Estimating the daily dry matter intake of Svalbard reindeer in late winter

Nicholas Tyler

Research Group in Mammalian Ecology and Reproduction, Physiological Laboratory, Downing Street, Cambridge CB2 3EG, U.K.

* Present address: Avdeling for Arktisk Biologi, Universitetet i Tromsø, Postboks 635, 9001 Tromsø.

Summary: Svalbard reindeer (*Rangifer tarandus platyrhynchus*) store large reserves of subcutaneous fat during summer and autumn which, it has been suggested, might be sufficient to meet a substantial part of their energy requirements during winter. An alternative suggestion, however, is that fat is not their main source of energy after all and, moreover, that the principal role of their fat reserves is for enhancing reproductive success rather than for substituting for forage (Tyler, in press). Is it realistic to suggest that these high arctic herbivores could meet the greater part of their energy requirements in winter by feeding, given that the aerial biomass of available forage in Svalbard in late winter is very low? This question was investigated by using a simple model to predict what rate of food intake Svalbard reindeer would have to achieve to maintain energy balance in late winter. The results were surprisingly low: pregnant and nonpregnant females could meet their daily energy demands by consuming 3.1 and 1.7 g dry matter per grazing minute, respectively. This supports the suggestion that Svalbard reindeer could live principally off forage in winter.

Key words: food intake, energy balance, *Rangifer*, Svalbard reindeer

Rangifer 7 (1): 29 - 32

Introduction

Reimers (1984) suggested that the fat reserves of Svalbard reindeer (*Rangifer tarandus platyrhynchus*) might be large enough to meet a substantial portion of the animals' energy requirements in winter and discussed the implications of this for natural limitation of the abundance of reindeer on Svalbard. Tyler (in press) confirmed that Svalbard reindeer store considerably more subcutaneous fat during summer and autumn than most other subspecies of *Rangifer* but found, nevertheless, that fat is not their principal source of energy in winter: adult females, for example, have enough fat in autumn to meet approximately 25% of their energy requirements in winter, not including the energy costs of gestation (ibid.). The implication of this is that the animals must normally meet not less than 75% of their daily energy requirements by feeding. Moreover, Svalbard reindeer, like other cervids, appear to use their reserves of fat essentially for reproductive purposes and as an «emergency ration» in winter (ibid.). Fat, therefore, perhaps normally only *supplements* their winter diet rather than actually *substituting* it (ibid.). This begs the question: Given that the available forage biomass in late winter in Svalbard is very low, is it possible that the animals could normally eat enough to meet their energy requirements by feeding alone?

It is not easy to measure how much a free ranging ungulate eats. There are no data on bite size or biting rate in Svalbard reindeer nor have feeding trials been conducted with oesophageal fistulated animals. Consequently, a simple calculation was developed to estimate what weight of food Svalbard reindeer would have to eat to meet their energy requirements in winter. The purpose was simply to see whether or not the suggestion that they might normally meet most of their daily energy requirements by feeding is realistic. The calculation began with an estimate of the animals' daily energy expenditure and then worked backwards to arrive at a figure for reindeers' required rate of dry matter (DM) intake in g per grazing minute.

