptes chrysolophus*) and Rockhopper penguins (*Eudyptes chrysocome*). King penguins (*Aptenodytes patagonica*) are eaten by Killer whales, but occur at the island throughout the year, although in much increased numbers during the summer season. Fur seals are probably eaten as well, although Killer whales have never been seen in the vicinity of the fur seal rookeries.

Herd size

Mean monthly herd size is shown in Table I. The largest herds occur in October (mean 4.8 ± 4.31 individuals), the months in which most observations were logged. The largest herd seen consisted of 25 individuals, and also occurred in October. Of the total of 281 herds seen over the study period, mean herd size was 4.2 ± 3.17 individuals per herd. The

TABLE I

Mean monthly herd and group sizes of Killer whales at Marion Island between October 1973 and September 1976

Month	Herd size				Group size			
	Mean	<i>n</i>	Range	s.d.	Mean	<i>n</i>	Range	s.d.
June	1.0	1			1.0	1		
July	3.0	1			3.0	1		
August	3.3	3	2-5	1.23	2.5	4	1-5	4.11
September	4.4	22	1-9	2.46	3.1	31	1-7	2.35
October	4.8	78	1-25	4.31	3.5	113	1-11	1.99
November	3.4	68	1-12	2.08	2.8	81	1-11	2.03
December	3.6	50	1-8	2.08	2.5	87	1-9	1.24
January	3.9	21	1-9	1.87	2.9	29	1-6	1.30
February	2.8	4	1-5	1.48	2.5	5	1-6	0.50
March	3.4	15	1-13	3.01	2.8	20	1-3	2.44
April	3.3	10	1-6	1.61	2.6	14	1-10	1.35
May	3.5	8	1-9	2.24	3.3	8	1-5	2.38
Study period	4.2	281	1-25	3.17	2.9	394	1-11	1.89

frequency of herds ranging from one to more than five individuals at Marion Island is given in Fig. 4. Most frequent are herds of only two animals, followed by herds of over five individuals.

Martinez & Klinghammer (1970) report that Killer whales usually travel in groups of from three to 50 individuals, Hancock (1965) reports a herd of seven seen killing a minke whale, and Baldrige (1972) observed a herd of five or six killing a grey whale calf. At Possession Island Voisin (1972) observed herds of up to 12 individuals, while at Ile aux Cochons (another of the Crozet group) he saw herds of up to six only (Voisin, 1976).

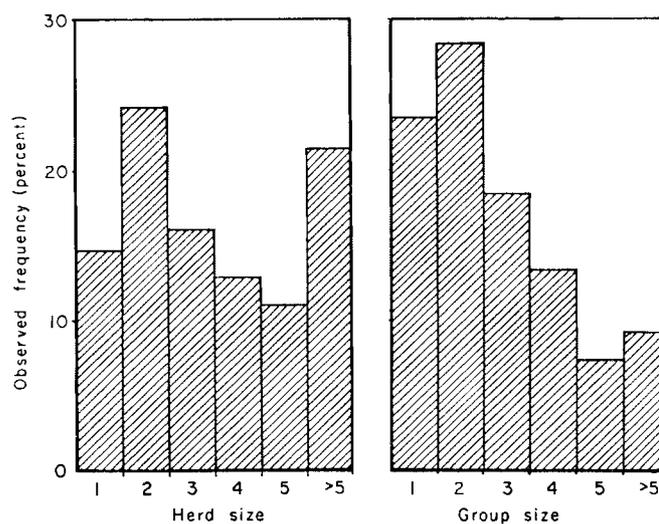


FIG. 4. Frequency of herd and group sizes of Killer whales from October 1973 to November 1976.

Group size

Members of one herd were usually observed in smaller sub units. Mean group size (Table I) over the study period was 2.9 ± 1.89 individuals per group, the largest groups occurring in October (mean 3.5 ± 1.99 individuals).

Most groups of one were adult males, groups of two usually adult females and their calves, or pairs of subadults, and groups of three usually consisted of an adult male and subadults, or an adult male, female and calf.

The largest groups seen were two of 11 individuals each, both groups forming part of a herd of 23 animals. Groups of one and two individuals were the most frequent (Fig. 4).

Sex and age composition

Of the total of 954 Killer whales seen during the study period, 28.7% were adult males, 21.4% adult females, 7.8% calves, 24.7% subadults and 17.4% were unidentified. The ratio of adult males to adult females (274 A♂♂ : 204 A♀♀) differs significantly from unity ($P < 0.05$). Of the adult females 36.3% had calves. Voisin (1976) indicates that at Ile aux Cochons 71.1% of the Killer whales he saw were adult males, and only 5.3% were adult females, the remainder being either young males or females. His observations were made from early January to late April, and on Marion Island over the same months 26.8% of the whales observed were adult males and 29.3% adult females.

