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Reproductive bioenergetics of the antartic fur seal *Arctocephalus gazella*

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During austral summer 1983 – 1984, we had the unusual opportunity to examine the reproductive bioenergetics of the antarctic fur seal during a period when food was scarce. Food scarcity was indicated by an increase in pup mortality, reduced pup masses, and long female foraging trip durations. During austral summer 1984 – 1985, we were able to complete equivalent measurements when prey was abundant as indicated by low pup mortality, high pup growth rates, and female foraging trips of short duration.

Field measurements were completed during the months of December, January, and February 1983 – 1984 and November, December, and January 1984 – 1985 on the fur seal rookery in the immediate vicinity of the British Antarctic Survey base at Bird Island, South Georgia. Logistic support was supplied by the British Antarctic Survey. Specific parameters quantified were milk intake of pups; change in milk composition through time; metabolism and protein catabolism of fasting pups, subadult males, and females; and energy expenditure of lactating females onshore and while foraging.

The rate of milk ingestion by pups was estimated from total body water influx (Ortiz, Le Boeuf, and Costa 1984; Costa and Gentry in press). Milk intake and fasting metabolism were determined in 25 pups each year during the first 2 months of life. Fasting water influx, measured while their mothers were absent, was used to estimate the pups' metabolism (Ortiz, Costa, and Le Boeuf 1978).

The contribution of protein to energy metabolism was determined by the turnover of carbon-14-labeled urea in the pup's blood (Pernia, Hill, and Ortiz 1980). Measurements were made on 16 of the 25 pups studied. Additional measurements of protein catabolism were completed on nine fasting subadult males whose masses ranged from 15 to 40 kilograms. The maintenance metabolism and protein catabolism of eight (four in 1983 – 1984; four in 1984 – 1985) fasting females during the initial perinatal period were also measured.

Food and energy consumption of eight female fur seals foraging at sea was measured during 1983 – 1984. Of these, four were measured twice: once in December and once in January to determine whether there were changes in foraging energetics within a season. Additional measurements were made on 15 females during 1984 – 1985 to quantify foraging energetics during a normal season when food was abundant. These measurements were completed on eight females with male pups and seven females with female pups ranging in size from 25 to 50 kilograms. These data will allow comparisons of differences in foraging energetics as a function of pup sex and body size. Measurements were completed using a combination of tritiated and oxygen-18-labeled water. Tritiated water turnover (HTO) provides an estimate of prey intake (Nagy 1975; Costa and Gentry in press), and the difference in the turnover of tritium and oxygen-18-labeled water measures carbon dioxide production, an index of energy expenditure (Lifson and McClintock 1966; Nagy 1980).

Figure 1. A female antarctic fur seal, nurses her pup, while resting on a tassock mound. (Photo by Daniel Costa.)

The at-sea average daily metabolic rate of eight adult females in 1983 – 1984 was 788 ± 131 sd kilojoules per kilogram per day, 6.6 times the predicted rate for a terrestrial mammal of equal size and nearly equivalent to the 846 ± 60 kilojoules per kilogram per day reported for northern fur seal females foraging during a poor season (Costa and Gentry in press). Food intake estimated from water influx was 20 ± 3.4 percent of their body mass or 1024 ± 174 kilojoules per kilogram of krill per day. The fasting metabolic rate of lactating and fasting female antarctic fur seals was 415 ± 43 kilojoules per kilogram per day, a value similar to the 406 kilojoules per kilogram per day reported for lactating and fasting northern fur seals (Costa and Gentry in press). In addition, the fasting metabolic rate of eight subadult animals ranging in mass from 15.1 to 38.4 kilograms was 569 ± 92 kilojoules per kilogram per day.

Figure 2. Researcher P. Thorson catches a female fur seal using a choker. As can be seen from the photograph, fur seals near the base are accustomed to the activities of the researchers. (Photo by Daniel Costa.)

It has been proposed that there is a body set point that regulates the intensity and duration of a female's foraging bout (Costa et al. 1985; Costa and Gentry in press; Gentry et al. in press). Data reported in the table support this hypothesis. In 1983 – 1984 the rate of mass increase was significantly less than in 1984 – 1985. Females appear to compensate for reduced prey intake and mass gain by increasing the foraging-trip duration until a predefined body-mass set point has been achieved. These observations are also consistent with the response of California sea lions to the severe 1983 El Niño event (Costa et al. 1985).

There was no significant trend in the percentage of fat, water, and protein in 63 milk samples taken over a 2-month period in 1983 – 1984. The mean composition of antarctic fur seal milk was: water 42.4 percent ± 6.8, fat 40.3 percent ± 6.1, and protein 17.4 percent ± 4.1. These data are closer to the values reported for the northern fur seal of 41.5 percent fat, 44.4 percent water, and 14.2 percent protein (Costa and Gentry in press) than values previously reported for a single milk sample of 51.1 percent water, 26.4 percent fat, and 22.4 percent protein for the antarctic fur seal (Bonner 1968). However, this single milk sample falls within the range of compositions observed.

The rate of mass gain, absolute mass change, and time in days between departure and arrival

		Mass increase	
Season	Days	Kilograms	Kilograms per day
1983–1984[a]	10.1 (0.6)[c]	2.53 (0.48)	0.24 (0.04)
1984–1985[b]	5.85 (1.51)	2.36 (0.37)	0.44 (0.07)

[a] For eight females.

[b] For 15 females.

[c] Figures in parenthesis are ± one unit of standard error.

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