Aquatic Mammals 2006, *32*(2), 145-151, DOI 10.1578/AM.32.2.2006.145

Description of the Pregnancies, Labours, and Pre- and Post-Partum Events of Two Harbour Seals *(Phoca vitulina)* in a Zoological Environment

Marie-Anne Blanchet,[1] Genevieve Desportes,[1, 2] Tiffany Nance,[1] and Cecilia Vanman[1]

[1]*Fjord & Bælt, Margrethes Plads 1, 5300 Kerteminde, Denmark*
[2]*GD Natur Stejlestraede 9, Bregnør DK-5300 Kerteminde, Denmark*

Abstract

Harbour seal *(Phoca vitulina)* births occur frequently in captive environments, yet little data have been published on observations associated with these events. We describe the quasi-simultaneous pregnancies and labours of two primiparous harbour seals at the Danish aquarium and research facility, Fjord & Bælt. There were considerable differences between these two females in their behaviour, the duration/frequency of labour contractions, and the postpartum events. One had a difficult labour, with an extended expulsion phase, and delivered a stillborn pup. The other successfully gave birth to a female. The physiological mechanisms regulating the food intake during pregnancy and lactation in harbour seals are unknown; however, observations during this study of both the increases in food intake during pregnancy and the cessation of eating when labour was imminent suggest that there may be similarities with other mammals, such as humans, cows, and minks, in which these processes involve leptin, a hormone involved in metabolism regulation. Whether this is indeed the case for harbour seals is unknown and is a recommendation for future studies as is the recording of birthing processes in captive environments. Such a database on birth may provide comparative indicators of labour progress, speed, and outcome.

Key Words: Harbour seal, *Phoca vitulina*, pregnancy, zoological environment, food intake

Introduction

Harbour seals (*Phoca vitulina)* are widely represented in zoos and aquaria around the world. However, events associated with pregnancy and parturition in such environments are not well documented (Greig, 2002). The species exhibits a seasonal pattern of reproduction with annual and synchronous breeding cycles (Reijnders, 1990). Pupping occurs at approximately the same time every year in a given group and location (Greig, 2002), making it possible to predict the parturition time in multiparous females. It remains difficult to do the same for primiparous females since their cycle is not synchronised yet. Describing the events associated with pregnancy and birth in harbour seals, especially primiparous females, might allow for identifying indicators, which will help predict not only the time, but also the outcome of the parturition. This would be a useful addition to the information gathered through the ultra-sonographic follow-up of the gestation period and very important when such a control is not possible. These observations also may be useful for management considerations in zoological environments, concerning the separation of males and females during or after birth, as males can display aggressive behaviour against newborn pups. The objectives of this study were to describe the development of two pregnancies and labours, report the females' variations in weight and food intake, and identify behaviours that may indicate the imminence of labour.

Materials and Methods

Fjord & Bælt (F & B) is a public, nonprofit marine centre in Denmark dedicated to marine mammal research and the promotion of public awareness about marine-related issues through an aquarium and exhibitions. The F & B harbour seals are kept in an outdoor open sea enclosure with a water surface of 500 m^2 and a water volume of 700 m^3. The enclosure is influenced by natural tide, with an average depth of 3.5 m, and is bordered by a 25-m long underwater tunnel topped with a surface bridge, a public amphitheatre (separated from the pool by a net), and a rock area. A 23.5-m long wooden walkway runs from the pool's entrance to the 12.8-m long rock area and leads to a training platform composed of two ramps, allowing the animals to come out of the water. At the time of the study, four harbour seals, one male and three females, ranging from 4 to 5 y of age, were housed in this pool.

Ultra-sonographic examinations during spring 2004 confirmed the suspected pregnancies of two 5-y-old females, Tulle and Gnejs. Both animals arrived at F & B in 2001 and were captive born. Because neither female had been pregnant before, it was decided to monitor their pregnancies very closely. This involved monthly sonographic examinations (last examination performed on May 15), weekly weight measurements, and the recording of daily food intakes in kilograms and kilocalories. According to the quality of the voluntary sonographic examinations, the general shape of the foetus and the heart activity were observed, but no measurements were taken.

