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Fostering in a subantarctic fur seal

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Female pinnipeds typically give birth to a single pup although some twins have been reported (Peterson and Reeder 1966 ; Spotte 1982 ; Bester and Kerley 1983 ; Doidge 1987 ; Arnbohm *et al.* 1997). Mother-pup recognition typically takes place immediately after birth presumably in order to maximize the likelihood that a mother would find her pup among the hundreds on dense colonies (Trillmich 1981 ; Roux and Jouventin 1987). This is particularly true for otariids where mothers leave the colony to feed and return to nurse offspring. However, fostering (i.e. mothers nursing non-filial/non-biological pups) is relatively common among pinnipeds, particularly the phocids (Stirling 1975 ; Reiter *et al.* 1981 ; Riedman and Le Bœuf 1982 ; Boness 1990 ; Riedman 1990). Among otariids, the incidence of fostering is reportedly rare (Trillmich 1981 ; Bowen 1991 ; Lunn 1992). Furthermore, to our knowledge, incidence of fostering have never been investigated in terms of maternal input and its consequences for the offspring.

During our monitoring of maternal attendance in subantarctic fur seals *Arctocephalus tropicalis* breeding on Amsterdam Island (37°55'S, 77°30'E), Indian Ocean, we observed a female suckling her biological male pup and a non-filial female pup over a 4-month period. We took this naturally occurring event to examine the incidence of fostering on (1) the maternal attendance pattern and maternal input (the amount of maternal resources received by the pups), and (2) the growth rate and (3) the probability of post-weaning survival of these pups. To do so, we compared basic parameters (e.g. maternal body length, attendance patterns, pup absolute mass gain for each foraging trip cycle, pup growth, and pup mass at weaning), between 67 mothers nursing single pups and the mother nursing two pups. Means for each variable were calculated for each mother-pup pair, and then averaged, to produce a representative value of the standard population. All of these parameters were derived from the analyses of mass changes in pups that were weighed daily during the study period (see Georges and Guinet, in press). Pup absolute mass gain was calculated for each foraging trip cycle, i.e. trip at sea and subsequent attendance period ashore. Pup growth rate was determined by the linear regression of body mass on age, while the probability of post-weaning survival was assessed using weaning mass. Weaning was assumed to occur the last day pups were seen on the study colony at the end of the reproductive season. Statistics were performed using Systat 7.0 (Systat Inc., Evanston, IL, USA), although the small sample size avoided several statistical analyses.

From 2nd May to 6th September 1995, the study mother performed 4 very long foraging trips at sea and 5 short attendance periods ashore compared to mothers nursing one single pup (Table 1). Standard body length was known for 14 mothers (133 ± 7 cm, range [120-146 cm]) whereas the study mother was 120 cm long. For these 14 mother-single pup pairs, a multiple linear model with pup absolute mass gain as the dependent variable and pup sex, maternal standard body length, foraging trip duration, and attendance period duration as independent factors indicated that neither the sex of the pup nor the attendance period duration had a significant contribution to the model ($P = 0.843$, and $P = 0.747$, respectively). After stepwise backward analysis (significant level $P < 0.1$), the final model indicated that pup absolute mass gain (PMG) was positively related to maternal standard body length (MSBL) and to foraging trip duration (FTD): $PMG \text{ (kg)} = -3.1 + 0.046 \text{ MSBL (cm)} + 0.068 \text{ FTD (d)}$, $R^2 = 0.556$, $P = 0.017$, $n = 14$. Thus, a single pup of a female with a standard length of 120 cm that spend on average 29.5 days at sea (as the study mother did) would be predicted to have an absolute mass gain of 4.4 kg. This was similar to the cumulated mass gained by both pups nursed by the study mother (4.4 ± 0.7 kg, $n = 4$, range [3.7–5.4 kg]).

The biological pup grew slowly (28 g/d) and left the colony later (23th October) and lighter than single male pups of the standard population (Table 1). The non-filial female pup did not grow during the whole rearing period (< 1 g/d) while single female pups grew at similar rates to single male pups (Table 1). The non-filial pup was the last tagged pup observed on the colony and left on 4th November with a body mass of 6.0 kg, i.e. later and lighter than single female pups (Table 1).

