BODY COMPOSITION AND POPULATION REGULATION OF SVALBARD REINDEER

Kroppsammensetning og bestandsregulering hos svalbardrein.

EIGIL REIMERS, Institute of Zoophysiology, University of Oslo, Box 1051 Blindern, 0316 OSLO 3.

Summary: After severe winters, body weight, fat, and lean tissue of the high Arctic Svalbard reindeer may be reduced by 50, 90-97 and 30-40% respectively. Absence of harassment from predators, insects and man allows surviving animals to rapidly restore body reserves during the summer. That accumulation of large pre-winter body reserves is essential, as the reindeer's survival and population control is dependant upon use of winter forage which is resistant to grazing but poor in quality.

Key Words: Svalbard reindeer, *Rangifer tarandus platyrhynchus*, growth, body composition, starvation, population regulation.

Rangifer *4 (2): 16 - 21*

REIMERS, EIGIL. 1984. Kroppssammensetning og bestandsregulering hos svalbardrein.

Sammendrag: Etter harde vintre kan kroppsvekt, fett og magert vev bli redusert med henholdsvis 50, 90 - 97 % henholdsvis. Fravær av forstyrrelser av rovdyr, insekter og mennesker tillater overlevende dyr å fornye sine kroppsreserver raskt gjennom sommeren. Denne akkumulering av store kroppsreserver før vinteren er livsviktig, da reinens overlevelse og bestandskontroll er avhengig av et vinterfôr som er motstandsdyktig mot beiting, men er av dårlig kvalitet.

Rangifer *4 (2): 16 - 21*

REIMERS, EIGIL. 1984. Huippuvuorten porojen ruumiinkokoonpano ja eläinkannan säätö.

Yhteenveto: Ankarien talvien jälkeen voi ruumiinpaino, rasva ja laiha kudos vähetä 50, 90-97 ja 30-40 % jokainen erikseen. Petoeläinten, hyönteisten ja ihmisten häiriöiden poisjäädessä on eloonjääneillä eläimillä mahdollisuus uusia nopeasti ruumiin vara-aineet kesän kuluessa. Tämä suurien ruumiin vara-aineiden kasaantuma ennen talvea on elintärkeä, koska porojen eloonjääminen ja eläinkannan valvonta on riippuvainen talvilaitumesta, joka sietää laiduntamisen, vaikka se on huonoa laatua.

Rangifer *4 (2): 16 - 21*

INTRODUCTION

Svalbard, 77 - 81° NL, is inhabited by a population of reindeer, *Rangifer tarandus platyrhynchus*, that lacks natural predators, parasitizing insects and grazing competitors. The subspecies was protected in 1925 and now they occur in densities (up to 4 - 6 animals/km^2) exceeding naturally-occurring subspecies elsewhere (Alendal and Byrkjedal 1976, Reimers 1977).

I suggest that their winter survival is associated with a rapid build-up in summer of lean tissue and large fat deposits that are economized through reduced activity (Kastnes 1979) and probably depressed metabolic rate (Nilssen et al. 1982) during the 8-month winter. The maintenance of reasonably stable animal numbers (Reimers 1982) is related to the widespread overgrazing of lichens and the replacement of them by more grazing-

