Table 1. Breeding cycle of Ross seals.

| Feature | Time | Reference |
|---|---|---|
| Moulting | January/February | Present study and refs 1, 7. |
| Mating peak | After 1 February | Present study |
| Delayed implantation | Not known | |
| Pregnancy rate | 100% in Sept/Oct | 10 |
| | 7 ♀ ♀ > 3 years | |
| | 90% | 12 |
| Parturition peak | First half of November | 1, 12 |
| Birthweight | 16.5 kg (single ♂) | 11 |
| Gestation length | About 9 months | Deduced |
| Suckling | 4 to 6 weeks | Deduced |
| Weaning | Complete about mid-December | Present study |
| Sexual maturity | 3 years | Present study and refs 10,12 |
| Longevity | At least 14 years | Present study |

Since these early surveys our research has been directed at finding out more about age structure of the population, reproductive state and diet in order to define better measures aimed at effective conservation of the species if deemed necessary. We therefore obtained permission to take 40 seals for a preliminary investigation into the life history of the species. The data collected from this study are presently being processed but the following preliminary results can be given here.

About 25% of the seals taken were immature. Maturity often proved difficult to ascertain until the seal was handled but no newly weaned seals were taken. The sex ratio of the mature seals was 1 ♂ : 3 ♀ ♀ and their age varied from 4 to 14 years. Mature females weighed 169 kg and were 2.17 m long (curvilinear), compared with 177 kg and 2.07 m for males.

Only half the stomachs contained food remains, probably because many of the seals taken were moulting and had been on the ice floes for some time. Squid beaks and fish remains are at present awaiting identification. Although it has been suggested that Ross seals may consume squids up to 76 cm long and weighing up to 6.8 kg, no evidence was found of prey of this size. Øritsland[10] found the diet consisted of 22% fish, 64% cephalopeds and 14% other invertebrates. Preliminary analyses of food remains from our seals also indicate that cephalopods predominate but fewer stomachs contained fish remains.

The most important data which can be provided at this stage are those on aspects of the life cycle of the species and these are summarized in Table 1. No pregnant females were taken in January but ovaries from mature females contained large follicles at this stage and one female taken in early February was apparently in oestrus, suggesting that mating occurs after the beginning of February. The earliest reported foetus collected[11] was on 23 September and the latest of the seven collected on 29 October. A newborn pup has been observed on 14 November[12] and eight females suckling pups have also been taken between 18 and 21 November,[12] indicating that gestation length is about nine months. Although Wilson[3] observed a female with a pup half her length in January, all other observations we have made indicate that weaning is complete by then.

Our research efforts so far have been dilatory due to the enormity of the logistical problems encountered and the competition for adequate ship's time. A full report on the first phase of the project should be published next year, which will enable a baseline to be drawn from which to launch the second phase.

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# Aspects of the Population Biology of the Southern Elephant Seal, *Mirounga leonina*, at Îles Kerguelen

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Southern elephant seals, *Mirounga leonina*, breed and moult on islands on both sides of the Antarctic Convergence and most of these sub-populations have been the subject of several independent studies over the past three decades. Elephant seals that breed and moult on the coast of the Kerguelen archipelago (49°15′S, 69°30′E) represent a major part of one of the three distinct breeding stocks of this species, with population estimates varying from 100 000 in 1960[1] to 210 000 in 1970.[2] If we assume that they feed predominantly on fish and squid, this population consumes approximately 193 $\times$ $10^3$ ton of fish and 880 $\times$ $10^3$ ton of squid annually,[3] the former figure comparing well with the estimated production of fish on the Kerguelen shelf area.[4]

At Kerguelen most elephant seals breed along the 79 km of the southern and eastern coastlines of the Courbet Peninsula. In 1977 the highest density of cows was recorded on sandy beaches (1 550 $km^{-1}$), followed by pebble beaches (450 $km^{-1}$), vegetated humps (22 $km^{-1}$) and cobble beaches (30 $km^{-1}$).[5] Numerical changes in southern elephant seal populations at various localities have been reported in several papers and factors responsible for these have been a source of speculation.[3,6,7] Carrick and Ingham[8] suggested that the population at Kerguelen had stabilized at its 'natural level' after its recovery following the cessation of intense sealing activities before 1940. The present report, based on information published elsewhere,[2,3,7,9,10] centres on intrinsic factors responsible for numerical changes in the numbers of breeding cows between 1952 and 1979, thereby providing a basis for future research on this population. Adjustments to census figures to facilitate direct comparisons have been discussed elsewhere.[3,7]

The number of cows hauling out to breed on the coast between Point Molloy and Cap Ratmanoff (see Fig. 1 in ref. 7) varied from 19 180 to 36 111 between 1952 and 1979; in spite of fluctuations, the estimated annual rate of increase over this period was less than 1.5%. This rate of change, however, varied from −12.4% per year between 1958 and 1960, to 7.6% annually between 1952 and 1958.

