Calving time and foetus growth among wild reindeer in Norway

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Abstract: Mean calving dates among 7 wild reindeer (*Rangifer t. tarandus*) herds in southern Norway varied between the 6th and the 27th of May. Ln transformed foetus weights relate linearly to ln age in days. Regression analyzes based upon 225 days pregnancy predicts birth wet weights between 4600 and 7500 g in the different areas and years. At 130 days, foetus weights varied between 547 and 746 g ($\bar{x}$=681, standard deviation s=63) in all areas and years, indicating that foetus growth up to this size is independent of mothers body weight or condition. During the remaining 95 days of pregnancy, very poor body condition, reflected in dressed weights, resulted in slower foetus growth and smaller regression estimated birth weights. The foetus weight variation recorded at similar dates within areas and sampling years indicates a dispersed breeding time mostly within two ovulations. A small sample of foetuses from pregnant yearlings and calves indicate that these cohorts conceive later than 2 yr + females. Assuming similar foetus growth pattern among all female age cohorts within areas, yearlings conceive around 1 week later and calves (in Ottadalen) more than 3 weeks later than 2 + yr olds.

Key words: birth weight, carcass weight, calving date, foetus development, gestation, *Rangifer tarandus*.

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Introduction

Variation in calving time and birth weight may play an important part in the demographic processes. They relate both to neonatal mortality and to growth later in life (Lenvik & Aune, 1988; Eloranta & Nieminen, 1986). Among wild reindeer (*Rangifer t. tarandus*) in southern Norway, mean calving time (the time when 50% of the females have given birth) relates to female body weights in autumn (Reimers, 1997) and possibly to genetic differences (Flydal & Reimers, in press Wildl. Biol. 8 (2)). Heavy weight females, as in North Ottadalen, gave birth 6 of May, a month before snow melt, while low weight females, as in Hardangervidda, calved three weeks later (i.e. a week before snow melt) (Table 1). The nutritional aspects relating to this difference is discussed in Reimers *et al.* (1983). Jacobsen *et al.* (1981), Rognmo *et al.* (1983), Skogland (1984), Eloranta & Nieminen (1986) and Lenvik & Aune (1988) found that calves from undernourished reindeer were born smaller and suffered higher neonatal mortality than those from mothers in prime condition. The effect of calf birth weight may extend beyond the neonatal stage. Low weights at birth may (Espmark, 1980) or may not (Rognmo *et al.,* 1983) be sustained through summer. Determinants include milk production, as influenced by maternal nutrition (White & Luick, 1984; White, 1991), and the degree of compensatory growth that is possible on a given summer range. This paper: (1) compares differences in foetus growth rates in relation to mother carcass weights in 7 wild reindeer areas in southern Norway, (2) assesses the variation of

Table 1. Dressed weights from pregnant females 1 yr + sampled from Nov through May and calving time and estimated conception date among wild reindeer herds in Norway. *s* = standard deviation.

Area and Year	Mean weights (with *s*) in kg from Feb-Apr. Sample size (*n*).	Conception date [a]	Calving date [a]
North Ottadalen 1966-72	40.4 (7.7) (*n*=8)	24 Sep	6 May[b]
South Ottadalen 1977-79	41.2 (4.3) (*n*=4)	30 Sep	12 May[b]
Forelhogna 1984[c]	44.0 (5.8) (*n*=22)	25 Sep	7 May[c]
Knutshø 1984[c]	40.6 (2.8) (*n*=23)	4 Oct	16 May[d]
Rondane North 1972-73	32.8 (3.5) (*n*=17)	10 Oct	22 May[d]
Snøhetta 1952-58	28.9 (5.1) (*n*=71)	15 Oct	27 May[b]
Hardangervidda 1955-73	29.0 (3.6) (*n*=70)	15 Oct	27 May[c]
Hardangervidda 1983[c]	24.5 (2.9) (*n*=60)	15 Oct	27 May[c]

[a] Calving date, the date when 50% of the pregnant females have given birth, is registered in field. Conception date is estimated on basis of a pregnancy period of 225 days including conception and calving dates.
[b] From Holthe (1975). [c] From Skogland (1984). [d] From Reimers (1983a; 1997).

foetus weights in relation to sampling dates and (3) estimates the female age effect on conception dates.