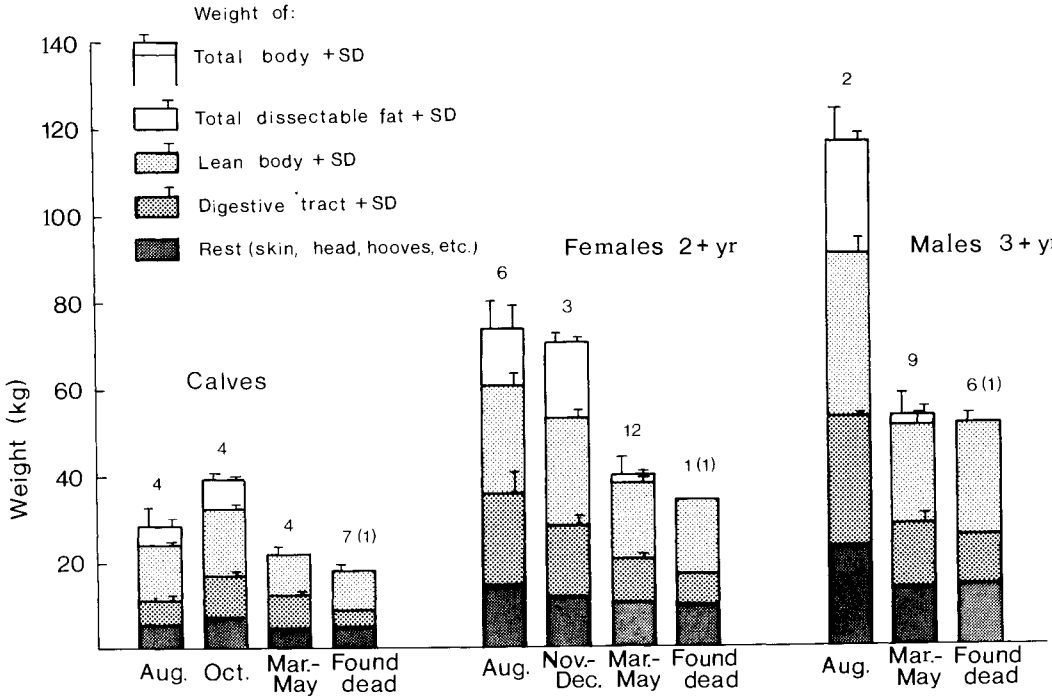

Fig. 1. Total body weights and body composition of Svalbard reindeer killed in autumn and late winter and animals found dead in April - May. Among the animals found dead only one in each of the 3 age and sex groups (number in parentheses) were autopsied.

Fig. 1. Total kroppsvekt og kroppssammensetning av svalbardrein skutt høst og senvinter og av dyr funnet døde i april - mai. Av de dyr som ble funnet døde ble bare ett i hver av de tre alders- og kjønnsgrupper obdusert (antallet i parantes).

resistent mosses and graminoids in the vegetation mat (Brattbakk and Ronning 1978) and in the diet (Hjeljord 1975, Ekern and Kildemo 1978), thus rendering ranges less susceptible to overgrazing. Such replacement has been observed to occur under heavy grazing (Klein 1968, Gaare et al. 1970). In winter this forage has a lower content of easily digestible energy than lichens (Ekern and Kildemo 1978, Thomas and Kroeger 1980, Boertje 1981). Starvation in severe winters causes increased mortality and decreased recruitment (Reimers 1977, Reimers 1982). Such years occur frequently enough to prevent severe overgrazing and subsequent severe population fluctuations. The purpose of this paper is to present data and arguments that led me to the above conclusion.

MATERIALS AND METHODS

In 1975-78 in Nordskiold Land on the island of Spitsbergen, 48 animals were shot, and 14 animals were found dead. Measurements were taken of total body weight, dressed weight (less viscera, head, hide and lower legs), back fat depths (Riney 1955) and weight of the intact digestive tract. The total dissectable fat from the dressed carcass and from the viscera was removed and weighed. Lean body weight was calculated as dressed weight minus dissectable carcass fat. Mandibles, dressed weights, and back fat depths were measured in wild reindeer from southern Norway by hunters and game wardens from 25 August - 25 September. The age classes were identified from tooth wear and eruption characteristics (de Bie 1976) and cementum annuli (Reimers and Nordby 1968). No distinction was made between male and female calves or between pregnant/lactating and non-pregnant females.

RESULTS AND DISCUSSION

Four adult males (> 3 years) weighed 86.8 ± 13.3 kg (SD) at the start of the active rutting season in mid-October. The average weight loss of 30 kg (25%) from late August was caused by a gradual decrease in grazing and increased activity (Kastnes

Table 1. Weight and fat measurements (mean ± SD; N) of wild reindeer in a prime habitat (North Ottadalen)[1] and a severely overgrazed habitat (Hardangervidda)[2] on mainland Norway and on Svalbard.

Tabell 1. Målinger av vekt og fett (middel ± SD; N) hos villrein på godt beite (Nord-Ottadalen) og på kraftig overbeitet beite (Hardangervidda)[2] på norsk fastland og på Svalbard.

