Seasonal variations and responses to normal activity of the deep body temperature in the Svalbard reindeer *(Rangifer tarandus platyrhynchus)*

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Abstract: Deep body temperature was recorded in two female Svalbard reindeer during summer and winter. The reindeer were subjected to naturally occurring weather, photoperiod and stimuli in outdoor pens on Svalbard. A telemetry system was employed using transmittors ingested into the rumen. Mean deep body temperature was 0.3°C higher in winter and while the animals were lying down. This suggests a different strategy for thermoregulation than that employed by other reindeer subspecies.

Key words: reindeer, deep body temperature, seasonal changes, resting means, normal activity means.

Rangifer, Special Issue No. 1, 1986: 81 - 85

Introduction

The Svalbard reindeer is found on the high arctic Svalbard Archipelago, between 77° and 81° N.Lat. Mean monthly air temperatures are below 0°C for most of the year, strong winds are common and the sun is below horizon for over 4 months. To maintain a constant deep body temperature (T_{db}) in this cold climate these reindeer employ various means for reducing heat loss. Morphological adaptations such as their small appendage size and thick pelt, as opposed to other reindeer races have been described by many and may assist in reducing heat loss. Still, relatively little is known about the T_{db} of these animals.

The T_{db} of caribou calves (*R. t. tarandus*) was studied by McEvan *et al.* (1965) and observed to be 39°±0.78°C. Later the T_{db} for non-exercising and exercising adult reindeer (*R t. tarandus*) was recorded by Hammel *et al.* (1972) as 38.4°±0.2°C and 39.2°±0.1°C respectively. Yousef and Luick (1975) reported T_{db}'s between 38.4° and 38.8°C from yearling reindeer (*R. tarandus*) in ambient temperatures of 10° to 30°C. Segal (1983) and Segal and Ignatov (1974) investigated the T_{db} of adult reindeer (*R. t. tarandus*) and found a 0.3°C reduction during winter. Cermnych and Visneveckaja (1980) studied adult reindeer (*R. t. tarandus*) during late winter and reported T_{db}'s of 38.3°±0.01°C, with fluctuations from 38.0 to 38.8°C. They also stated that the T_{db} of 16 animals dropped to 37.7±0.02°C in response to a 16°C decrease in ambient temperature, which occurred over 12 hours. This suggests an inertia in the regulatory system's response to decreased T_{db}'s. Also, the above information indicates that there are seasonal deep body temperature differences, differences between calves and adults and from rest to exercise.

Since there was no published literature on T_{db} in Svalbard reindeer (*R. t. platyrhynchus*), a study seemed warranted. The present work investigated for seasonal variations in T_{db}, and the possible relationship between T_{db} and their normal lethargic movements and resting.

Methods and materials

Seasonal variations and responses to normal activity of T_{db} were investigated by the remote monitoring of two tame female reindeer, F_1 and F_2, subjected to naturally occurring weather, photoperiod and stimuli in outdoor pens.

Activity observations recognized only two activity levels 1) resting and 2) active. «Resting» meant lying down. During the winter resting was always in the curled up, legs under, round ball posture. «Active» included all activities where the reindeer were on their feet, eg. standing, walking, grazing. All such movement was usually lethargic.

Measurements of T_{db} and observations of activity were recorded hourly for a minium of 96 continuous hours during an observation period. Observation periods were in February, March and December for both F_1 and F_2, while for F_2 July and August were also included. In addition, during December, February and March, the animals were continually observed between measurements to ascertain the length of time they spent resting.

Deep body temperature was actually rumen temperature, measured using SINTEF temperature sensitive radio transmitters (SINTEF Reguleringsteknikk, 7034 Trondheim) which were ingested. These thermistor temperature sensors had an accuracy of ±0.2°C and were Teflon coated cylinders, with length 50 mm and diameter 20 mm. The transmitters responded to changes in temperature by altering signal-pulse frequency, which was detected by an FM radio. A stop watch was used to measure the time taken to record 50 signals. The T_{db} was then read from the calibration chart for that transmitter. Calibration of transmittors before use was done by the SINTEF office. Body temperatures were always measured at least three times. The mean from these three was taken as the T_{db} for that measurement.

