

PREDATORY INTERACTIONS BETWEEN ANTARCTIC FUR SEALS, MACARONI PENGUINS AND GIANT PETRELS

By W. N. BONNER and S. HUNTER

ABSTRACT. Sub-adult Antarctic fur seals *Arctocephalus gazella* were observed catching macaroni penguins *Eudyptes chrysolophus* off a colony at Bird Island, South Georgia. Many of the birds caught were not eaten by the seals but were torn to pieces and devoured by giant petrels *Macronectes* spp. Penguins form more than half of the diet of both species of giant petrel chicks, and greater availability of such food may have contributed to an expansion in the population of giant petrels.

SEVERAL species of *Arctocephalus* fur seals have been recorded feeding on sea birds, penguins in particular (Cooper, 1974; Shaughnessy, 1978; Bonner, 1981). Penguins are said to form a significant part of the diet of the New Zealand *Arctocephalus forsteri* (Street, 1964; Csordas and Ingham, 1965). The first record of penguins being taken by the Antarctic fur seal, *A. gazella* (then described as *A. tropicalis gazella*) was when Bonner (1968) found penguin rectrices in the stomach of an adult bull collected on the breeding grounds at Bird Island, ten weeks before the start of the breeding season. Since then the fur seal stock on South Georgia has continued to increase dramatically (Payne, 1977) and presumably interactions between fur seals and penguins have become more frequent.

The importance of penguins in the diet of giant petrels *Macronectes* spp. is well documented (Warham, 1962; Mougín, 1968; Voisin, 1968; Conroy, 1972; Johnstone, 1977) and at Bird Island, South Georgia, penguins form about half of the food, by weight, that is fed to the chicks of both southern giant petrels *Macronectes giganteus* and northern giant petrels *M. halli* (Hunter, in prep.). However, most penguins must be taken at sea as very few healthy birds are killed on land (Conroy, 1972; Johnstone, 1977; S. Hunter, personal observations). Giant petrels are poorly adapted for catching adult penguins at sea and we suggest that most of the food comes from penguins killed or injured by fur seals.

METHODS

Observations were made on five occasions during December 1980 and January 1981 at a macaroni penguin colony on the west side of Bird Island, South Georgia (lat. 54°00'S, long. 38°02'W) and on 30 December 1980 from a ship at sea off Bird Island. The colony, which numbers 63 000–93 000 breeding pairs (Croxford and Prince, 1979) as well as several tens of thousands of non-breeding birds, is situated on the north side of a steep-sided narrow creek (Payne Creek) some 500 m long by 150 m across at the mouth. Penguins come and go on feeding forays in parties of between ten and 100 or more birds, mostly landing or entering the water at one of two places where the rocks slope less steeply into the sea. The rocks on either side of the creek are used by Antarctic fur seals, mostly juvenile and sub-adult males, for basking. Watch was kept either from the cliff at the head of the creek, or from near one of the penguin landing places, using 8 × 30 binoculars when necessary. Ship-borne observations were made from about one to one and a half kilometres offshore in the vicinity of the rookery.

During the periods of observation from shore the number of penguins killed, the number of active Antarctic fur seals and the composition of the giant petrel groups were noted. All cases where penguins were seen to die after an encounter with a fur seal are referred to as 'kills', though rarely was it certain that the birds were killed outright by the seals (and in some cases it was certain that this was not so). Seal scats and regurgitations, on tussock grassland behind the fur seal breeding beaches, were examined for evidence of feeding on penguins. Penguin feathers were readily recognizable when they occurred in scats.

RESULTS

Observations on seals and penguins at Payne Creek

The number and rate of penguin kills made by fur seals during the five observation periods are shown in Table I. Kills occurred at intervals of up to 68 minutes, ($\bar{x} = 20.72 \pm 15.97$, $n = 25$). On three occasions two seals made kills at the same time. The mean rate of kills was 2.44 ± 1.56 per hour. When more than one seal was involved it was not normally possible to identify which animal actually made a kill. Only sub-adult animals were involved, and on a number of occasions all catching activities were suspended as the seals engaged in mutual chasing and play activities with other immature seals.

