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The suckling period of a Grey seal (*Halichoerus grypus*) while the mother had access to a pool

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Summary

In January 1989 a Grey seal cow gave birth to a female pup at the Harderwijk Marine Mammal Park. Mother and pup were kept in an outdoor suckling area and the mother had free access to a pool. Constant observation of mother and pup provided comparable information on suckling parameters as in 1988 when the mother and her pup were confined to an outdoor suckling area.

In contrast to the 1988 situation the following was found in the present 1989 study:

(1) On average the pup vocalized more often before a suckling session.
(2) Mother and pup spent less time together.
(3) The mother rested less and spent a great deal of time swimming.
(4) On average the suckling sessions were shorter, but the frequency of suckling was similar. This resulted in a shorter total daily suckling time.
(5) The pup did not start to move around in the suckling hollow during the last 3 days before weaning.
(6) The pup grew faster (2.2 kg/day) than in 1988.

These differences were probably caused by the different weather conditions (the suckling period of 1988 was very wet, that of 1989 was completely dry), and by the different degrees of freedom of the mother.

Key words: *Halichoerus*, suckling, reproduction, behaviour.

Introduction

Both in the wild (Davies, 1949; Coulson & Hickling, 1960; Gallacher & Waters, 1964; Summers *et al.*, 1975; Anderson *et al.*, 1979; Baker *et al.*, 1980; Baker, 1984 & 1988) and in zoological parks (Leslie, 1974; Kastelein & Wiepkema, 1988) many Grey seal pups (*Halichoerus grypus*) die soon after birth. To elucidate the factors which determine the chances of survival of the pups, the Harderwijk Marine Mammal Park has launched a long term study programme on the suckling period of Grey seals born at the park.

The first pup studied was a female, born in 1987. Mother and pup were moved to a completely undisturbed indoor quarantine area one hour after birth because the pup had entered the water (Kastelein & Wiepkema, 1988). Research continued in 1988 when another female pup was born, and mother and pup were placed in a specially made outdoor suckling area next to the pool. A fence prevented the animals from leaving this area (Kastelein & Wiepkema, 1990).

In January 1989, another pup was born next to a newly dug suckling area, into which it was placed immediately after delivery. This pup had the same parents, the same sex and was born at the same time of year as the 1988 pup, but this time the mother was free to move in and out of the suckling area, since there was no fence. This study describes the suckling period of this Grey seal pup and discusses the effects of the weather and the mother's liberty on several suckling parameters.

Materials and Methods

Study animals

At the Harderwijk Marine Mammal park there are two adult Grey seals: A male (code: HgZH002); estimated to have been born in 1972, found stranded on the Belgian coast in May 1978, and afterwards sent to Harderwijk, and a female (code: HgZH001); born in September 1973, stranded in Belgium in November 1973 and also sent to Harderwijk. After a gestation period of 343 days (copulation took place on 12 Febuary 1988) their fifth pup (code: HgZH008) was born on 21 January 1989. This report is concerned with the behaviour of the mother and this pup.

Study area

The Grey seals are kept with 4 Harbour seals (*Phoca vitulina*) in an outdoor freshwater pool system with a total surface area of 530 m^2 and a maximum depth of 1.2 m (Fig. 1). This pool can be divided into two pools by means of a fence. In preparation for the

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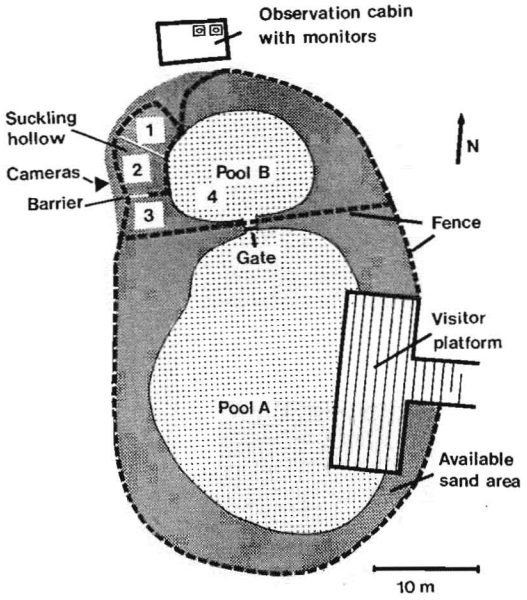

Figure 1. The pool system in which the Grey seals and Harbour seals were kept, which could be divided into two pools by means of a fence and a gate. Note the suckling hollow in the upper left hand corner.

birth of the pup, a sheltered sandy hollow was dug at the side of pool B to serve as a pupping and suckling area. In the previous year a hollow had been dug much farther from the pool (Kastelein & Wiepkema, 1990). Large stones were placed between the hollow and the pool to prevent the pup from entering the water (Fig. 2). On one side a log formed a barrier that could only be negotiated by the mother.