Although adult females were seen in all months except June, calves were only seen between September and May (Fig. 5). Both were most abundant between September and January. No mating as described by Voisin (1972) was seen and it is not known whether females calve at the Prince Edward Islands. Some very small calves have been seen which indicates that Killer whales may in fact use the area as a calving ground.

Diurnal pattern

Killer whales were only observable between dawn and dusk, and between 15.00 and 17.00 hrs (Table II) there was an increase in the number of observations. Killer whales do appear to take rest periods (described below) during which activity is of a low intensity. Although they probably remain near the islands all the time during the summer, they are most likely to be seen when active along the coast. The apparent increase in activity between 15.00 and 17.00 hrs probably reflects an increase in hunting activity.

Behaviour

Hunting

The behaviour of Killer whales while seeking food was quite distinct. Groups of one or more patrolled the coast, within metres where depth allowed (Plate II(a)), surfacing at short and regular intervals. They moved reasonably fast and their dorsal fins were visible for much of the time. However on reaching a cove or bay in which a beach occurred, they submerged completely and could often be seen underwater as they moved in to as close to the surf zone as possible. They remained underwater as they swam along the surf zone and only surfaced once past the beach or back alongside the coastal cliffs. Rarely did they retrace their passage, but would continue straight on to the next beach, submerging again on arrival. Sometimes they were seen some distance offshore, moving fast and surfacing regularly, occasionally interrupting this trend by remaining submerged for 100 m or more,

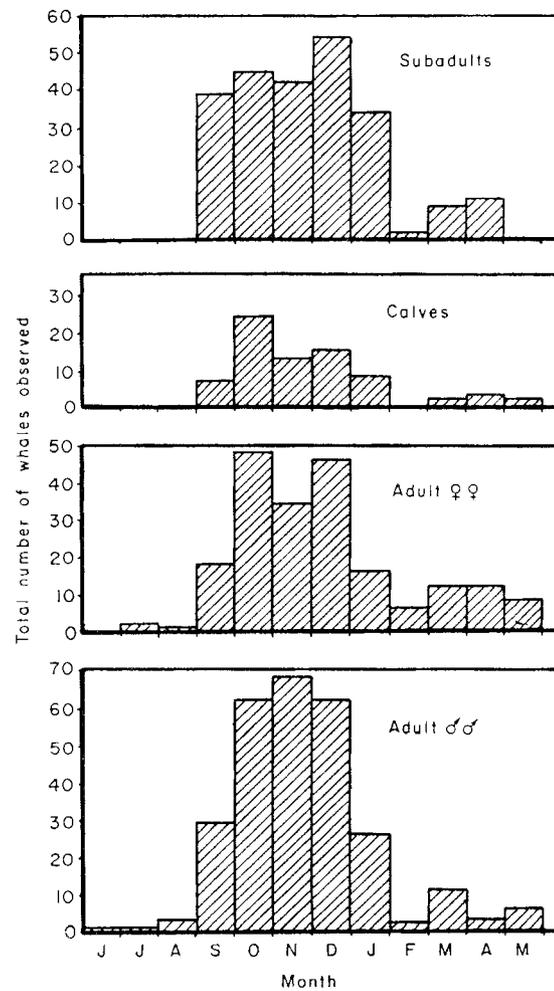


FIG. 5. Total number of Killer whales counted from October 1973 to November 1976 according to age classes and sex.

or remaining on the surface in one place for a few minutes. It appears that they hunt offshore as well as close inshore. On other occasions a group of five and another of 10 Killer whales were seen to have cornered a bull elephant seal against the coastal cliffs, in deep water and where retreat onto land was not possible. Although the seal was almost surrounded the whales never approached closer than a metre. After about 40 min, in both cases, they moved on without ever having been in visible contact with the seal. Voisin (1972, 1976) describes hunting and patrolling as separate behavioural patterns which we consider to be synonymous.