The model

The different steps in the calculation are shown in Fig. 1. The calculation starts with an estimate of a reindeer's daily energy requirements (kcal.day^{-1}) including the energy cost of activity and, optionally, gestation. Details of estimation of these values have been presented elsewhere (Tyler, in press). Step 2 is to subtract the energy which the animal obtains each day from catabolism of fat and muscle; what remains is the daily net energy (NE) intake which must be achieved by grazing. The net energy available to an animal is the metabolizable energy (ME) derived from digestion of forage, less heat produced during anaerobic fermentation of the feed. Step 3, therefore, is to calculate the animal's ME requirement. The efficiency of utilization of ME, k, varies depending on the level of feeding, the metabolizability (q) of the feed and the purpose for which the energy is used i.e. maintenance, growth, pregnancy, lactation or work (activity) (ARC 1980). In this case k was set at 0.64, which is the value for maintenance in domestic ruminants fed on poor quality forage (ARC 1980:81). The efficiency of utilization of ME for activity is, in fact, lower than for maintenance; k = 0.30 (ARC 1980:83). No correction was made for this because maintenance accounts for 71% of the total daily energy expenditure of Svalbard reindeer in winter (Tyler 1987). Consequently, the animal's ME requirement is calculated by multiplying its NE requirement by 1/0.64. (The efficiency of utilization of ME for growth of the conceptus is considerably lower (0.13 in domestic ruminants (ARC 1980:88). Allowance for this is made in the estimated cost of gestation). Metabolizable energy is the gross energy (GE) of the feed less the energy content of the of faeces, urine and combustible gas produced. The metabolizability

Fig. 1. Steps in calculating the dry matter intake and rate of forage intake necessary for a non-pregnant adult female Svalbard reindeer to meet its daily energy requirements in late winter.

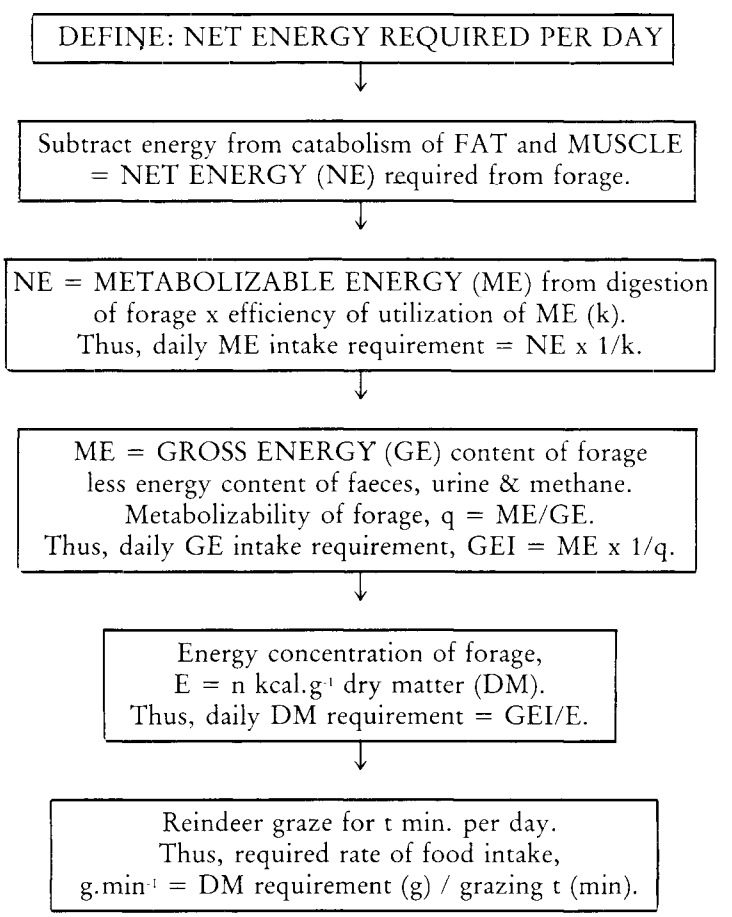

Table 1. Example calculation for estimating the daily dry matter requirement of a non-pregnant adult female Svalbard reindeer in late winter.