Two television cameras made it possible to watch and listen to the animals constantly when they were in or near the suckling area. With a remote control rotor, the cameras could be aimed at the animals. The area was artificially lit at night. The images could be observed on screens in an observation cabin that was hidden behind the dunes (Fig. 1).

Recording technique

The behaviour of the mother and pup was recorded every 15 minutes between 0800 and 1800 hours, and every hour between 1800 and 0800 hours (maximum score per day: $10 \times 4 + 14 \times 1 = 54$). In addition, each suckling session was monitored in more detail.

The following parameters were recorded:

—Rest or activity.
—Together or separate (a distance of less than 1 m was counted as being together).
—Number of vocalizations (barks) of the pup.
—Nose contact between mother and pup.
—The time of day and duration of each suckling session (i.e. length of time that the pup's mouth was in contact with the nipple).
—Which animal cancelled a suckling session by moving away.
—Position of mother and pup. For this purpose the study area was divided into 4 sections by an imaginary grid (Fig. 1).
—Miscellaneous data (such as rate of moult, etc).
—Four times per day the weather conditions were recorded (air temperature, wind force, wind direction, and occurrence of precipitation).

Throughout the winter the Grey seals were fed 6 days a week, as fasting is probably common in the wild (Kastelein *et al.*, 1990), and when the park is closed it is not necessary to feed them for the benefit of the visitors. On the days when she was fed, the mother was offered a quantity of fish (Herring, *Clupea harengus* and Mackerel, *Scomber scombrus*) once a day. The leftovers were removed later on. This method of feeding barely disturbed the animals and enabled the mother's food consumption to be recorded as usual. The pup was weighed about every 3 days during the suckling period.

All correlations (r) in this study are based on the Spearman rank correlation procedure (Siegel, 1956).

Results

Succession of events

White mucus was visible in the female's vagina 8 days prior to delivery. This mucus was believed to be the cervix plug. It probably had an odour, since the male started to smell and harass the female. Male Grey seals often try to copulate just before a birth and thus before oestrus (Boness & James, 1979; Kastelein & Wiepkema, 1988 & 1990), and it was decided that the female would be under less stress if kept alone. Therefore pools A and B were separated using a gate and fence, and the female was placed in pool B with a Harbour seal. During the last week before birth the trainers noticed the pregnant female breathing louder than usual. This behaviour had been observed before the delivery of her previous pups, and was taken to indicate that birth would soon occur.

On January 21, 1989 the female lay on the sand all day with swollen nipples. The pup was born around 14.45 hrs on the sandy slope between pool B and the suckling area. Like all previous pups, this one was born within seconds. Quick births, without any visible warning sign seem usual in the wild as well (Burton *et al.*, 1975). Within 15 minutes after birth, the pup was carried into the suckling area, and the mother followed. The placenta was delivered 20 minutes after birth. As a barrier to prevent the pup from leaving, a log was placed between the suckling area and the slope towards the pool (Figs 1 & 2). On day 2 a fence was put around the suckling area as an