TABLE I. NUMBER AND RATE OF PENGUIN KILLS MADE BY FUR SEALS

Date	Period of observations (GMT)	Total no. of kills	No. of kills per hour	Fur seals involved
16 Dec 1980	13.20-15.20	10	5.00	Two sub-adults
18 Dec 1980	11.15-15.00	9	2.40	Two/three sub-adults
18 Dec 1980	15.45-17.00	1	0.80	One sub-adult
27 Dec 1980	12.45-15.00	5	2.22	Three/five sub-adults
16 Jan 1981	15.15-17.30	4	1.78	Two or three sub-adults

Typically the pattern of a seal/penguin interaction was that a sub-adult male fur seal (probably in the age range 3-6 yr, though it is hard to estimate the age of seals in the water) cruising along the side of the creek adjacent to the penguin landing rocks would intercept a group of penguins coming in to land. The precise position of the interception was difficult to locate, but it seemed most often to occur near the landing place. However, evasive action by a group of penguins was frequently seen in the middle of the mouth of the creek. This may have been associated with the presence of a seal, but this could not be confirmed. The first positive sign of an interaction was usually when the seal's head emerged from the water, holding a penguin in its mouth. Penguins were seen to be held by the leg, the tail, the lower part of the back, and the flipper. Wounded birds on shore were seen to have gashes on the lower part of the belly as well as the other places mentioned. While holding the penguin up, the seal would thrash its head from side to side. Often the penguin would come free from the seal's grip, either because it had been released or because an area of skin and blubber had torn out. One penguin was seen to escape from a seal with three large chunks of skin removed from its back. It porpoised some 75 m across the creek, pursued by the seal (which did not seem to be swimming at its full speed) before it was caught again and finally dispatched. Commonly a seal would recapture a penguin it had cast aside, and shake it again, repeating the action while the bird showed signs of life. On one occasion a penguin was flung away and lay floating belly-down in the water moving its head feebly from side to side, but otherwise motionless. The seal ignored the bird and swam away. The presence of wounded penguins on the rocks indicated that from time to time penguins managed to evade seals which had seized them, though it was unlikely that the wounded penguins seen would survive.

On many occasions the seals did not eat any of the penguins they caught, though of course mouthfuls of skin and blubber might have been swallowed unobserved. However, feeding activity was very variable and on 18 December major portions of seven animals were eaten, with one seal in particular eating most of its prey.

Observations on giant petrels

Between 75 and 180 giant petrels were present in the creek throughout the observation periods, although as there was a regular turnover of birds, many more individuals were involved. At Bird Island *M. halli* is the more common breeding species outnumbering *M. giganteus* by two

to one (Hunter, in press). During December, when *M. halli* have small chicks, this species made up 80–90% of the birds present. However, on 16 January, by which time most *M. giganteus* chicks are hatched, only 58% of the giant petrels present in the creek were *M. halli*. Although exact counts were difficult to make, about 30–40% of the giant petrels were females and at least 50% were breeding birds, identified by paint marks applied during censuses and by the stage of their wing moult (Hunter, in press).

Giant petrels very rapidly collected around any fur seal pursuing or holding a penguin. They fed on pieces of flesh or skin torn loose by the fur seal. Occasionally they were also seen to try to pull a penguin away from a seal. At no time were seals seen to attack these birds, but one seal, that had been feeding on a corpse, actively prevented birds from trying to tear at the flesh by lunging at them repeatedly. Any injured penguin that escaped from a seal was chased and attacked by the surrounding giant petrels and a number were killed in this way. On two occasions penguins with severe wounds managed to get out on to the landing platform. Each time they were followed out by three or four giant petrels which killed them by ripping at their open wounds.