Attacking

Three unsuccessful attacks were observed from beginning to end. Four Killer whales in the first instance and three in the second were seen moving fast on the surface towards the

TABLE II
Diurnal pattern of Killer whale observations at Marion Island between October 1973 and September 1976

Period	Observations		Period	Observations	
	<i>n</i>	*% of total		<i>n</i>	*% of total
08.00–09.00 hrs	19	5.5	13.00–14.00 hrs	32	9.3
09.00–10.00 hrs	12	3.5	14.00–15.00 hrs	33	9.5
10.00–11.00 hrs	15	4.3	15.00–16.00 hrs	51	14.8
11.00–12.00 hrs	32	9.3	16.00–17.00 hrs	48	13.9
12.00–13.00 hrs	21	6.1	17.00–18.00 hrs	34	9.8

* % calculated from a total of 345 logged observations, 48 of which occurred between 18.00 and 08.00 hrs.

corner of beaches. One attack led to nothing unusual and the whales turned and moved on, an adult female elephant seal lying in the surf apparently being the intended victim. It only became aware of the attackers when they were some 5 metres away and rushed up the beach. Since the attackers were on the surface and the seal was only intermittently submerged, it probably detected the Killer whales visually. In the second attack seen at another beach, one of the attackers (an adult female with a calf) came so close inshore that it was temporarily stranded in less than 1.5 m of water. A swell was running at the time and a large wave breaking over the stranded Killer whale gave what assistance was required, and they all departed. In this case a 2-month-old elephant seal appeared to have been the intended prey, and it also rushed up the beach. As the seal had not been seen before the attack, we are unable to draw conclusions as to how far offshore it had been or how it detected the attackers. The third attack, watched at Ship's Cove from atop 50 m cliffs was preceded and followed by events seen only once. While still some 200 m offshore one of a group of six Killer whales raised its head about a metre out of the water and seemed to look at the beach. Immediately on submerging all six swam at high speed underwater towards the centre of the beach, where a number of weaned elephant seal pups were lying in the surf. About 50 m from the shore the whales surfaced and remained on the surface thereafter. When some 20 m offshore, about as close inshore as the shallow water allowed, a bull elephant seal from a nearby harem charged roaring into the surf, stopped some 10 m out, raised itself high out of the water and continued roaring. At no stage did it show any fear of the Killer whales, which eventually turned and departed. The Killer whales could not have reached the pups or the bull, so their departure was not necessarily due to the challenge. This challenge was similar to the response elicited from a territorial bull when challengers approach the fringes of a harem. From this observation it would appear that visual examination of the beaches is at least one of the prey detector systems.

Feeding

Killer whales at Marion have been seen feeding on elephant seals as well as King penguins and Rockhopper penguins. On two occasions they were seen eating elephant seals, one being a 4-month-old yearling and the other an adult female.

Penguins, especially King penguins possibly comprise a large proportion of the Killer whale's diet. We have seen a group of three Killer whales completely dispose of a flock of

approximately 20 King penguins, while other fieldworkers on Marion have often reported such observations to us. However Voisin (1972, 1976) states that at the Crozet Islands penguins do not appear to be eaten by Killer whales. It is likely that smaller species such as the Rockhopper and Macaroni penguins at Marion Island are too agile in the water to be of major importance as prey. King penguins appear to be swallowed whole judging by the absence of feathers or skins in the vicinity of a kill. Rice (1968) noted that yearling Steller sea lions (*Eumetopias jubatus*) were also swallowed whole, indicating that small prey is not fragmented before ingestion.

Resting

On a number of occasions groups of up to 10 Killer whales were observed in sheltered coves, one group remaining in the same cove for over three hours. Members of a resting group moved slowly about the cove in all directions, sometimes on the surface and at other times totally submerged (Plate II(b)). Some were seen lying on the surface belly up, others doing the same on the bottom, possibly rubbing themselves on the rocky sea bed. On occasions individuals made brief contact with each other and a calf was seen suckling from its mother, who was lying belly up on the surface. Some, lying motionless and partially submerged, allowed themselves to be pushed back and forth by the swell.

Voisin (1972) recorded similar aimless behaviour in sheltered areas off Possession Island in the Crozet group. Unlike his observations we did not see any whales bringing up mouthfulls of *Macrocystis* from the bottom, nor did we see the sounding behaviour he describes (Voisin, 1976).

Some coves appeared to be more favoured than others. The more protected from the open sea the coves were, the more favoured they appeared to be. Voisin (1972) also noted this at Possession Island.

Distance offshore

Over the entire study period 34.0% of the Killer whales observed were in zone 1, 27.6% in zone 2, 24.5% in zone 3 and 13.9% in zone 4. At Marion Island, elephant seals and penguins together undoubtedly comprise a large proportion of the Killer whales' diet and in comparison to other oceanic areas these resources occur in summer in highest density at the land-ocean boundary. It is not surprising then that Killer whale activity is greater in this region than farther out to sea.