Area and years *Område og år*	Sampling period *Prøve-periode*	Age (years) *Alder*	Sex	Dressed weight (kg) *Slaktevekt kg*	Back fat depth (mm) *Ryggfett, tykkelse, (mm)*	Dissectable fat (kg) *Preparerbart fett (kg)*	Dissectable fat as percentage of dressed weight *Preparerbart fett i prosent av slaktevekt*
North Ottadalen		1/3	F+M	28.3±3.7(83)	6 ± 6(50)	0.9[2]	3
Southern Norway 1967-74	Aug.-Sept.	2 1/3 +	F	42.6±6.1(640)	15 ±14(506)	2.2[2]	5
Hardangervidda		1/3	F+M	15.2±2.8(62)	0.4± 1(28)	0.2[2]	1
Southern Norway 1969-70, 1973-74	Aug.-Sept.	2 1/3 +	F	29.3±5.5(637)	4 ± 6(340)	0.7[2]	2
Nordenskiøld land		1/3	F+M	17.3±0.6(2)	34 ± 4(2)	5.5±0.3(2)	32
Svalbard	August	2 1/3	F	39.0±3.5(4)	54 ±11(4)	14.7±4.1(4)	38
Nordenskiøld land		1/3	F+M	21.3±0.8(4)	31 ± 1(4)	6.8±0.3(4)	32
Svalbard	Oct.-Nov.	2 1/3 +	F	40.2±1.0(3)	56 ± 6(3)	17.5±0.8(3)	44

[1] *Habitat evaluation of North Ottadalen is from Reimers et al. 1983 and of Hardangervidda from Gaare and Skogland (1975).*

[2] *Estimated from the regression $Y = 0.3501 + 0.0785x + 0.0030 x^2$; Y= dissectable carcass and visceral fat (kg) and X = back fat depth (mm). From Reimers and Ringberg 1983.*

1979), including herding of females and aggressive behavior towards potential rivals. Calves (1/3 year) and females are affected little by the male rutting behavior (Kastnes 1979) and continue to grow and fatten (Fig. 1, Table 1). Calves are able to accumulate appreciable amounts of fat, far exceeding the deposits of *Rangifer* calves at lower latitudes (Table 1), but both absolute and relative fat deposits are smaller than in females (Table 1). Even under excellent grazing conditions as in North Ottadalen (Reimers 1972, Reimers et al. 1983) females and calves on the mainland of Norway do not accumulate fat reserves to the extent observed in Svalbard reindeer. That may indicate a stronger dependency on winter pastures and a different survival strategy for mainland reindeer than is suggested for Svalbard reindeer (Reimers 1980).

The Svalbard winter lasts approximately from October to early June and is characterized by the low precipitation, frequent strong winds and low temperatures with occasional temperatures above freezing (Table 2). Hard windpacked snow and occasional ice cover limits the winter grazing areas and hence quantity and quality of available forage (Ekern and Kildemo 1978, Reimers 1980).

To counter the negative energy and nitrogen balance in winter the reindeer catabolize fat and lean tissue. Towards the end of winter, calves and females have lost 44% and males 54% of their maximum autumn body weights (Fig. 1). A major part (84 - 96%) of this loss is caused by weight reduction in dissectable fat, lean tissue, and the digestive tract. While fat was reduced by 97% in calves and 90% in the adults, the weight reduction of lean tissue was 39% in calves and males and 29% in females. Judging from the weight loss and body composition, adult females appear to be in somewhat better condition in late winter than calves and males. Lean tissue of Svalbard reindeer contains 21% protein and 4.5% fat (Reimers et al. 1982). Assuming an energy value of 35.1 kJ/g fat and 5.0 kJ/g lean tissue (Gilder et al. 1968), the weight reduction of these tissues implies an energy output of 887, 590, and 264 MJ in males, females, and calves, respectively. Nilssen et al. (1982) measured heat production of standing Svalbard reindeer at 2.4 W/kg in autumn and 1.6 W/kg in winter. When fed 25% of the ad lib. diet in winter, the heat production fell to 1.1 W/kg. Thus, the energy output from the body tissues cover a substantial part of the reindeer energy demands during the winter.