Mean daily energy requirement in April and May	= 1 735 kcal
Contribution from fat	= 242 kcal.day^{-1}
NE required from forage	= 1 493 kcal.day^{-1}
Efficiency of uptake of ME	= 0.64
ME required from forage	= 2 332 kcal.day^{-1}
Metabolizability of forage	= 0.40
GE required from forage	= 5 832 kcal.day^{-1}
Energy content of forage	= 4.5 kcal.g^{-1}
DM requirement (GE / energy content of forage)	= 1.3 kg.day^{-1}
Reindeer graze for 12.9 h.day^{-1}, thus	
Required rate of intake (g DM.grazing min^{-1})	= 1.7 g.

of the feed, q, is the ratio of ME to GE: q was set at = 0.40, which is the value for domestic ruminants fed poor quality forage (ARC 1980;81). The animal's gross energy requirement is calculated by multiplying its ME requirement by 1/0.40. There are no estimates of the gross energy content of forage plants in Svalbard in winter so I have assumed a value of 4.5 kcal.g^{-1} DM (Schwartz and Hobbs 1985). An animal's daily dry matter (DM) requirement (g DM.day^{-1}) is, thus, its GE requirement divided by 4.5. Svalbard reindeer graze, on average, for 12.9 h per day during April and May (Tyler 1987): hence, their required rate of food intake (g DM.grazing min^{-1}) is their GE requirement (g DM.day^{-1}) divided by 12.9 x 60 min.

Results

An example calculation is shown in Table 1. This shows that a non-pregnant adult female reindeer which was using fat at the observed rate of 28 g.day^{-1}, equivalent to 242 kcal.day^{-1} (see Tyler, in press), could meet its daily energy requirement in late winter if it ate 1.7 g DM per grazing minute. If the water content of forage plants in Svalbard in winter is assumed to be 30%, this value would be increased to 2.2 g fresh weight of forage per grazing minute. Svalbard reindeer actually feed for only 80% of grazing time in late winter (Tyler 1987); hence the rate of ingestion required is 2.8 g forage per feeding minute. Results are summarised in Table 2.

Discussion

The winter daily dry matter intake of Svalbard reindeer has not been estimated before. White and Staaland (1983) estimated that the animals (age and sex not specified) ate 3.6 kg DM per day in summer, based on measurements of volatile fatty acid production. My estimates (2.4 and 1.3 kg DM per day respectively for pregnant and non-pregnant females; Table 2) are lower as would be expected: Svalbard reindeer undergo a pronounced seasonal cycle in body weight (Reimers and Ringberg 1983; Tyler, in press) which seems to have an intrinsic basis (Nilssen,

Table 2. Rates of ingestion necessary for pregnant and non-pregnant adult female Svalbard reindeer to meet their daily energy requirements late in winter.

	Pregnant	Non-pregnant
Daily energy expenditure (kcal)*	2 829	1 735
Contribution from fat (kcal)*	87	242
Required forage intake (kg DM.day^{-1})	2.4	1.3
Required rate of forage intake (g DM.grazing min^{-1})	3.1	1.7
Required rate of ingestion (g FW.feeding min^{-1})	5.0	2.8

* from Tyler (in press).
DM Dry matter
FW Fresh weight

Sundsfjord and Blix 1984). Hence, their maintenance energy requirements are lower in winter than in summer and they eat less (see also Larsen, Nilsson and Blix 1985).

Fancy (1986: 155) calculated that free ranging caribou eat between 3.0 and 8.3 g DM per grazing minute in late winter. Caribou, however, are much bigger animals than Svalbard reindeer (adult female caribou weigh between 73 to 100 kg in late winter compared to about 50 kg in Svalbard reindeer) and so they would be expected to eat more.

The model predicted that pregnant and non-pregnant adult female Svalbard reindeer could meet their daily energy requirements in late winter if they achieved rates of food intake of 3.1 and 1.7 g DM, respectively, per grazing minute. We have no figures for the aerial biomass of forage in Svalbard but inspection of the range late in winter suggests that these values are not unreasonably high. The results are therefore consistent with the suggestion that Svalbard reindeer live off forage, not fat, during winter.

Acknowledgement:

This study was a part of the Norwegian MAB (UNESCO Programme on Man and the Biosphere) project on Svalbard. Additional support was provided by a Special Research Grant from the Eco-Sciences division of NATO.

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Manuscript received 1. November 1986