Material and methods

The data include female reindeer killed under various sampling programs or in snow avalanches in 7 wild reindeer areas in southern Norway (Table 1). Three populations are reindeer from domestic origin released as wild in 1964-65 in North and South Ottadalen (Reimers, 1972) or had their status changed to wild in 1956 in Forelhogna (J. J. Meli, pers. comm.; Røed, 1986). The data from Forelhogna and Knutshø in 1984 and Hardangervidda 1983 were obtained from a joint sampling program (Skogland, 1984). Sampling of pregnant females occurred from February through May. Female dressed weights (Langvatn *et al.*, 1966) were measured to the nearest 100 g and foetus total weights to the nearest g when smaller than 1500 g, and to the nearest 25 g when heavier. Age of females was determined on basis of tooth development or tooth wear (animals sampled in 1952-59) or annuli in the incisor teeth cementum (Reimers & Nordby, 1968). The gestation period was set at 225

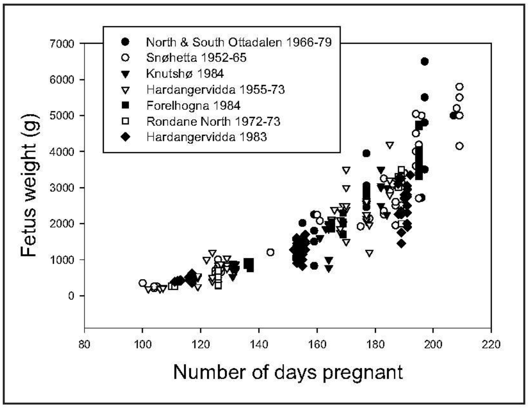

Fig. 1. Foetus weights from wild reindeer sampled in different areas and years and plotted against estimated number of days pregnant.

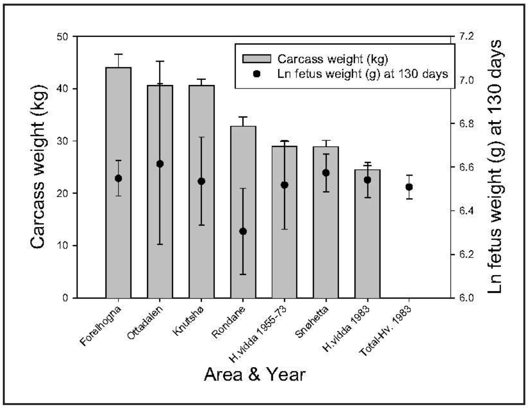

Fig. 2. Female carcass weights (from Table 1) +95% confidence intervals (CI) and regression estimated ln foetus weights ±95% CI at age 130 days. Foetus weights are calculated on basis of regression equations in Table 2.

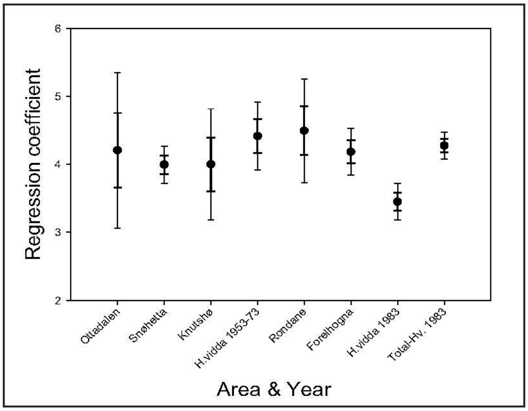

Fig. 3. Regression coefficient estimates ±95% confidence intervals (CI) calculated on basis of regression equations in Table 2.