The behaviour of the seals was monitored during working hours by the trainers, and after that, it was recorded automatically with a video camera. From June 15, observations by the staff started after working hours every 2 h for 15 min. When the seals showed signs of being close to the initial stages of parturition (loss of appetite, refusal to come up on platforms during sessions, loss of motivation in training), 24-h observations began from an adjacent building in order not to disturb the animals. The general behaviour and the number and duration of observable contractions of the parturient animals were recorded on a video camera and noted on observation sheets. Events on the days before the birth were designated as B-x, and the days after birth as B+y.

Results

Weight and Food Intake

Tulle and Gnejs showed similar overall weight increases during their pregnancies, which were assumed to have started in August/September 2003 and ended in June 2004 (Figure 1). During this time, weight gain for both females was approximately 30 kg. Tulle's weight gain was gradual throughout the pregnancy, while Gnejs lost weight during the first trimester and then gained weight from December through delivery.

Food intake generally increased during the pregnancy. The diets of mackerel (*Scomber scrombus*), herring (*Clupea harengus*), and sprat (*Sprattus sprattus*) were calculated according to the animals' motivation, weight, and general appetite. The fish was analyzed for protein, fat content, and energy by the methods used in the *Nordic Nutrition Recommendations* (Becker et al., 2004) at the State Laboratory of the Ministry of Food, Agriculture and Fisheries. Both females ate more in January to June 2004 than in January to June 2003 when they were not pregnant. This difference was only significant for Tulle (paired *t*-test: $t = -3{,}122$, $p = 0.03$), however. Food intake reached a maximum in November 2003 for Gnejs (6,855 kcal/d) and in March 2004 for Tulle (4,944 kcal/d). A decrease was observed for both animals from March 2004, which developed into cessation of eating as the females approached delivery (Figures 2 & 3). Tulle stopped eating at B-4 and Gnejs at B-1.

There was a considerable difference between the two females in their post-delivery food intake (Figures 2 & 3). Tulle, who gave birth to a stillborn pup, resumed eating at B+1 and reached her pre-birth diet (3,560 kcal/d) at B+5. At B+5, Gnejs, who gave birth to a live pup, started eating again, but she did not reach her full pre-birth diet (4,399 kcal/d) until B+14. Tulle also remained at her

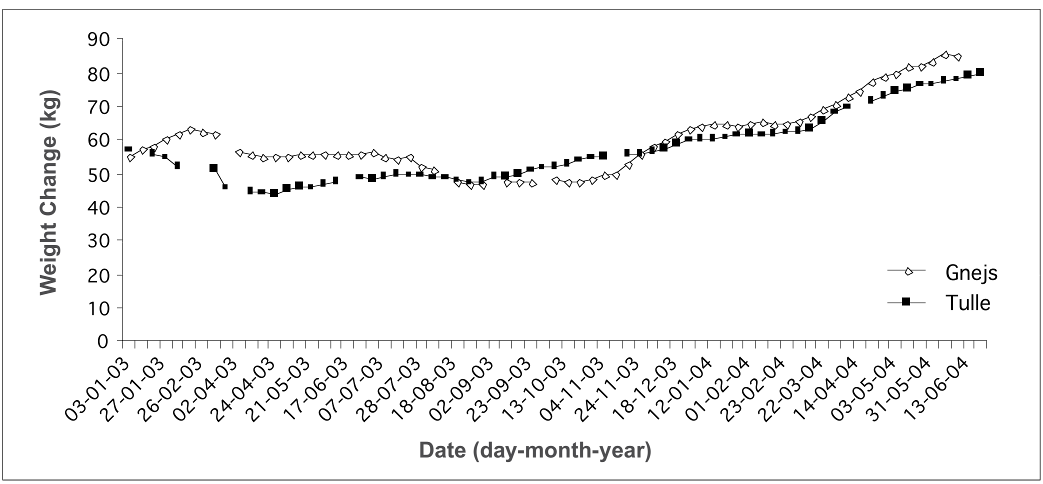

Figure 1. Weight change of the two female harbour seals from January 2003 to June 2004 at F & B; recordings ended 11 June 2004 for Gnejs (birth on 26 June 2004) and 14 June 2004 for Tulle (birth on 19 June 2004). Weights were recorded by voluntary medical behaviours. Hence, some data are missing when the animals refused husbandry behaviour, such as during uncomfortable late phases of pregnancy.