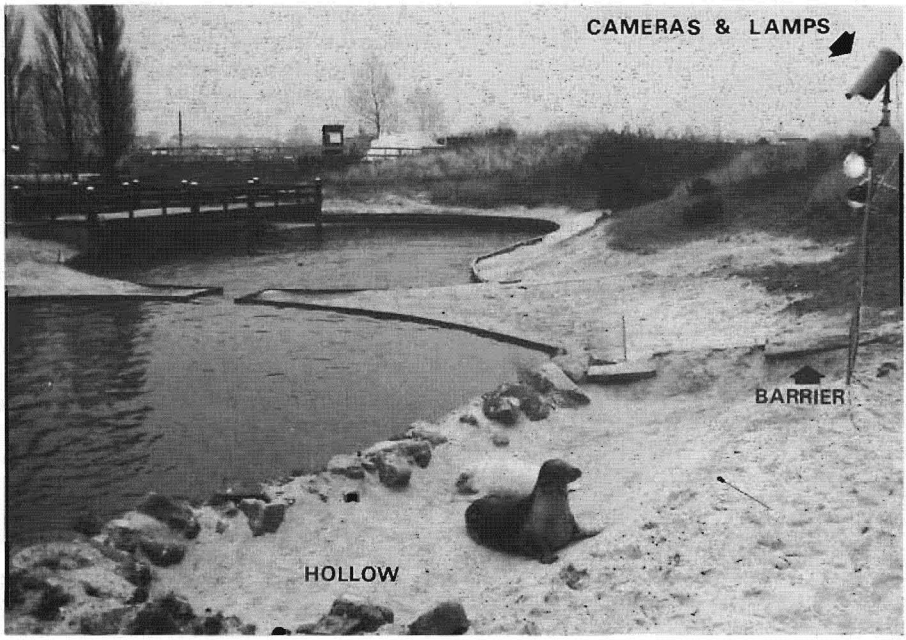

Figure 2. The hollow in which the Grey seal pup was suckled. Note the barrier which could only be negotiated by the mother (Photo: Ron Kastelein).

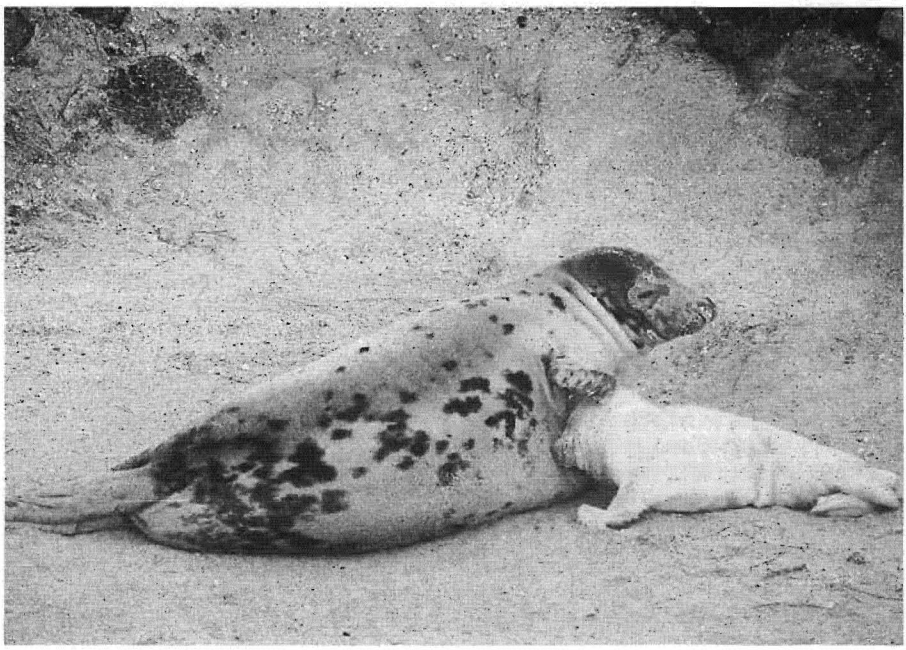

Figure 3. The Grey seal mother and pup during flippering, a behaviour often seen just before and during a suckling session (Photo: Henk Merjenburgh).

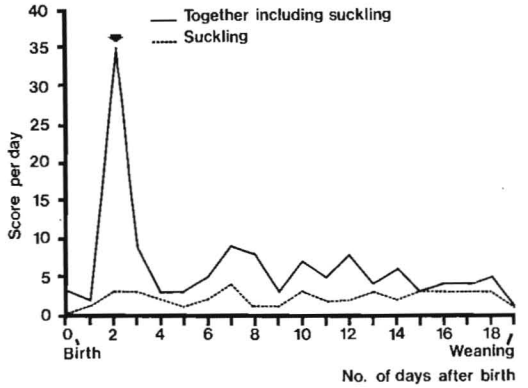

Figure 4. The score of observed occasions per day that mother and pup were found together (including suckling), and the number of observed times a day that suckling was taking place (maximum possible score per day: 54, except for day 1 and 19). The arrow indicates day 2, on which it took the mother 19 hours to find the exit of the hollow.

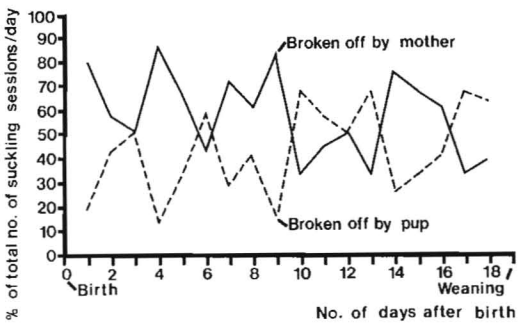

Figure 5. The percentage of suckling sessions broken off by the mother and by the pup during each day of the suckling period.

extra safety measure. It prevented the pup from leaving and only allowed the mother to leave over the barrier. After the fence was put up, the mother stayed in the suckling area for 19 hours before crossing the barrier. The mother came on heat noticeably 17 days later; her labia were swollen, and she became aggressive towards the Harbour seal with which she had had no visible interaction before. On day 19 she stopped suckling her pup and 13 hours later the male was allowed to re-enter pool B. He copulated with the female in the water immediately after the gate was opened.