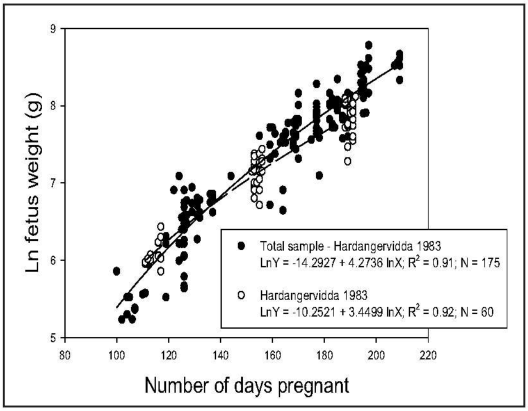

Fig. 4. Comparison of regression curves from Hardangervidda 1983 (dashed line) and total sample – Hardangervidda 1983 (solid line). Equations are from Table 2.

days (7 1/2 months) (Skjenneberg & Slagsvold, 1968) and conception dates were estimated form mean calving dates. Number of days pregnant was calculated on basis of sampling dates and conception dates in the various areas. Foetus weights and number of days pregnant were ln-transformed to give a linear relationship. Foetus weights and birth weights were estimated from regression equations on basis of these transformations and a gestation period of 225 days.

Differences in regression slopes were evaluated from regression coefficients ±95% confidence limits and from analysis of variation (Nissen, 1994).

Results

Pregnant female dressed weights differed in the various areas as did the mean calving dates (Table 1). Foetus weights plotted against number of days preg-

Table 2. Ln transformed regressions of foetus weights (Y) in g from pregnant females $1^1/_2$ yr+ at conception in relation to number of days pregnant (X) in Feb, Mar, Apr and May (211>X>85 days). *s* = standard deviation.

Area and Year	*n*	Equation	R^2	Est. foetus weight (g) 130 days[a]	Est. birth weight (g) 225 days. 95% confidence intervals in parenthesis	Calf weight (with *s*) in g. Sample size (*n*) Age ≤ 1 week Age ≤ 1 week
North and South						
Ottadalen 1966-79	21	LnY=-13.8606+4.2066lnX	0.76	746	7501 (5540–10160)	7300 (±1100) (*n*=3)
Forelhogna 1984	22	LnY=-13.8157+4.1837lnX	0.97	698	6929 (5584–8601)	
Knutshø 1984	23	LnY=-12.9304+3.9990lnX	0.83	689	6177 (4560–8366)	6200 (*n*=1)
Rondane North 1972-73	15	LnY=-15.5718+4.4942lnX	0.92	547	6433 (4552–9092)	5300 (±800) (*n*=2)
Snøhetta 1952-65	47	LnY=-12.8694+3.9945lnX	0.95	716	6407 (5758–7130)	
Hardangervidda 1955-73	47	LnY=-14.9758+4.4158lnX	0.87	677	7636 (6070–9606)	5538 (±2100) (*n*=8)
Hardangervidda 1983	60	LnY=-10.2521+3.4499lnX	0.92	693	4596 (4106–5144)	3430 (*n*=18)[b]
All areas and years except						
Hardangervidda 1983	175	LnY=-14.2927+4.2736lnX	0.91	671	6999 (6476–7564)	

[a] The foetus weight at 130 days and the birth weights are estimated from the regression lines and based upon a pregnancy period of 225 days.
[b] From Skogland (1984).

nant (Fig. 1) reveal a log linear relationship (Table 2). Estimated foetus weight at age 130 days varied between 547 and 746 g in the different areas and years and the weights were apparently unrelated to female carcass weights (Table 2, Fig. 2). Among females with mean carcass weights over 30 kg the foetus growth rate between age 85 and 225 days apparently was unrelated to the weights of the mothers (Table 2, Fig. 3). The foetus growth rate in a pooled sample excluding Hardangervidda 1983 was significantly higher (F=16.1; P=0.02) than the rate estimated among foetuses from Hardangervidda in 1983 (Figs. 3, 4). Assuming a gestation period of 225 days, the estimated wet birth weight was 4596 g in Hardangervidda in 1983 (95% Conf. Int. between 4106 and 5144 g) and 6999 g in a pooled sample from the other areas (95% Conf. Int. between 6476 and 7564 g) (Table 2). Birth weights recorded in field were somewhat lower than those estimated from the regression lines (Table 2). The maximum and minimum foetus weights recorded within areas and years during February through May (Table 3) indicate considerable variation in conception dates.A small sample of pregnant yearlings and calves indicate that these age groups conceive later than the older females (Table 4). The estimated later conception dates range from 1-31 days (average=8, s=8) in yearlings and 22-51 days (average=34, s=12) in calves.