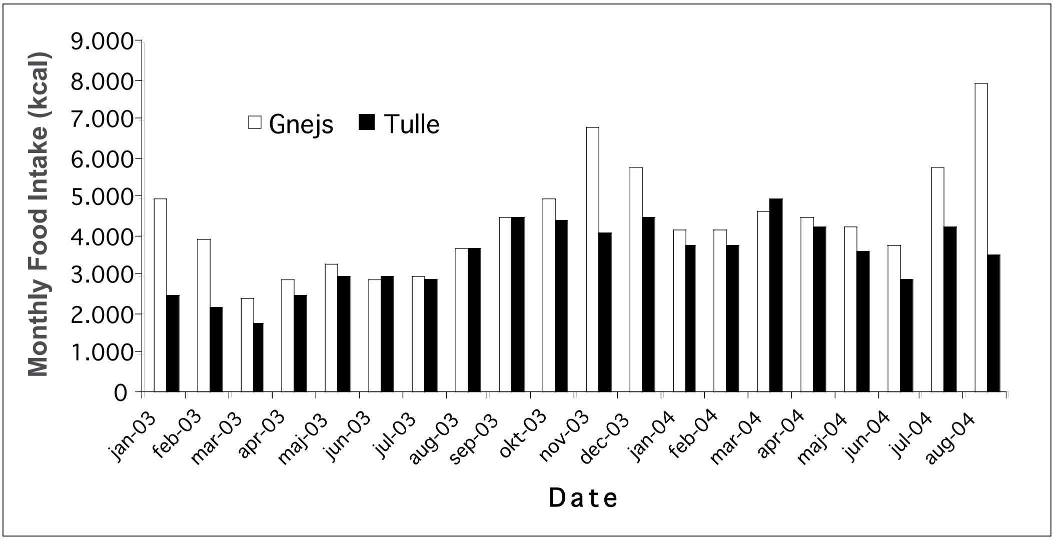

Figure 2. Food intake by the two female harbour seals at F & B from January 2003 to August 2004; the general trend is an increase in food intake during the pregnancies. The estimated start of the pregnancies is September 2003.

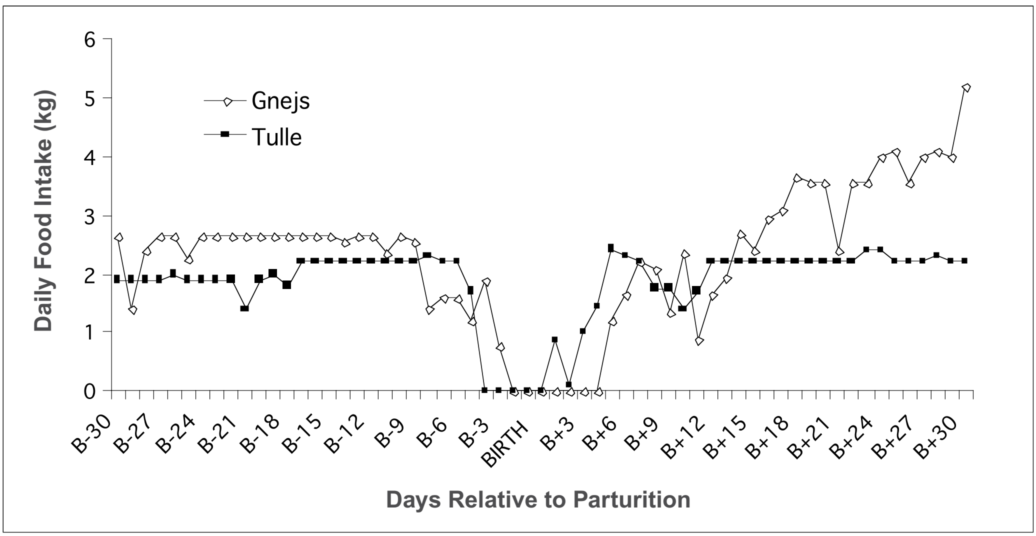

Figure 3. Daily diets for both female harbour seals at F & B 30 days prior and 30 days after the birth; the food intake is recorded in kilograms can be linked to the data presented in Figure 2 recorded in kilocalories.