The weight decrease of the digestive tract (20, 40, and 50%, respectively, in calves, females, and males) in winter most likely reflected reduced feed intake and metabolism.

Weight differences were small between animals killed during March - May in 1976 - 77 and animals found dead in April - May (Fig. 1). Fat was not present in the dead animals, not even in the long bones, the last fat deposits to be mobilized during malnutrition (Riney 1955). Three of the animals were autopsied and judged to have starved.

In early April 1978, total body weights of adult males and females where 64.5 ± 4.8 (SD) and 51.0 ± 8.6 (SD) kg, respectively (Bye 1980), 20 and 28% higher than in March - May 1976 - 77.

Apparently there was a relationship between winter mortality and subsequent calf survival (Reimers 1977), and body weights in late winter.

Table 2. Precipitation, temperature, and number of days with rain from 1 January - 1 May at Longyearbyen, Svalbard. (Det norske meteorologiske institutt, unpublished.)

Tabell 2. Nedbør, temperatur og dager med regn fra 1. januar til 1. mai i Longyearbyen, Svalbard. (Det norske meteorologiske institutt, upublisert).

Year *År*	Precipation (mm) *Nedbør (mm)*	Temperature (°C) *Temperatur (°C)*	No. of days with rain > 0.1. mm *Antall dager med regn > 0.1. mm*
1975 - 76	96	—11.8	9
1976 - 77	33	—17.2	2
1977 - 78	38	—17:3	2
AVERAGE 1957 - 77	71	—13.8	0.9

The late winters 1975 - 76 and 1976 - 77 body weights were low, a large number of carcasses were found (Reimers 1983) and calf percentages the following summers were below 12% of all reindeer (Alendal pers. comm.). The following winter body weights of adults were 20 - 28% higher, mortality was low (Reimers 1983) and calf percentages exceeded 20% (Alendal pers. comm.).

Although difficult to quantify, severity of winters is generally related to winter precipitation and packing of the snow by strong winds. Particular severe grazing conditions may arise after winter rainfall and subsequent freezing resulting in a more or less impenetrable ice-cover over the vegetation.

In winter 1975 - 76 precipitation and number of days with rain were above normal (Table 2), and several ice layers formed over the vegetation (Kastnes 1979). Precipitation was lower than normal and the number of days with rain about normal the following 2 winters. Yet, body weights in late winter were lower and the number of carcasses from starved animals twice as high in 1976 - 77 as in 1977 - 78 (Reimers 1983). The lack of consistency is not conclusive as I believe the standard meteorological measurements frequently are too crude for an evaluation of grazing conditions.

The survival and population control mechanisms expressed by the Svalbard reindeer are rare among reindeer/caribou. Predation, harvest by man, and emigration to suboptimal habitats are the major controlling elements for most cervid species. Their absence resulted in population eruptions and crashes of reindeer on islands in Alaska due to severe overgrazing of the lichen ranges and severe winters (Scheffer 1951, Klein 1968). A population of reindeer on South Georgia gradually decreased during the past 20 years from the highest density ever reported (23 animalsk/km^2) to the present density of 9 animals/km^2 in one subpopulation (Leader-Williams 1980). The dependence on tussock grass rather than lichens for winter forage was the major reason for the absence of a population crash (Leader-Williams et al. 1981).

Having been protected since 1925, without predators and with extremely poor winter nutrition (Ekern and Kildemo 1978, Reimers 1980), the Svalbard reindeer should have faced the above described crash-like situation. And yet, high and presumably stable population densities (up to 5 - 6 animals per km^2 (Alendal and Byrkjedal 1976)), rapid body growth, and favorable body composition (Krog et al. 1976, Ringberg et al. 1980, Reimers et al. 1982) indicate no impending crash. In the absence of predators, hunters, and biting or parasitic insects, selection has favored sedate animals with a high capacity to obtain and store energy in times of plenty for use in times of want. During severe winters, however, the accessible range forage will not supply the necessary energy to cover energy requirements and some mortality occurs.

The occasional high winter mortality (Reimers 1982) followed by low calf survival maintain reasonably stable populations and ranges and a continued selection for reindeer capable of accumulating large amounts of fat.

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