Discussion

The estimated wet birth weights and the weights of the newborn (Table 2) were between 4.5 and 7.5 kg. This is mostly within the expected range between 3.7 and 7.1 kg (see review by Reimers, 1997). In Hardangervidda, Skogland (1984) found a mean birth weight of 2.98 kg among 7 dead calves and 3.72 kg among 11 live-captured calves. He pooled the two samples and arrives at an average newborn weight of 3.43 kg, 1.17 kg less than predicted from the regression model (Table 2). Newborn Hardangervidda calves one week or younger weighed 5.90 kg, s=1.45 (n=3) in 1970 and 5.32, s=1.55 (n=5) in 1973 or 2.5 and 1.89 kg heavier respectively than the average weight reported by Skogland (1984). The newborn weights presented are dry weights as presumably are the weights reported in the literature; i.e. the calves are licked dry by their mothers. It is not known what this weight loss represents, but the weights estimated from regression should probably be reduced somewhat to account for the water loss occurring during drying up. Foetus weights at age 130 days were reasonably similar in all areas and years (Table 2). Foetus growth up to this size and during this period was independent of the mothers body condition. During the remaining 95 days of pregnancy, poor body condition reflected in dressed weights apparently has a major influence on the foetus growth as found by Skogland (1984). Factors explaining foetus weight variations may include area, mother's age (Table 4), dressed weight (Skogland, 1984; Table 1), the ovulation pattern (Ropstad *et al.,* 1995) and the conception date. The ovulation pattern, i.e. the number of days between two ovulations, is 21 days among reindeer (Ropstad *et al.,* 1995). Without conception, the female continues to ovulate every 21 day at least up to 6 times (Ropstad *et al.,* 1995). Judging from the calving season, which within areas are rather concentrated, the majority of females give birth within 10 days, the females breed synchronized and most of them apparently during two ovulations (Table 3). Alternatively, as discussed by Krog *et al.* (1980), breeding is spread out in time and foetus growth is later synchronized by delayed implantation to give a concentrated calving time. The foetus weight variation (Table 3) does not support a synchronization of foetus growth. Rather, it indicates a spread out breeding or differences in the intrauterine environment. If breeding involved more than two ovulations, the maximum difference between foetus weights measured at the same time would have been more than recorded in Table 3, as would the calculated difference in number of days pregnant.At similar dates, calves and yearlings bore smaller foetuses than adults (Table 4). Krog *et al.* (1980) report corresponding results for yearlings. Yearling females had foetuses weighing 38% less than foetuses of 2 1/2+ year old females when measured at the same date in February. This foetus weight difference could either imply a later conception and thus calving date or a smaller birth weight. Assuming similar birth weights, the foetus weight differences represents a birth date delay of 5-6 days among yearlings and more than 3 weeks among calves compared with the 2 1/2+ years old. It is well documented that birth weight relates to the mothers weight (Eloranta & Nieminen, 1986). In feeding experiments, Rognmo *et al.* (1983) and Eloranta & Nieminen (1986) found that newborn weights decreased with decreasing weights of their mothers. Female calves and yearlings have smaller carcass weights than the older females (Reimers, 1983a). Hence, some of the birth date delay indicated in Table 4 may be compensated by smaller birth weights. However, it is possible that the apparent age effect in reality is a body weight or body composition effect (Reimers, 1983b; Ropstad *et al.,* 1991). Being in a growth phase, it is conceivable that yearlings, and in particular calves meet the weight or fat:lean ratio needed for ovulation (Ropstad *et al.,* 1991) later than the older females.

Table 3. Minimum and maximum foetus weights form pregnant females 1 yr+ sampled in Jan – May and the corresponding number of days the differences represent.