pre-birth diet throughout September 2004, while Gnejs continued to increase her diet in the 2 mo following the birth, finally reaching 10,161 kcal/d—a 2.3-fold increase. Both animals continued being fed according to their motivation and appetite.

Changes in Behaviour Before Labour

Some anecdotally known, but rarely documented, pregnancy behaviours that are thought to announce labour were observed for both females before the births (Table 1). They included moments when the animals refused to come on land during training sessions, and when the animals' haul-out behaviour at night included frequent shifts in body position during what appeared to be discomfort. Several unusual attempts to haul out during the day began to occur at B-4 in the case of Tulle and at B-1 for Gnejs.

No obvious physical changes were observed for Tulle during this time, while several were observed for Gnejs. Her nipples became visible a month prior to the birth, with milk appearing the day before sporadic contractions were observed at

Table 1. Behavioural observations of two harbour seals recorded prior to birth (B); the time scale is in days.

Tulle (stillbirth)	Days before birth	Gnejs (live birth)
Normal behaviour	B-10	Contractions observed
Normal behaviour	B-6	• Refused to come up on land during training sessions • Poor appetite
Stopped eating	B-5	
Several attempts to haul out during day	B-4	
Seemed uncomfortable on land while hauled out	B-3	
Spent most of time in water, occasionally hauling out to check land area	B-2	• Seemed uncomfortable on land while hauled out at night • Restless • Poor appetite
Spent most of the time in water, occasionally hauling out to check land area; displaying exploratory behavior on land	B-1	• Stopped eating • Several attempts to haul out during day • Milk seen at tip of nipples • Mucus plug expulsed 11 h before birth • Visible vagina opening 10 h before birth
• More restless during night • Observable labour for 4 h 47 min • Stillborn pup expulsed in water	Birth	• Observable labour for 9 h 35 min • Live pup expulsed on land

night on B-10. The expulsion of the mucus plug occurred 11 h prior to the parturition, followed by a visible opening of her vagina an hour later.

Labour and Contraction Observations

The frequency of contractions increased as labour progressed for both animals (Figures 4 & 5). A pause in labour occurred 2 h 30 min after the short labour. During this time, the females stayed mostly in the water, and no contractions were visible when on land. The duration of the pause, however, was different for the two animals: 4 h 25 min for Gnejs and 2 h 5 min for Tulle. During the pause, the amniotic pouch was visible for Tulle, but not for Gnejs. After this break, contractions resumed and were more frequent in both females. Tulle gave birth 30 min after the end of the break in contractions, while Gnejs gave birth 2 h 30 min afterwards.

The overall average duration of contractions was different for the two females (Figures 6 & 7),