An estimate of the 'coefficient of fluctuation',[11] on which estimates of the 95% confidence limits of the mean population size were based, suggests that until now fluctuations were well within the expected limits. On the assumption that the observed fluctuations probably result from factors (extrinsic and intrinsic) operating to stabilize population numbers, the 'range of fluctuations' observed for areas with different population densities was related to density.[3] The positive, significant ($r = 0.97$; $P < 0.01$; d.f. = 4) and linear relationship between these variables suggests that factors regulating population numbers can be related, at least partly, to density.

After their 1979 survey, Bester and Lenglart[7] concluded that pup mortality (expressed as a percentage of the number of pups alive) was linearly and significantly ($r = 0.94$; $P < 0.001$; d.f. = 6) related to cow density. Pup mortality, however, also increased linearly with an increase in the density of bulls around a harem ($r = 0.96$; $P < 0.001$; d.f. = 6).[7] Le Boeuf and Briggs,[12] who worked on the northern elephant seal *M. angustirostris,* showed that although separation between cow and pup (a key event leading to the death of pups) occurs more readily in large harems, the density of cows per harem is not affected by the number of cows per harem. Since trampling by bulls is the main source of injury to pups,[12] Bester and Lenglart[7] concluded that the linear relationship between pup mortality and the density of bulls implies that the density of cows is not important in pup deaths.

Changes in the numbers of cows greatly affect harem structures. It has been observed[3,5] that a slight increase in the density of cows on densely inhabited coastlines resulted in a large increase in harem size and a decrease in the number of harems. On moderately occupied coastlines large increases in the density of cows did not affect harem size. If pup mortality, or pup growth affecting the time taken to reach physical maturity,[13] or any other factor which may affect survival or production, is positively related to harem size, changes in the latter as a reult of variations in the numbers of cows may in turn affect population size.

It is therefore suggested that future research on these seal populations should centre on the relationship(s) between population density, harem structure, survival and conception rates (see ref. 6), and other factors which may vary with density and so help regulate their numbers. It is also important to note that at least three of the sub-populations of southern elephant seals (see ref. 1) have, since 1970, been decreasing at rates varying from 4.6% to 8.0% per year.[6] The factors responsible for these trends have received some attention[3,6,7] but should be pursued further.

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# Rationale and Strategy for a Collaborative Research Programme between SASCAR and TAAF on Pinnipeds Inhabiting South Indian Ocean Islands (The Kerguelen Province)

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The first phase of the cooperative study of elephant seals (*Mirounga leonina*) and fur seals (*Arctocephalus tropicalis* and *A. gazella*) on the Prince Edward, Amsterdam, Crozet and Kerguelen island groups in the South Indian Ocean, between the Mammal Research Institute and Laboratoire de Zoologie began in 1977 and continued until the 1981/82 summer season. Initially, attention was focused on the elephant seal population at Îles Kerguelen. In addition, the elephant seal mark-recapture programme, initiated by TAAF (*Terres Australes et Antarctiques Francaises*) in 1975, was revived and a further 6593 seals were tagged, and 1202 tagged seals older than one year were resighted at least once. The work on Îles Kerguelen, and later fur seal research on Amsterdam Island, were designed primarily to obtain a better understanding of the various elephant and fur seal sub-populations comprising the so-called 'Kerguelen Province' populations. The sub-populations include those at the Kerguelen, Crozet and Prince Edward groups of islands and at Heard, Amsterdam and Saint Paul islands.

A final project report entitled 'The Spatial and Temporal Distribution of Pinnipeds', which included Gough Island, was submitted to SASCAR in February 1983 and was based on the above research, which resulted in 18 scientific publications (listed in the accompanying bibliography), of which eight arose from the collaborative research with TAAF.

**Present situation**

The results of the project to date indicate that the seal populations concerned are undergoing fairly drastic changes in size which can be summarized as follows:

(a) The Kerguelen stock of elephant seals, sub-populations of which occur at Îles Crozet, Îles Kerguelen and the Prince Edward Islands, has a known history of population decrease.

(b) It is suspected that competition with commercial fishing operations (for example at Îles Kerguelen) could be an important factor influencing the decline of this elephant seal sub-population since 1970.

(c) On the other hand, fur seal stocks are on the increase, triggered by the cessation of commercial sealing.