Month	Area/Year	Weighing dates		Minimum and maximum foetus weight Y (g)		Corresponding number of days pregnant X[a]		Difference (days) in calving date[b]
February	Ottadalen 1972	1	25	819	2015	136	168	8
	Knutshø 1984	12	11	700	900	131	139	7
	Forelhogna 1984	7	8	850	950	137	141	3
	Rondane 1973	12	12	281	688	106	131	25
	Snøhetta 1957	17	17	220	800	100	135	35
	Hardangervidda 1957	15	10	400	550	115	124	4
	Hardangervidda 1973	17	20	327	1035	110	144	31
	Hardangervidda 1983	2	8	385	623	110	126	10
March	Ottadalen 1977	25	25	2590	3950	178	197	19
	Knutshø 1984	16	16	770	2000	134	168	34
	Forelhogna 1984	12	12	1700	2300	162	173	11
	Hardangervidda 1973	31	31	1755	2400	163	175	12
	Hardangervidda 1983	18	19	825	1700	137	168	30
April	Ottadalen 1972	8	8	3500	6500	191	221	30
	Knutshø 1984	5	3	2250	3500	173	191	16
	Forelhogna 1984	7	7	3300	4750	189	205	16
	Rondane 1972	15	16	3000	3500	185	191	5
	Snøhetta 1956	15	22	2250	3400	173	190	10
	Snøhetta 1959	19	18	1950	3100	167	186	18
	Hardangervidda 1957	2	2	1500	3500	157	191	34
	Hardangervidda 1970	10	9	1970	2620	167	179	11
	Hardangervidda 1983	21	24	1450	3350	161	205	41
May	Snøhetta 1958	11	11	5000	5800	208	215	7

[a] Calculated from regression lines (Table 2) and solved for X. All areas and years except Hardangervidda 1983: lnY= -14.2927+4.2736lnX. Hardangervidda 1983: lnY= -10.2521+3.4499lnX. X=number of days pregnant; Y=foetus weight (g).

[b] Difference in calving date is corrected for the number of days between measuring dates: (X_{max} - X_{min}).

Table 4. Ln transformed regressions of foetus weights (Y) in g from pregnant females 2 1/2 yr + at conception in relation to number of days pregnant (X) in Feb, Mar, Apr and May (211>X>85 days).

Area and Year	*n*	Equation	Estimated delay (days) in conception date among: Yearlings (*n*=16)	Calves (*n*=4)[a]
North & South Ottadalen 1966-79	17	LnY=-12.2006+3.8960lnX	3, 7, 3, 31	22, 31, 31, 51
Forelhogna 1984	18	LnY=-13.0896+4.0462lnX	1, 4, 7, 7	
Rondane North 1972-73	12	LnY=-16.3426+4.6603lnX	4, 4, 19	
Hardangervidda 1983	55	LnY= - 9.8707+3.7770lnX	2, 4, 5, 9, 12	

[a] Two pregnant calves killed in an avalanche in South Ottadalen March 25, 1977 had foetuses weighing 775 and 1625 g. Two calf leading yearlings killed in North Ottadalen June 14, 1972 had calves age ≤ 1 week weighing 6300 and 8500 g.

Conclusions

Foetus growth rate in wild reindeer up to around age 130 days and weight 550-750 g appears not to be influenced by the mothers body weights. Later in pregnancy females in very poor condition (mean carcass weights around 25 kg) support a foetus growth rate which is significantly lower than among females with mean carcass weights of 29 kg or above. Foetus weight variations within areas and years indicate that conception in two year or older females mostly occur within two eustrous cycles. Yearling females conceive within a week later than older females while calves apparently conceive 3-4 weeks later.

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References

Eloranta, E. & Nieminen, M. 1986. Calving of the experimental reindeer herd of Kaamanen during 1970-85. – *Rangifer* Spec. Issue No. 1: 115-121.

Espmark, Y. 1980. Effects of maternal pre-partum undernutrition on early mother-calf relationships. – *In*: E. Reimers, E. Gaare & S. Skjenneberg. (eds.). *Proceedings from the 2nd International Reindeer/Caribou Symposium, Røros, Norway, 1979*. Direktoratet for vilt og ferskvannsfisk, Trondheim, pp. 485-496.