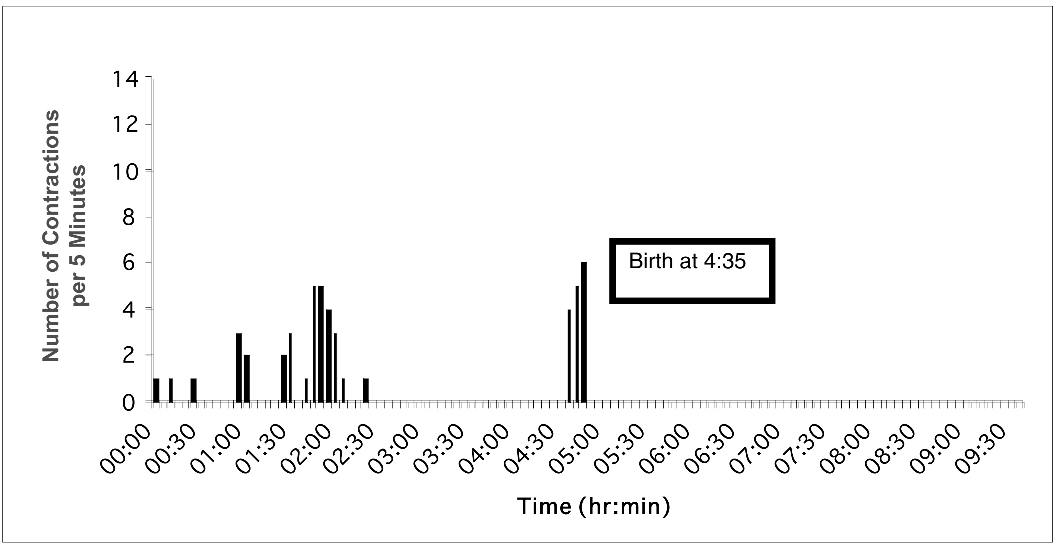

Figure 4. Frequency of observable contractions for Tulle; the x-axis represents the time from the beginning of the labour.

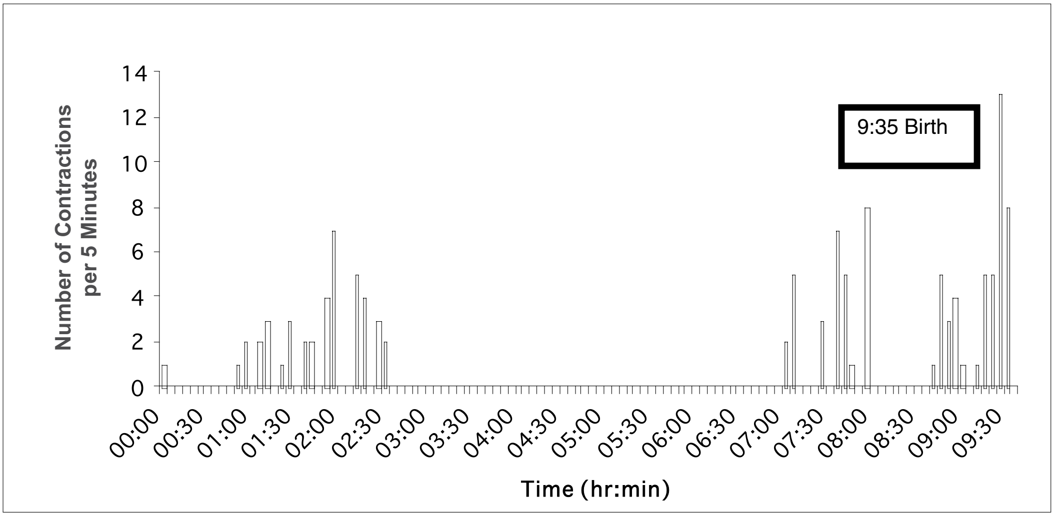

Figure 5. Frequency of observable contractions for Gnejs, a harbour seal at F & B; the x-axis represents the time from the beginning of the labour.

however. Gnejs' contractions increased in length as the labour progressed, while Tulle's remained stable at 10 sec throughout the labour, reaching a sudden peak of 55 sec just before the amniotic pouch became visible.

The expulsion is defined here as the period between the moment the amniotic pouch becomes visible in the vaginal opening and the actual birth when the pup is completely out. The duration of the expulsion phase differed between the two females, from 2 h 20 min for Tulle to just 30 min for Gnejs.

The above-mentioned pause in labour occurred before the expulsion for Gnejs and during the expulsion process for Tulle. Tulle spent 67% of the expulsion time in the water where she gave birth to a stillborn pup after 4 h 47 min of labour. The necropsy showed a perfectly constituted pup (female, length 94 cm, weight 9.4 kg), which had died recently. The lungs did not inflate, and the presence of amniotic fluid in them indicated that the pup suffocated during the expulsion. There were no findings indicative of malformations or infectious causes of death. Gnejs, on the other hand, remained on land during the entire expulsion phase. She gave birth to a live female pup after 9 h 30 min of labour.