Suckling ritual

The first suckling session occurred $15\frac{1}{2}$ hours after birth. Throughout the suckling period the suckling ritual was basically the same as described

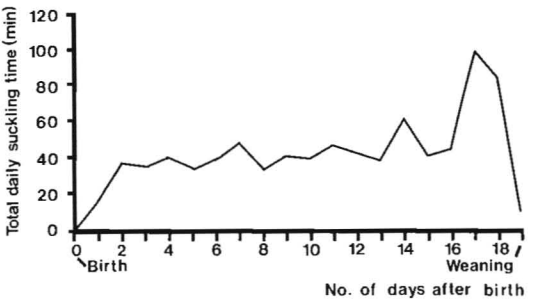

Figure 6. The total suckling time per day during the suckling period.

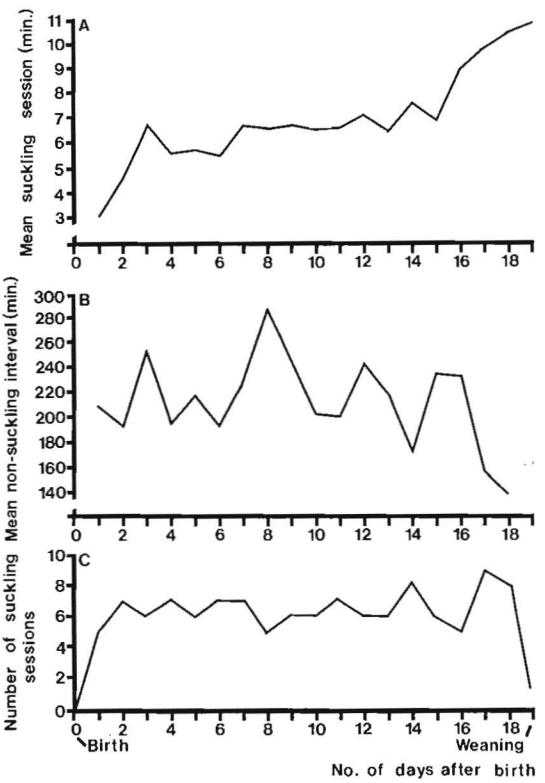

Figure 7. Duration of the mean suckling session per day (A), the mean non-suckling interval (B), and the total number of suckling sessions per day (C).

by Kastelein & Wiepkema (1990), including flippering (Fig. 3). Nose contact between mother and pup was seen near the beginning of each suckling session.

Vocalization

The number of vocalizations preceeding a suckling session was very variable (N = 115, average: 15, range:

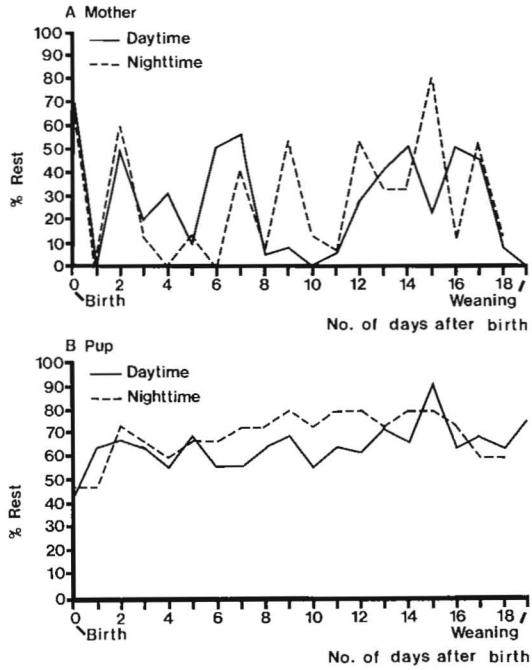

Figure 8. The percentages of scored times spent resting during the day (08.00–18.00 hrs) and during the night (18.00–08.00 hrs) by mother (A) and pup (B).