Small numbers of cape petrels *Daption capense* also attended the kills. These were probably feeding on small pieces of tissue and oil droplets from the penguin carcasses. One kill, seen to take place beyond the mouth of the creek, was also attended by black-browed albatrosses *Diomedea melanophrys* and sub-Antarctic skua *Catharacta lönnerbergi*.

Observations at sea

On 30 December, between 19.50 and 20.30 GMT, observations were made at sea off Bird Island. The weather was calm and foggy. Two kills attended by giant petrels were seen in this time and a group of penguins being followed by a fur seal was noted. A dead penguin (which might have been killed by a fur seal) was seen floating in the water. It is supposed that this had been killed during poorer weather earlier in the day and had not been found by scavenging birds because of fog.

Observations on regurgitations and scats

Sub-adult male fur seals have been observed to regurgitate penguin feathers and skin, and scats containing penguin feathers are occasionally found. It was not possible to devise a sampling method to determine the frequency of scats containing feathers, but the incidence is low. On one occasion a scat was found that contained both penguin feathers and krill exoskeletons. It seemed likely that the seal had fed on both penguin and krill, though the possibility that the krill had been obtained from the penguin's crop cannot be discounted. One scat was found containing feathers from a bird other than a penguin, probably from a large procellariiform.

DISCUSSION

These observations confirm that Antarctic fur seals at Bird Island both kill and eat penguins. The observations relate to macaroni penguins, but other species are likely to be involved and king (*Aptenodytes patagonica*) and gentoo (*Pygoscelis papua*) penguins have been seen bearing wounds probably inflicted by fur seals. Only sub-adult male fur seals have been seen hunting penguins or regurgitating penguin feathers, and the distribution of feather-containing scats makes it likely that these were produced also by sub-adult males (though the opportunities to look for scats on the breeding beaches were very limited). Even within this group of the population the habit seems to be restricted to only a few individuals. None of the other sub-adult male fur seals at Payne Creek showed any interest in the penguins, though it is of course possible that the seals might have started to hunt penguins when they entered the water. However, it is clear that only a very small segment of the fur seal population is engaged in hunting penguins at any one time. The behaviour observed does not conform to ordinary feeding behaviour, as the

seals only sometimes eat the penguins they catch. Additionally, it is significant that penguin hunting was seen to be abandoned in favour of interacting with other seals, either small males or females, when these entered the water.

Bonner (1968) suggested that the occurrence of penguin remains in Antarctic fur seals could be regarded as anomalous behaviour, analogous to the record of the New Zealand sea lion, *Phocarcos hookeri*, feeding on penguins ashore (Gwynn, 1953). Similar behaviour has been noted also in the Australian sea lion, *Neophoca cinerea* (Wood Jones, 1925). Adult bull Antarctic fur seals are adapted, like other polygynous pinnipeds, to spending lengthy periods ashore during the breeding season without feeding (Bartholomew, 1970). From observation of the behaviour of sub-adult males ashore, it seems likely that this adaptation is developed before breeding status is achieved. If this is the case, the penguin catching observed may be an extension of the play activities, such as chasing other seals, worrying pieces of kelp and other floating objects, etc. which are characteristic of this class of seals. It is possible also that the occasional fish remains found in the stomachs and scats of young fur seals (Bonner, 1968) have been acquired in a similar manner, though there is no direct evidence of this.

As the seals do not eat much of the penguins they kill or disable, the chief beneficiaries seem to be the giant petrels. At Bird Island the numbers of breeding *M. halli* have increased dramatically in recent years and this has been associated with increased carrion from the expanding fur seal population (Croxall and Prince, 1980). In addition, for both species, penguins are a major source of food during the chick period. Very few penguins are preyed upon, or even scavenged, at their breeding colonies and it seems likely that seal kills may provide an important supply of food.