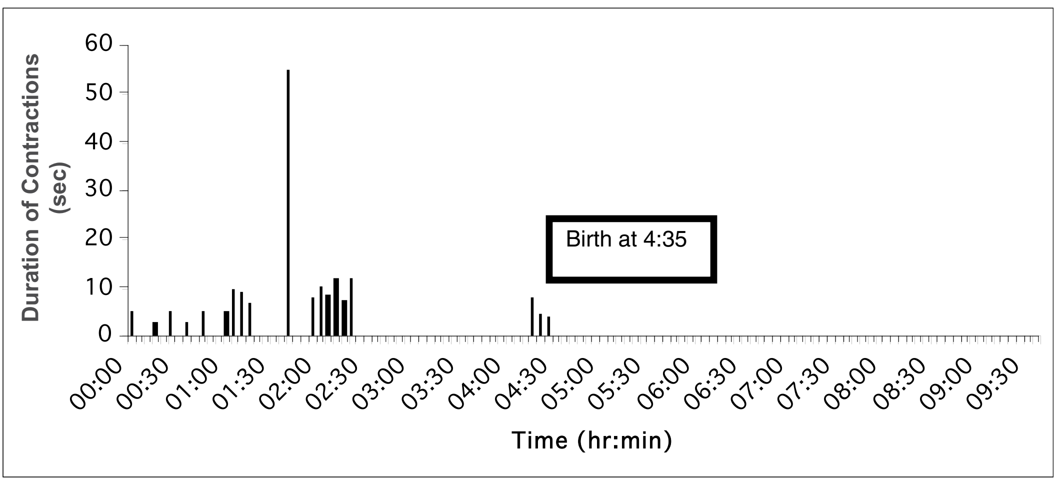

Figure 6. Average duration of contractions in seconds for Tulle, a harbour seal at F & B; the x-axis represents the time from the beginning of the labour.

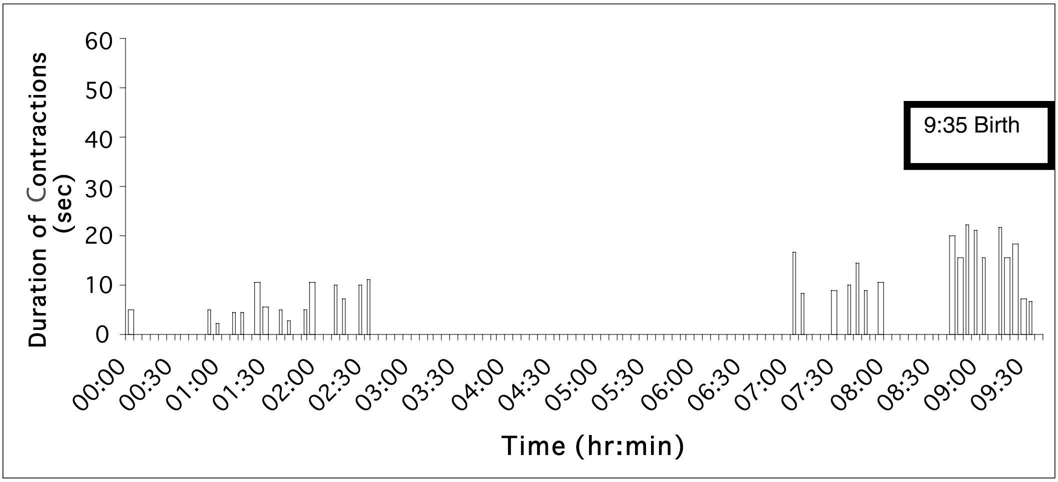

Figure 7. Average duration of contractions in seconds for Gnejs; the x-axis represents the time from the beginning of the labour.

Discussion

Little is known about the factors influencing the actual time of the day births occur for harbour seals (Hutchins et al., 1996). For some species, like the northern elephant seal (*Mirounga angustirostris*), births seems to occur in early morning when light levels are low and disturbances are greatly reduced (Le Boeuf et al., 1972). This was also the time of day when both F & B females gave birth (0600 h and 0700 h).