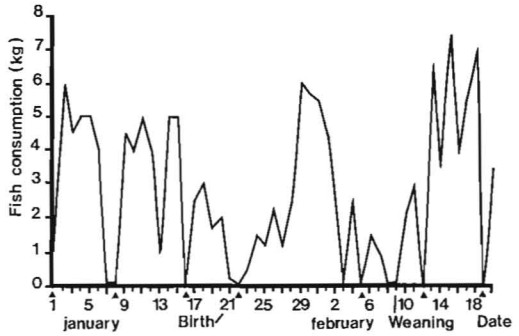

Figure 9. The mother's daily food consumption before, during, and after the suckling period. Triangles indicate days on which no food was offered.

0 to 126), and no consistent trend could be found. In the second half of the suckling period a positive correlation ($r=0.36$, $p=0.005$) existed between the number of vocalizations and the duration of the immediately following suckling session. Over the same period the number of vocalizations per day increased significantly ($r=0.52$, $p=0.0001$), whereas a suggestive decrease was detected over the first half of the suckling period ($r=-0.26$, $p=0.06$).

Encounters between mother and pup

The mother had voluntary access to the suckling area. Over the entire suckling period she was together with the pup for 12% of the times that their behaviour was scored (Fig. 4). The peak on day 2 was caused by the placing of the fence, which prevented the mother from leaving until she had found the way out over the log barrier. Of the 127 scored cases of their being together during the whole suckling period, 43 were while suckling (34%).

Slightly more than half of the suckling sessions (56%) were broken off by the mother (Fig. 5).

Suckling parameters

The total daily suckling time increased slowly throughout the suckling period, except for during two periods of sharp increase just after birth and just before weaning. For most of the period in between, the time spent suckling was around 40 minutes per day (Fig. 6).

The average duration of the suckling sessions each day increased significantly ($r=0.54$, $p=0.0001$) from 3 minutes on day 1 to nearly 11 minutes on day 19 (Fig. 7A). The mean duration of the non-suckling intervals (between successive suckling sessions) was around 210 minutes (Fig. 7B). The duration of these intervals increased during the first half of the suckling period ($r=0.32$, $p=0.02$), and decreased afterwards ($r=-0.30$, $p=0.02$). The number of suckling sessions per day was around 7, and was slightly more variable after day 13.

In the second half of the suckling period a correlation was found between the durations of successive non-suckling intervals ($r=0.33$, $p=0.01$). There was no correlation in the first half. Over the whole period the correlation was $r=0.28$, $p=0.004$. This implies that, especially in the second half of the suckling period, successive runs of intervals were either long or short.

There was no correlation between the duration of a suckling session and the duration of the non-suckling interval before or after the session, except in the first half of the suckling period. Here a positive correlation was found between the duration of a suckling session and the length of the immediately following interval ($r=0.39$, $p=0.003$).

Activity

Although there was a lot of variation between days, the mother rested almost as much during the day as during the night throughout the suckling period (Fig. 8A). The pup spent considerably more time resting than the mother (Fig. 8B). It rested a little more at night than during the day and the percentage of scores spent resting by the pup did not fluctuate as much as that of the mother.

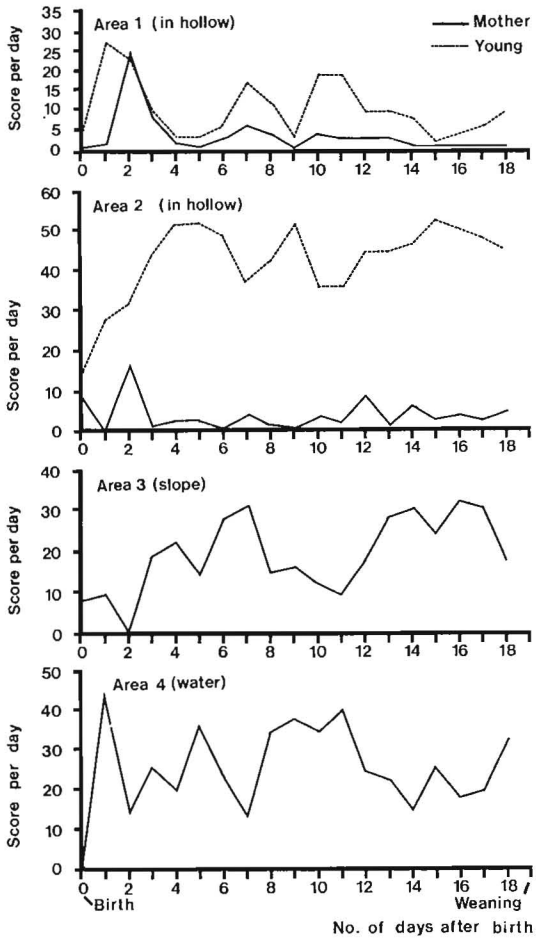

Figure 10. The use of the four parts of the study area (see Fig. 1) by mother and pup (maximum possible score per day: 54, except on day 1 and 19). On day 2 it took the female 19 hours to find the exit of the hollow.