Traditionally deep body temperatures are measured by rectal probe. To help evaluate this study's results to those of previous studies, comparison measurements of rectal and rumen temperature were taken simultaneously at 5 different ambient temperatures (—20°, —2°, 5°, 11° and 23°C).

Comparison of sample means was done by computing "t" for unpaired series of samples from two populations, a "t" test with no assumptions made as to equality of the variance (Snedecor and Cox, 1967). All temperature means are given with their standard error of the mean. The ±0.2°C accuracy error of the sensors became intrinsic within the standard deviation for individual measurements and standard error of the mean due to the volume of samples.

Results

Mean T_{db} for F_1, at age 4 months, was 39.14±0.07°C, (mean ambient temperature —3°C). The mean T_{db} for F_1 and F_2, from 12 to 18 months of age, was 38.83±0.05°C.

T_{db}'s changed seasonally. For F_1 T_{db} rose from a combined mean for activity and resting of

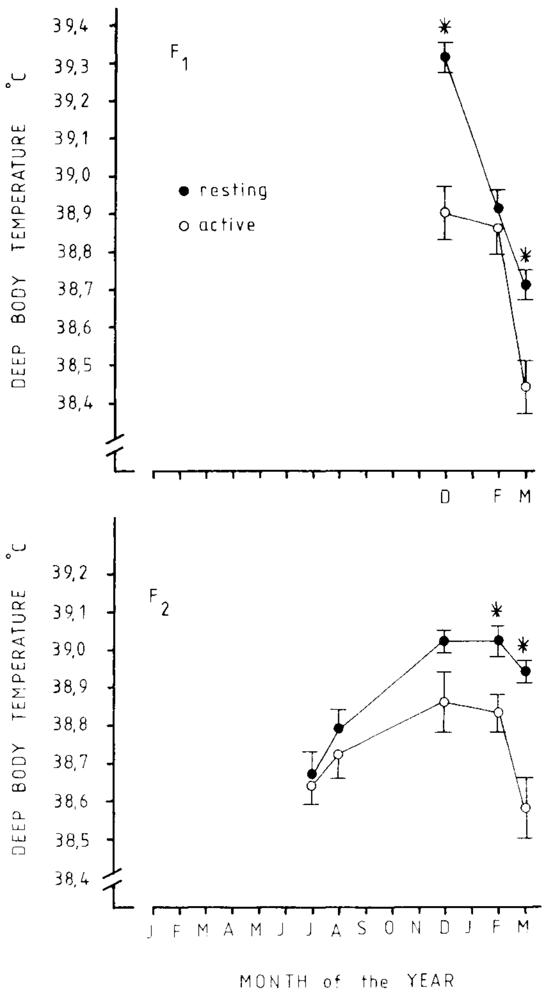

Fig. 1 Deep body temperature means for normal activity and rest in July, Aug., Dec., Feb. and March. Animals F_1 and F_2 are shown separately (mean±se). Months in which the difference between the two means was significant are marked with an asterix.

38.65±0.04°C in July (n=107) to 38.96±0.04°C in December (n=108). This difference in the means from July and December was significant ($P<0.001$).

The mean of all resting values for F_1 and F_2 combined was 38.92±0.02°C(n=530). Similarly the mean for all activity values was 38.73±0.02°C (n=360). The difference between these means was also significant ($P<0.001$).

Examined each month, the mean T_{db}'s for resting are higher than mean T_{db}'s for activity (Fig. 1), but the difference was not always statistically significant. For F_1 there was a significant difference between the mean T_{db}'s for resting and activity, in the months of December and March ($P<0.001$ and $P<0.002$ respectively). For F_2 significant differences occurred in February and March ($P<0.01$ and $P<0.001$ respectively) (Fig. 1).