A wide range of internal and/or external factors acting on the female or on the foetus can lead to a stillbirth. One of the factors is dystocia, a prolonged or difficult labour, usually characterized by some functional defect or physical blockage in the birth canal, which leads to foetal death through suffocation or trauma (Hutchins et al., 1996). Other factors can also lead to dystocia. Difficulty during parturition, such as an inappropriate stop in contractions, may be another factor. While a pause in labour is obligatory in some mammals, cats are one example (Gunn-Moore, 1995), it is not yet known whether this is the case in harbour seals.

The main difference between the F & B females lies in the duration of the expulsion and the timing of the pause, occurring during the expulsion phase for Tulle and before it for Gnejs. Tulle's contractions also were less frequent and shorter than Gnejs'. The pup suffocated in the amniotic pouch, as revealed by the presence of amniotic liquid in the lungs. Since no other causes of death were identified, it is likely that the pup died while in the birth canal because the expulsion, prolonged by the pause, was too long and the contractions too weak. Tulle's behaviour of remaining in the water during the expulsion seems abnormal since harbour seal births usually occur on land (for review, see Riedman, 1990; Bonner, 1999). This behaviour could be linked to her inexperience combined with a difficult birth. Since the pup died when still in the birth canal, however, this behaviour was not the determining factor leading to the stillbirth. These hypotheses are only based on the observation of two pregnancies and could be challenged by additional observations.

Age-specific morphology data collected by Bishop (1967) in harbour seals from Alaska showed that mass and standard length of females increase linearly until 5 y of age and then stabilise. Kastelein et al. (2005) also found that captive harbour seals stop growing between the ages of 4 and 5. Hence, Tulle and Gnejs, both 5 y of age at the time of the study, were therefore considered to be physically mature. Their weight gain of 30 kg each during pregnancy is highly likely to be related to this change in physiological state, while the temporal differences in weight gain between the two females may be due to individual differences in energetic needs.

Female body mass in small phocid species plays a significant role in the survival rate of their offspring (Bowen et al., 2001). The increase of food intake as the mothers' energy intake goes into provisional storage for lactation is essential not only for the growth and development of the foetus but also for the survival of a newborn. Female harbour seals in the wild tend to stay with their pup on the birthing spot instead of foraging. Indeed, separation from the mother has been found to be one of the most common mortality causes for pups (Boness & Bowen, 1992; Bowen et al., 2001). It may be that the behaviour of Gnejs, who did not resume eating until 5 d after the birth, is a captivity variation of the stationary behaviour of mothers remaining near their pups seen in the wild. During this time, her expenditures are covered mainly by a reduction in energy storage and body mass. During late lactation, the high cost of milk production can incur up to a 6-fold food intake increase (Bowen et al., 2001). Similarly, Gnejs, in a captive environment, followed such a pattern, increasing her food intake up to 2.3-fold during late lactation.

In both F & B females, the food intake diminished from the month of March, 3 mo prior to the births. Since the animals were fed according to their motivation towards food and their weight, the availability of food was not the limiting factor. It may be that the increase in water temperature with the onset of spring and summer was partly responsible for a lesser need of blubber insulation and, therefore, a drop in energy intake. It is also possible that this observation could be related to a limitation in the storage capacity of a pregnant harbour seal. Such a phenomenon has been described in cows where food intake is reduced during the last trimester of the pregnancy and particularly so in the last 2 to 3 wks pre-partum (Ingvartsen et al., 1992, 2001).

It is thought that such a reduction is related primarily to a physical limitation of the abdomen (Ingvartsen et al., 1999), but it seems that metabolic signals may play an equally important role. The concentration of plasma leptin, a hormone associated with the adaptations required during periods of energy deficiency first increases during pregnancy then starts to decline 1 to 2 wks before parturition, reaching a nadir at early lactation (Ingvartsen & Boiscalir, 2001). Leptin appears to play a determinant role in the mobilisation of energy storage and the increase of food intake in late lactation (Tauson et al., 2004) and has been shown to decrease food intake and maternal weight gain in human beings (Brann et al., 2002). The possible presence and detection of these mechanisms in harbour seals is a recommendation for future studies, as is the recording of birthing events. Such a database on birth events may provide indicators of labour progress, speed, and outcome.