The non-filial pup was usually displaying a milk thieving behaviour as described by Roux (1986), and was always chased away by lactating females except the study mother. When the non-filial pup was suckling successfully, it was always suckling on the study mother, either alone, or with the mother's biological pup. Even when suckling alone, the non-filial pup was never chased away by the study mother while she was usually looking at and smelling it. This is the first record of fostering in the subantarctic fur seal. Furthermore, fostering is usually brief in duration, lasting several minutes

TABLE 1. – Maternal attendance pattern, pup growth rate, weaning date and weaning mass, in the study mother nursing two pups and mothers nursing a single pup. Values are given as mean \pm SD, sample size [range].

	Study mother-pup couple n = 1	Mother with single pup n = 67
Attendance pattern (days)		
Foraging trips	29.5 \pm 1.5, [27-31]	17.8 \pm 5.0, [8.6-30.5]
Attendance periods	2.4 \pm 0.5, [2-3]	3.5 \pm 0.7, [2-5]
Pup growth rate (g/day)		
males	28	¹² 57 \pm 1 , n = 31, [27-79]
females	< 1	52 \pm 1 , n = 33, [32-69] ₈
Weaning date*		
males	23 Oct.	8 Oct. \pm 10, n = 34, [5 Sept.- 2 Oct.] ²³
females	4 Nov.	9 Oct. \pm 7, n = 29, [25 Sept.-23 Oct.]
Weaning mass* (kg)		
males	10.6	16.0 \pm 3.1, n = 34, [6.8-22.0]
females	6.0	14.5 \pm 2.6, n = 29, [7.4-18.9]

* Weaning was defined by the last day pups were seen on the colony.

to several days (Bowen 1991), and it is rare that non-filial pups suckle on the same mother (Lunn 1992), while the observed event concerned the same individuals for several months. Fostering implies that mothers make mistakes in recognition (Lunn 1992). Although not known, the observed fostering may be a function of maternal inexperience, as the study female was probably young based on her overall body length (Payne 1979 ; Trites and Bigg 1996).

One might expect that, when nursing two pups, mothers would increase their foraging effort in response to extra demands, if they are able to do so (Clutton Brock 1991). The study mother showed very long foraging trips and short attendance periods compared to the standard population, but these values were within the ranges observed in mothers nursing a single pup. Unfortunately, attendance pattern was not monitored in the study mother before fostering began (i.e. before April), so that we are not able to determine whether any change in attendance pattern occurred related to fostering. Doidge (1987) showed that two Antarctic fur seals *A. gazella* nursing twins did not modify their attendance pattern compared to those rearing a single pup. Interestingly, the com-

lated mass gained by both pups did not differ to what was predicted for a single pup of a mother with the same traits (body length, foraging trip duration) as the study mother. Thus, although one might expect extra-demands when fostering occurs (rearing two pups may increase total offspring requirements), the study mother did not appear to increase maternal input compared to mothers nursing a single pup. However, by nursing two pups, maternal input by the study mother may have increased compared to that before fostering occurred, but to a level that was similar to that of mothers nursing a single pup. This suggests that fur seal females may normally care for their single pup near their metabolic maximum with respect to provisioning of maternal resources as it has been reported for Antarctic fur seals (Doidge 1987 ; Costa *et al.* 1989) and elephant seals *Mirounga leonina* (Arnbom *et al.* 1997). This is also supported by the rarely reported twins in otariids, and more generally in pinnipeds (Peterson and Reeder 1966). This is finally consistent with life history theory which predicts that adults do not jeopardize their own survival when conditions become severe (Stearns 1976). The growth rate of the legitimate male pup was 50 % of that of single male pups and this pup was weaned later and lighter than single male pups. These results concerning the biological pup are similar to results previously found in natural twins, where pup growth rate and mass at weaning are depleted (Doidge 1987 ; Arnbom *et al.* 1997). However, the non-filial pup left the colony with a body mass of 6.0 kg (i.e. its growth rate was near zero during the whole rearing period) and suggests that milk intake just allowed the pup to survive through the weaning period (i.e. compensate mass loss related to its requirements), but not to grow in mass. According to the assumption that the survival probability of independent offsprings is related to their weaning mass, then one might expect the probability of the legitimate male pup surviving to be lower than single pups. However, given the extremely low mass of the non-filial pup when it left the colony, it is almost certain that it would not survive. In Hawaiiin monk seals *Monachus schauinsland*, fostering does not incur a reproductive cost because it is widely frequent in this species (Boness 1990). However, prolonged milk stealing may have severe consequences in the future reproductive life of the study mother, as fostering is rare in otariids and natural selection has favored uniparity in pinnipeds (Peterson and Reeder 1966).

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