Food consumption of the mother

The mother's food consumption fluctuated strongly before, during and after the suckling period (Fig. 9). In January she consumed on average 2.9 kg per day, but her intake was low for a week before birth and only 0.5 kg on the day of birth. During the suckling period her food intake increased until day 8 (29 January) after which it decreased before weaning (to zero for two days, one of which was her usual scheduled weekly fasting day). It increased strongly after copulation, which occurred on the day of weaning; in March she ate on average 6.3 kg per day.

Use of space

After day 1 the pup spent most of its time in area 2 of the hollow (Fig. 10). The mother spent very little time in the hollow except on day 2 before she had discovered the way out over the barrier. She spent most of her time in the water (area 4) or lying on the slope leading to the hollow (area 3).

Table 1. Weight changes of the pup and the weight of the placenta

Occasion	Days after birth	Weight pup (kg)	Weight placenta (kg)
Birth	0	15	1.6
	3	17	
	6	24	
	10	35	
	13	43	
	17	52	
Weaning	19	—	
	26	48	
Start force-feeding	37	—	
	45	41.3	
Start hand-feeding	49	—	
	60	41.8	
	76	36.8	
To sea	101	—	

Growth and moult of the pup

During the study the weight of the pup changed as shown in Table 1. The pup gained on average 2.2 kg a day during the suckling period. No faeces was observed during the suckling period. After weaning the pup lost weight, but as soon as it had learned to eat fish it started to gain weight again. When the pup was 13 days old it started to moult on its head and paws. Moulting was complete by day 20.

Environment

The average daily temperature was around 4°C (range: 2 to 7°C). The average daily windforce ranged from 1 to 4 Beaufort during the suckling period. There was no precipitation during the entire suckling period.

Events after weaning

In order to monitor the pup's food intake after weaning, it was placed in an indoor quarantine area (described by Kastelein & Wiepkema, 1988). The pup was force-fed from day 37 on, and started to eat fish voluntarily from the hand on day 49 after birth. In April, its first full month on fish, it ate on average 2.6 kg a day.

In order to prevent future inbreeding, the young Grey seal was released on 2 May 1989 (101 days after birth) on the sand bank Engelse Hoek in the Dutch North Sea. Before release it was vaccinated against Phocine Distemper Virus and a tag (no. 2599) was attached to one of the flippers.

Discussion and Conclusions

This discussion focusses on the comparison of data from the present study (the 1989 pup) with those of the suckling period of the pup born in 1988 which spent its suckling period confined with its mother in a different outdoor land area; it will be referred to as the 1988 pup (Kastelein & Wiepkema, 1990). Some references will be made to the 1987 pup and its mother, which were confined to an undisturbed indoor suckling area (Kastelein & Wiepkema, 1988).

Suckling ritual

The mother nosed both the 1988 pup and the 1989 pup before almost every suckling session. Nosing probably serves to identify the pup by smell. In the wild the same behaviour can be seen (Davies, 1949; Fogden, 1968 & 1971; Burton *et al.*, 1975). Fogden (1968) suggested that flippering might be carried out by the mother to direct the pup towards her nipples, but later he observed that the mother also flippers when the pup is in a good feeding position and said that maybe flippering serves as a stimulus for the pup to suck (Fogden, 1971).

The 1989 pup vocalized more before each suckling session than the 1988 pup. This could be a result of the mother spending much of her time swimming outside the hollow, and it might have taken longer for her to get to the pup after it started to call. The vocalizing seems to have at least two functions: it tells the mother that the pup is hungry, and it aids the mother in finding her pup (Davies, 1949). The trainers noticed that the pup stopped vocalizing after weaning, which suggests that this behaviour is evoked under certain circumstances (i.e. with a lactating female in the area) or that it is determined by endogenous factors, and only occurs during the suckling period.

Encounters between mother and pup

The total number of scores that the mother and pup were together was much lower in 1989 than in 1988. This probably resulted from the restrictions on the mother's freedom during the 1988 suckling period, and suggests that when given the opportunity, the mother avoided the pup except during the suckling sessions. She spent a large proportion of her time in the water, swimming or watching the hollow. Maybe this behaviour is an adaptation for safety so that the mother would not accidently crush her pup if suddenly alarmed, or perhaps she preferred the water for thermoregulatory purposes.