Acknowledgments

We thank all the people who helped record the data and did the night watches with a lot of dedication: Gary Chu, Michelle Guttman, and Mia Young. We also would like to thank Dr. Ursula Siebert from FTZ (Forschungs und Technologizentrum Westkuste University of Kiel) who performed the necropsy on the stillborn pup.

Literature Cited

Becker, W., Lyhne, N., & Pedersen, A. N. (2004). *Nordic nutrition recommendations: Integration nutrition and physical activity* (4th ed.). Copenhagen: Nordic Council of Ministers.

Bishop, R. H. (1967). *Reproduction, age determination, and behavior of harbor seals,* Phoca vitulina*, in the Gulf of Alaska.* Master's of Science thesis, University of Alaska. 121 pp.

Boness, D. J., & Bowen, W. D. (1992). The evolution of maternal care in pinnipeds. *Bioscience*, *45*, 645-654.

Bonner, N. (1999). *Seals and sea lions of the world.* New York: Sterling Publishing Co.

Bowen, W. D., Iverson, S. J., Boness, D. J., & Oftedal, O. T. (2001). Foraging effort, food intake and lactation performance depend on maternal mass in small phocid seal. *Functional Ecology*, *15*, 325-334.

Brann, D. W., Wade, M. F., Dhandapani, K. M., Mahesh, V. B., & Buchanan, C. D. (2002). Leptin and reproduction. *Steroids*, *67*, 95-104.

Greig, D. J. (2002). *Pregnancy and parturition rates of harbour seals in Monterey Bay, California.* Master's of Science thesis, San Jose State University. 68 pp.

Gunn-Moore, D. (1995). *Parturition and its problems.* Available online: www.persiancats4u.co.za/catbirthaid.htm. Retrieved 17 April 2006.

Hutchins, M., Thomas, P., & Asa, C. (1996). Pregnancy and parturition in captive mammals. In D. G. Kleiman, S. Lumpkin, & M. Allen (Eds.), *Wild mammals in captivity* (pp. 468-496). Chicago: The University of Chicago Press.

Ingvartsen, K. L., & Boiscalir, Y. R. (2001). Leptin and the regulation of food intake, energy homeostasis and immunity with special focus on periparturient ruminants. *Domestic Animal Endocrinology*, 215-250.

Ingvartsen, K. L., Andersen, H. R., & Foldergaer, J. (1992). Effect of sex and pregnancy on feed intake capacity of growing cattle. *Acta Agriculture Scandinavia, Section A, Animal Science*, *42*, 40-46.

Ingvartsen, K. L., Dewhurst, R. J., & Friggens, N. C. (2001). On the relationship between lactational performance, and health: Is it yield or metabolic imbalance that causes production disease in dairy cattle. *Livestock Production Science* (Invited Review, Accepted).

Ingvartsen, K. L., Friggens, N. C., & Faverdin, P. (1999). Food intake regulation in late pregnancy and early lactation. *British Society of Animal Science Occasional Publication*, *24*, 37-54.

Kastelein, R., Staal, C., & Wiepkema, P. R. (2005). Food consumption and body mass of captive harbor seals (*Phoca vitulina*). *Aquatic Mammals*, *31*(1), 34-42.

Le Boeuf, B. J., Whiting, R. J., & Gantt, F. (1972). Perinatal behaviour of northern elephant seal females and their young. *Behaviour*, *43*, 124-156.

Reijnders, P. J. H. (1990). Progesterone and estradiol-17 beta, concentration profiles throughout the reproductive cycle in harbour seals (*Phoca vitulina*). *Journal of Reproduction and Fertility*, *90*(2), 403-410.

Riedman, M. (1990). *The pinnipeds seals, sea lions and walruses.* Berkeley: University of California Press. 413 pp.

Tauson, A-H., Forsberg, M., & Chwalibog, A. (2004). High leptin in pregnant mink (*Mustela vison*) may exert anorexigenix effects: A permissive factor for rapid increase in food intake during lactation. *British Journal of Nutrition*, *91*, 411-421.