Hunter (in prep.) has estimated that well in excess of 10 000 penguins, predominantly adult birds, are fed to giant petrel chicks at Bird Island during January–April. This is a very large number in relation to the Bird Island population of macaroni penguins. However, almost certainly, penguins from colonies on the nearby Willis Islands, with an estimated five million breeding birds (Croxall and Prince, 1979) are killed also. As most of the penguins eaten by giant petrels seem to come from fur seal kills, it is probable that this has become an increasingly important source of food as the fur seal population has built up, and by augmenting the food available to the giant petrel population during the critical chick-rearing period, enhances breeding success and may contribute to the population increase.

ACKNOWLEDGEMENTS

We wish to thank J. P. Croxall and P. A. Prince for comments on the manuscript of this paper.

MS received 23 February 1982; accepted 5 March 1982

REFERENCES

- BARTHOLOMEW, G. A. 1970. A model for the evolution of pinniped polygyny. *Evolution*, **24**, 546–559.
- BONNER, W. N. 1968. The fur seal of South Georgia. *British Antarctic Survey Scientific Reports*, No. 56, 81 pp.
- . 1981. Southern fur seals—*Arctocephalus*. (In RIDGEWAY, S. H. and R. J. HARRISON, eds. *Handbook of Marine Mammals*, 1. *The Walrus, Sea Lions, Fur Seals and Sea Otter*. London, Academic Press, 161–208.)
- CONROY, J. W. H. 1972. Ecological aspects of the biology of the giant petrel *Macronectes giganteus* (Gmelin) in the Maritime Antarctic. *British Antarctic Survey Scientific Reports*, No. 75, 74 pp.
- COOPER, J. 1974. The predators of the Jackass Penguin *Spheniscus demersus*. *Bulletin British Ornithologists' Club*, **94**, 21–24.
- CROXALL, J. P. and P. A. PRINCE. 1979. Antarctic seabird and seal monitoring studies. *Polar Record*, **19**, 573–595.
- and ———. 1980. Food, feeding ecology and ecological segregation of seabirds at South Georgia. *Biological Journal of the Linnean Society*, **14**, 103–131.
- CSORDAS, S. E. and S. E. INGHAM. 1965. The New Zealand fur seal, *Arctocephalus forsteri* (Lesson), at Macquarie Island, 1949–64. *Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.) Wildlife Research*, **10**, 83–89.

- GWYNN, A. M. 1953. Notes on the fur seals at Macquarie Island and Heard Island. *Australian National Antarctic Research Expedition (A.N.A.R.E.) Interim Report*, 4, 16 pp.
- HUNTER, S. (In press). Interspecific breeding in giant petrels at South Georgia. *Emu*.
- JOHNSTONE, G. W. 1977. Comparative feeding ecology of the giant petrels *Macronectes giganteus* (Gmelin) and *M. halli* (Mathews). (In LLANO, G. A., ed. *Adaptations within Antarctic Ecosystems*, Proceedings of the 3rd SCAR Symposium on Antarctic Biology, Washington D.C., 647-668.)
- MOUGIN, J.-L. 1968. Etude écologique de quatre espèces de pétrels antarctiques. *Oiseau*, 38, No. spécial, 1-52.
- PAYNE, M. R. 1977. Growth of a fur seal population. *Philosophical Transactions of the Royal Society of London Series B*, 279, 67-79.
- SHAUGHNESSY, P. D. 1978. Cape fur seals preying on seabirds. *Cormorant*, 5, 31.
- STREET, R. J. 1964. Feeding habits of the New Zealand fur seal, *Arctocephalus forsteri*. *New Zealand Marine Department Fisheries Technical Report*, 9.
- VOISIN, J.-F. 1968. Les pétrels géants (*Macronectes halli* et *M. giganteus*) de l'île de la Possession. *Oiseau*, 38, No. spécial, 95-122.
- WARHAM, J. 1962. The biology of the giant petrel *Macronectes giganteus*. *Auk*, 79, 139-160.
- WOOD JONES, F. 1925. The eared seals of South Australia. *South Australian Museum Record*, 3, 9-16.