Both in 1988 and in 1989 the mother ended most suckling sessions (on average 58% and 56% respectively). This is in contrast with the 1987 indoor situation where the pup ended almost all suckling sessions. This could be due to more disturbances in the outdoor situations.

The number of vocalizations produced before each suckling session increased in the second half of the suckling period, and associated with this, the suckling sessions became longer and correlated with the number of proceeding vocalizations. A larger sample size would be needed to investigate whether the number of vocalizations reflect the degree of need for food.

Suckling parameters

The total suckling time per day was considerably less ($P < 0.001$, Mann-Whitney U-test) in 1989 (median 40 min) than in 1988 (median 101 min). This was linked to on average shorter suckling sessions in 1989, as the number of sessions per day and the length of the suckling period were similar in both years. So, the 1988 pup seemed to need more milk that the 1989 pup. This could be explained by the very wet weather during the 1988 suckling period, which caused the pup's lanugo coat to be wet most of the time. This suggests that to increase their energy intake, Grey seal pups try to keep the same feeding schedule (rhythm), but increase the length of the suckling bouts. Whether they can adhere to their preferred rhythm depends on the behaviour of the mother, which in turn is probably influenced by the environment.

The positive correlation in the first half of the suckling period between the length of a suckling session and that of the immediately following non-suckling interval suggests that milk intake factors determine the suckling pattern in this period. The longer the pup suckled in one bout, the more it may have taken in, and the longer it could last without a feed. This correlation was not found in the second half of the suckling period, which suggests that for some unknown reason non-feeding factors such as disturbances and the mother's behaviour became more important at this stage

The suckling parameters were influenced by external factors such as disturbances in the environment of the mother and pup. Often, when the pup was woken up by a disturbance, this seemed to increase its tendency to call for the mother and to suckle. Also the mother often offered her nipples to the young after a disturbance, such as the weighing of the pup. Environmental influences have also been observed in the field where the pups were disturbed while sleeping, and started to call for the mother. This resulted in shorter than usual non-suckling intervals (Fogden, 1971).

For some unknown reason, the average length of the non-suckling intervals increased during the first half of the suckling period, but this was compensated for by longer suckling sessions, so that the total suckling time remained constant on the days involved (Fig. 6). In the second half the non-suckling intervals became shorter while the duration of the suckling

sessions increased further. These factors led to a significant increase in total suckling time per day during the second half of the suckling period (Fig. 6). In the whole suckling period there were 10% more suckling sessions during the day (between 0800 and 2000 hrs) than during the night. A similar day and night difference was seen with the 1988 pup. This was thought to be due to disturbances during the day caused by weighing, construction, birds, feeding, etc.

Whether suckling time corresponds with milk transfer in a linear way is not clear, so care must be taken when interpreting the data of this report.

Baker (1990) suggests that the milk composition changes during the suckling period in such a way that the percentage of fat is relatively low during the first 3 days (approximately 42%), and higher thereafter (approximately 53%), while the water content falls correspondingly. This could be an effect of the time required to produce hormones such as thyroxine and cortisol (Engelhardt & Ferguson, 1979), which mobilize the fat reserves of the mother. A variation in milk composition may have an effect on the suckling parameters mentioned above. Another indication that food composition may influence the feeding pattern is provided by Spotte & Stake (1982). They fed twin Grey seal pups on a varying diet of formula and whole Herring (*Clupea harengus*). No suckling pattern was evident even when the formula was freely available. The pups grew less than healthy pups fed by their mothers.

Activity

In 1988, when the female's movements were restricted by a fence, she spent much of her time resting. In 1989, when she had access to the pool, she spent a large proportion of her time swimming while actively observing the suckling area. There are at least two possible reasons for the female's desire to leave the suckling hollow when given the opportunity: either she had a natural positive desire to swim, or she felt uncomfortable in the artifical suckling hollow and therefore spent less time ashore than she would have in a suckling hollow of her own choice.

The pup was resting for around 65% of the times that its behaviour was scored in both years. This high score shows a natural need to rest, to save energy for growth. In the wild, on Orkney, the pups were also usually asleep, unless they were hungry or disturbed (Fogden, 1971).