Body measurements

On the 22 October 1976 a young male was found on the beach at Ship's Cove (Plate III). Various measurements were made (Table III) according to the standardized methods suggested by Norris (1961). The cause of death is unknown, but since the bottom gradient in this cove is gently sloping and shallow, and the lungs and nasal passage of the Killer whale contained sand, stranding is a possibility. The specimen was in good condition and relatively fresh when found. However an opening at the umbilicus had been made from which Giant petrels (*Macronectes giganteus*) had scavenged some of the internal organs. Sheathbills (*Chionis minor*) were probably responsible for the removal of the eyes.

No external parasites were found, and the nasal passage, intestine (what remained of it), blubber and stomach were free of internal parasites and the stomach was empty. The



PLATE II. (a) Hunting Killer whales patrolling the coast. (b) A group of Killer whales resting in a sheltered cove.

TABLE III

Measurements from a young male Killer whale found at Ship's Cove, Marion Island on 22 October 1976

Description of measurement	Length (cm)
Total length *(1)	381.0
Tip of upper jaw to centre of eye (2)	44.5
Length of gape (4)	40.0
Centre of eye to angle of gape (7)	8.5
Centre of eye to centre of blowhole (8)	25.5
Tip of upper jaw to blowhole along midline (9)	54.0
Tip of upper jaw to anterior insertion of flipper (10)	84.5
Tip of upper jaw to tip of dorsal fin (11)	210.0
Tip of upper jaw to midpoint of umbilicus (12)	180.0
Tip of upper jaw to midpoint of genital apperture (13)	240.0
Tip of upper jaw to centre of anus (14)	280.0
Thickness of blubber: mid-dorsal (17)	8.9
mid-lateral (18)	5.2
mid-ventral (19)	5.9
Maximum girth at 162.0 cm posterior to tip of upper jaw (22)	220.0
Dimensions of eye (24): height	1.5
length	4.5
Length of genital slit (26)	38.5
Length of anal opening (26)	6.0
Blowhole: (27) width	10.0
length	4.5
Flipper length: anterior insertion to tip (29)	56.0
(left hand side) axilla to tip (30)	40.5
Maximum flipper width (31)	25.5
Dorsal fin: height (32)	30.0
length of base (33)	51.0
Width of flukes (34)	92.0
Nearest point on anterior border of flukes to notch (35)	28.7
Depth of notch between flukes (36)	3.0

* Numbers in brackets refer to measurement numbers given by Norris (1961).

entire skin was superficially scratched and cracked (see Plate III), possibly the result of the combined effects of sunshine and dehydration.

Jonsgård & Lyshoel (1970) consider that at birth Killer whales are approximately 2.1 m (7 feet) in length, and that males seldom exceed 9.1 m (30 feet). This specimen (3.8 m) was only 41.8% the length of adult males, and is therefore a relatively young animal.

Interspecific associations

Killer whales, whether hunting, resting or feeding, were usually accompanied by Giant petrels, Dominican gulls (*Larus dominicanus*), and often Skuas (*Stercorarius skua*).

On a few occasions a whitish cloud in the water, presumably excreta, emanated from passing Killer whales. There did not appear to be any large solid matter in the cloud, but it attracted the attention of accompanying gulls which landed at the spot.



PLATE III. A young male found stranded on the beach at Ship's Cove.

Voisin (1972, 1976) noted that King penguins, Dominican gulls and albatrosses in general showed little fear of Killer whales, except when lying directly in their path, in which case they moved away but appeared to follow the movements of the Killer whales, and our observations support this. However if attacked penguins scattered, porpoising out of the water along a zig-zag course.

Summary

At Marion Island Killer whales occur seasonally, and this pattern appears to be closely related to the seasonality of elephant seals. However as penguins are also eaten by these predators, their occurrence is likely to be influenced by the seasonal presence of penguins. Killer whales are most abundant from October to December. Numbers increase in August and September, and decline in January and February. There is an increase in March followed by a steady decline to zero in June.

The largest herds, of up to 25 individuals, occur in October (mean 4.8 ± 4.31). In the same month group size is also largest, comprising up to 11 individuals (mean 3.5 ± 1.99). The most frequent herd size is two per herd, followed by herds of over five, and the most frequent group size is also two per group. Over a third of the females (36.3%) were accompanied by calves, and there were significantly more adult males than adult females.

Sheltered coves are used for resting, some more favoured than others. There is an increase in hunting activity between 15.00 and 17.00 hrs, and most hunting takes place within 100 m of the shore. Visual examination of the beaches is at least one of the prey detector systems, and co-ordination of the attack indicates a good system of communication between the members of a hunting group.

Predation by Killer whales is probably an important factor in elephant seal mortality, especially in the case of the juveniles at Marion Island.

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