Holthe, V. 1975. Calving season in different populations of wild reindeer in South Norway. – *In*: J. R. Luick, P. C. Lent, D. R. Klein & R. G. White. (eds.). *Proceedings from the First International Reindeer/Caribou Symposium, Fairbanks, Alaska, 1972*. Biological Papers of the University of Alaska. Spec. Report No. 1, pp. 194-198.

Jacobsen, E., Hove, K., Bjarghov, R.S. & Skjenneberg, S. 1981. Supplementary feeding of female reindeer on lichen diet during the last part of pregnancy. – *Acta Agriculturae Scand.* 31: 81-86.

Krog, J., Wika, M. & Savalov, P. 1980. The development of the foetus of the Norwegian reindeer. – *In*: E. Reimers, E. Gaare & S. Skjenneberg. (eds.). *Proceedings from the 2nd International Reindeer/Caribou Symposium, Røros, Norway, 1979*. Direktoratet for vilt og ferskvannsfisk, Trondheim, pp. 306-310.

Langvatn, R. (ed.), Leth Sørensen, P., Nygren, K., Reimers, E. & Stålfelt, F. 1977. *Criteria of physical condition, growth and development in Cervidae, - suitable for routine studies*. Nordic Council for Wildlife Research, Stockholm. 1977. 27 pp.

Lenvik, D. & Aune, I. 1988. Selection strategy in domestic reindeer. 4. Early mortality in reindeer calves related to maternal body weight. – *Norsk Landbruksforskning* 2: 71-76.

Nissen, Ø. 1994. *NM - Statpack*. Norges landbrukshøgskole.

Reimers, E. & Nordby, Ø. 1968. Relationship between age and tooth cementum layers in Norwegian reindeer. – *J. Wildl. Manage.* 32: 957-961.

Reimers, E. 1972. Growth in domestic and wild reindeer in Norway. – *J. Wildl. Manage.* 36: 612-619.

Reimers, E. 1983a. Growth rate and body size differences in *Rangifer*, a study of causes and effects. – *Rangifer* 3 (1): 3-15.

Reimers, E. 1983b. Reproduction in wild reindeer in Norway. – *Can. J. Zool.* 61: 211-217.

Reimers, E. 1997. *Rangifer* population ecology: A Scandinavian perspective. – *Rangifer* 17: 105-118.

Reimers, E., Klein, D.R. & Sørumgård, R. 1983. Calving time, growth rate, and body size of Norwegian reindeer on different ranges. – *Arctic and Alp. Res.* 15: 107-118.

Røed, K. H. 1986. Genetisk struktur i norske villrein. – *Hognareinen* 2: 4-6.

Rognmo, A., Markussen, K. A., Jacobsen, E., Grav, H. J. & Blix, A. S. 1983. Effects of improved nutrition in pregnant reindeer on milk quality, calf birth weight, growth and mortality. – *Rangifer* 3 (2): 10-18.

Ropstad, E., Lenvik, D., Bø, E., Fjellheim, M. M. & Romsås, K. 1991. Ovarian function and pregnancy rates in reindeer calves (*Rangifer tarandus*) in southern Norway. – *Teriogenology* 36: 295-305.

Ropstad, E., Forsberg, M., Sire, J. E., Kindahl, H., Nilsen, T., Pedersen, O. & Edqvist, L. E. 1995. Plasma concentrations of progesterone, oestradiol, LH and 15-ketodihydro-PGF-2alpha in Norwegian semidomestic reindeer (*Rangifer tarandus tarandus*) during the first reproductive season. - *J. Repr. Fert.* 105: 307-314.

Skjenneberg, S. & Slagsvold, L. 1968. *Reindriften og dens naturgrunnlag*. Universitetsforlaget, Oslo. 332 pp.

Skogland, T. 1984. The effects of food and maternal conditions on fetal growth and size in wild reindeer. – *Rangifer* 4 (2): 39-46.

White, R. G. 1991. Nutrition in relation to season, lactation and growth of north temperate deer. – *In*: R. D. Brown (ed.). The biology of deer. Springer-Verlag, New York, pp. 407-417.

White, R. G. & Luick, J. R. 1984. **Plasticity and constraints in the lactational strategy of reindeer and caribou.** – *Symp. Zool. Soc. Lond.* 51: 215-232.

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