Food consumption of the mother

The mother's food consumption before, during, and after the suckling period in 1989 was very similar to that in 1987 and 1988. This implies that the pattern of food intake is regulated by endogenous parameters as suggested by Kastelein *et al.* (1990). In many areas in the wild, most females remain on land during the entire suckling period. Whether the females that leave the land during the suckling period eat, is not known. They probably eat little or nothing, since their body is set to utilize stored fat by lipolysis, and not to deposit fat (Engelhardt & Ferguson, 1979). At North Rona, Scotland, over 80% of the female's energy reserves are used to feed their pups (Fedak & Anderson, 1982). An endogenously determined reduction in appetite could be an adaptation for the suckling situation in which the females have difficulty in going far to catch fish because they have to stay in the vicinity of the pup. The strong increase in food consumption after copulation is probably necessary to restore the female's condition before the blastocyst which she is carrying is implanted. This occurs between 100 and 160 days after conception (Boyd, 1984).

Use of space

Both the 1988 pup and the 1989 pup only used a small part of the area that was available to them. In the wild on Orkney, pups also only moved a few metres during the whole suckling period (Fogden, 1971). This sedentary behaviour has at least two advantages: firstly, most of the milk's nutritional value can be used for growth, and secondly, it is easier for the mother to find her pup after she has been to sea. The latter advantage is especially important for newborn pups which are probably still difficult for the mother to identify (Burton *et al.*, 1975). In the wild, if the pup does not vocalize, the returning mother goes to the spot where she left her calf and searches around (Davies, 1949). If she cannot find her pup, the bond is broken and the pup may starve. This is a major cause of death in Grey seals (Baker *et al.*, 1980).

In contrast to the 1988 pup, the 1989 pup did not move around more on the last few days before weaning than it did on the previous days. Maybe the 1988 pup was avoiding its mother which became a little aggressive towards the end of the suckling period. In the unrestricted situation in 1989 the mother spent less time with the pup and directed her aggression towards the Harbour seal. The difference in the pup's behaviour could also be due to individual variation in the degree of locomotion, as was observed in one colony by Davies (1949).

In 1989 the mother did not spend much time in the hollow, other than during the suckling sessions. In the wild, the mothers haul-out behaviour depends on pup density, time of day, year, and geographical area (Davies, 1956; Fogden, 1971; Curry-Lindahl, 1970; Boness & James, 1979). The artificial suckling area in 1989 was probably not favoured by the mother, since she did not deliver the pup in it. Maybe the hollow was too deep, and did not provide a good view over the immediate surroundings. This could have made the mother eager to leave.

Growth of the pup

The 1989 pup gained on average 2.2 kg per day through suckling, the 1988 pup 1.3 kg a day. This difference could be due to individual metabolic differences, but was without doubt also due to the different weather conditions. The windforce and temperature did not differ much between the two compared suckling periods, but there was a difference in precipitation; during the 1989 suckling period it did not rain at all, while January and February 1988 were the wettest months of the century. These strongly different weather conditions were not compensated for by the much longer suckling sessions in 1988. The white birth coat (lanugo) lacks an oily texture and is therefore easily waterlogged and flattened. Most of the coat's insulating properties are then lost (Ling & Button, 1975; Blix *et al.*, 1979). Fedak & Anderson (1982), made accurate weather recordings, and found that pups gained on average 1.64 kg/day, while rain fell on 17 of the 27 study days. This growth rate is between that of the 1988 suckling period, in which is rained every day of the suckling period, and that of the completely dry 1989 suckling period. Spotte & Stake (1982) suspected that environmental pressures (such as: substrate, disturbances and weather conditions) are major parameters limiting the growth of Grey seal pups.

At weaning, the sculp weight (= blubber and skin) constitutes on average 50% of the total body weight compared with only 25% 2 days after birth (Mansfield, 1977). Like the pup in the present study, wild Grey seal pups lose weight after weaning until they are efficient at catching fish (Davies, 1949; Amoroso & Mathews, 1951; Coulson & Hickling, 1964). More than 70% of the post-weaning mass loss in Grey seals is in the reduction of blubber (Worthy & Lavigne, 1987). Nordøy & Blix (1985) calculated that around 94% of the energy expended by a pup during the first 4 weeks of the post-weaning fast is derived from subcutaneous fat deposits.

The 1987 pup started to accept fish 45 days after birth. The 1988 pup after 64 days, and the 1989 pup after 49 days. These periods seem to agree with a pup in a zoological park described by Wilson *et al.* (1985) which acepted fish 59 days after birth. How these periods correspond to what occurs in Grey seals in the wild is not known.

Recommendations

Fogden (1971) pointed out the differences in suckling behaviour between disturbed and undisturbed suckling areas, and commented on the influence of the seal density and the topography of the suckling areas. More studies of the present kind under a variety of conditions are needed to determine the proportional impact of weather conditions, the suckling area, disturbances, the pup's and the mother's activity, and individual metabolic variation on growth.

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