During December, February and March significant differences between resting and active T_{db}'s were found when the animals rested continuously (no activity between the hourly observations) for 1 or more hours. The mean T_{db} for rest and activity combined was 38.83±0.05°C. However the mean T_{db} for activity occurring in the hour just prior to continuous rest was 38.68±0.07°C (Fig. 2). After one hour of continuous rest, the mean T_{db} was 39.01±0.04°C (Fig. 2). The 0.3°C difference between the initial active T_{db} and the T_{db} following continuous rest of 1 more hours was statistically significant ($P<0.001$). There were no significant differences ($P<0.05$) among the resting means shown in fig. 2, though each by itself, was significantly different from the initial active T_{db} ($P<0.001$ for 1, 2, and 3 hours rest; $P<0.02$ for 4 hours and $P<0.05$ for 5/6 hours).

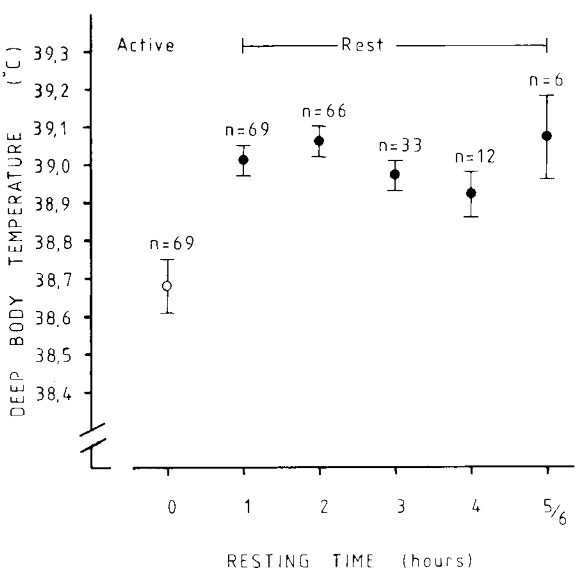

Fig. 2 Deep body temperature differences between resting for 1 or more hours and normal activity prior to rest during the Dec., Feb. and March observation periods (mean±se).

The mean rectal T_{db} was always lower than mean rumen T_{db} at all 5 ambient temperatures tested. The difference between the two was least, 0.3°C, at ambient temperatures above 0°C. At ambient temperatures of —2° and —20°C the temperature difference was 1.0° and 1.6°C respectively. All differences were significant ($P<0.05$).

Discussion

Deep body temperatures measured were rumen temperatures. When rumen and rectal measurements were compared mean rectal T_{db} was always lower than mean rumen T_{db}. The temperature difference perhaps can be accounted for by rumen microbial activity providing a fermentation heat increment thereby elevating all T_{db} measurements. Heat production of rumen ingesta can be as high as (0.09kcal/hr)/kg body wt. (Hammel *et al.*, 1962). However, the temperature difference between rumen and rectal means was not constant (being greater at ambient temperatures below 0°C) suggesting that rumen microbial activity may not be the only factor operating.

Snow ingestion affected only 9 out of the 100's of individual measurements within the study and were considered insignificant in affecting overall temperature means.

Mean T_{db} was 38.83°±0.05°C for normal activity and resting combined, in reindeer aged 12 to 18 months. These results were higher than the 38.4°C for adults from the study by Hammel *et al.* (1972). The presence of a fermentation increment might account for some of this difference. However, Yousef and Luick (1975), reported T_{db}'s of 38.4 to 38.8°C for yearlings (Table 1).

F_1 at 4 months of age had a mean T_{db} of 39.14±0.07°C similar to McEwans's *et al.* (1965) 39.0±0.78°C for caribou calves (Table 1).

Observed deep body temperatures were surprisingly higher when the animals were resting than when active. Mean deep body temperature rose 0.3°C and stabilized at

Table 1. Mean body temperature (°C) of reindeer/caribou, *Rangifer tarandus*

Subspecies	Adult/Subadult					Calf	Reference
	Summer	Winter	Rest	«Active»*	Exercise		
tarandus	------	------	------	------	------	39 ±0.78°	McEwan *et al.* (1965)
tarandus	------	------	------	38.4 ±0.2°	39.2 ±0.1°	------	Hammel *et al.* (1972)
tarandus	------	------	------	38.3 to 38.8°	------	------	Yousef and Luick (1975)
tarandus	38.7	38.4	------	------	------	------	Segal and Ignatov (1974)
tarandus	38.7 ±0.4°	38.4 ±0.2°	------	------	------	------	Segal (1983)
tarandus	------	38.3 ±0.01°	------	------	------	------	Cermnych and Visneveckaja (1980)
platyrhynchus	38.65 ±0.04°	38.96 ±0.04°	38.92 ±0.02°	38.73 ±0.02°	------	39.14 ±0.07°	This study
	mean (rest + normal activity) 38.83±0.05°						

* «active» for this study was all normal lethargic activity; for other studies «active» meant non-exercise.

≈39.0°C (Fig. 2) when lying down for 1 or more hours in winter (unfortunately summer data concerning lying down was not available). This increase was probably due to a reduction in total conductance as a result of the «round ball» resting posture. Thus small T_{db} increases, within the ranges measured, seen to be tolerated without any metabolic adjustment being made to keep T_{db} strictly constant. The T_{db} rise indicates an inertia in the regulatory system. Cermnych and Visneveckaja (1980) also found indication of inertia within the system, but in their study it was for T_{db} decreases.

Mean T_{db} was highest in winter and lowest in summer. The winter rise of 0.3°C in mean T_{db} may not be accounted for by rumen fermentation rate, as this is lower in winter, due to reduced food intake. If the fermentation heat increment was important, one would expect a winter decrease i rumen T_{db} and a summer increase. Instead this winter increase can most probably be accounted for by the extremely thick and long winter pelt providing a much lowered fur conductance, as opposed to the summer pelt, for the same amount of the heat production. Thus even with the cold winter air temperatues considered, the winter fur conductance is so low as to cause T_{db} to rise as heat loss is reduced. The T_{db} increase need not be a result of increased metabolism. In fact Segal (1983) reported a 25% reduction in winter metabolic rates for reindeer and Nilssen (1984) studying Svalbard reindeer, observed reductions in the winter resting metabolic rate. Nilssen (1984) suggested the reductions were due to the animal's decreased winter feed intake and not the result of a physiological adaption. The winter rise in mean T_{db}'s may also be to some extent affected by the Svalbard reindeer's very low level of locomotor activity in winter. Cuyler (1984) found that the same two reindeer studied spent 65% of their time resting i winter. Since the present study has shown mean T_{db} was highest while resting, this lack of winter movement may be of importance for thermoregulation and contribute to the high winter T_{db} mean.

In contrast to this study's 0.3°C winter increase in mean T_{db}, work by Segal (1983) and Segal and Ignatov (1974) reported a 0.3°C winter reduction in T_{db} for *R. t. tarandus* (Table 1). This difference may have been caused by experimental methods or may be the result of different strategies for thermoregulation being employed by these two subspecies of reindeer. It is difficult to describe a strategy for the reindeer used in Segal (1983) and Segal and Ignatov's (1974) studies without more information. However from observation, the winter strategy of Svalbard reindeer seems to include a thick insultative pelt, little activity and much rest in curled round ball posture (65% of the time). The resting posture by reducing overall conductance, enables the animal to maintain T_{db} without the expence of extra work or metabolism.

Aknowledgements

This study was financed by the Norwegian MAB project on Svalbard and conducted through the Norwegian Polar Research Institute.

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