The effect of changes in fur insulation and activity on different modes of heat loss in reindeer

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Climatic conditions in the natural habitats of reindeer (*Rangifer tarandus tarandus*) may show large seasonal fluctuations. At one extreme, low ambient temperatures may prevail in combination with wind and precipitation, which imposes a large negative thermal load on these animals. At the other extreme, high ambient temperatures in combination with intense solar radiation may, especially when combined with heavy exercise, cause reindeer to be severely heat stressed.

Maintenance of homeothermy under these circumstances is possible due to the physical, physiological and behavioural characteristics of the animal, *i.e.* a large seasonal change in the insulative value of the fur (Moote, 1955), a great capacity for changing the physiological insulation (*e.g.* by use of nasal heat exchange (Blix & Johnsen, 1983) and of counter current circulation in the extremities (Irving & Krog, 1955)) and finally adequate behavioural temperature regulatory responses.

The purpose of this study was to investigate how some of these thermoregulatory mechanisms respond to changes in the thermal environment of the reindeer. This was achieved by examining changes in the relative importance which different modes of heat loss have under various conditions.

Thus, partition of heat loss was performed in winter and summer insulated reindeer during rest (standing) and exercise (running on a level treadmill at 9.2 km·h^{-1}) in a climatic chamber set to an ambient temperature (T_a) of —30, 0 or 25°C. The experiments involved determining values for the parameters in the following heat balance equation:

$$S = MR + mo \pm W - E - R - K - C$$

The methods involved were as follows:

S (rate of change in heat storage) was calculated from the body weight of the animal and from changes in its body core (rectal) temperature

MR (metabolic rate) was determined by indirect calorimetry, using an open circuit system.

mo (heat produced by micro-organisms inside the gastrointestinal system of the reindeer) was not measured. However, a value of 0.05 W·kg (body weight)$^{-1}$ was used, the value taken from a previous study in the reindeer by Hammel *et al.* (1962).

W (work). The work exerted both by a standing reindeer and by an animal running on a level surface is zero.

E (evaporative heat loss), represented by respiratory evaporative heat loss, was determined by indirect calorimetry, using an open circuit system.

R (radiant heat loss) was calculated from the effective radiating surface area and the mean radiative temperature of the reindeer, (determined with an AGA Thermopoint 80 Infrared radiometer) according to a formula presented by Porter (1969).

K (conductive heat loss) was considered negligible as the contact area between the reindeer and the floor was very small.

C (convective heat loss) was calculated by subtraction.

Of the above parameters, S, MR, E and R were simultaneously determined.

Results showed that the resting winter insulated reindeer lost heat mainly through radiation and convection at the two lower T_a's (92.6% of total heat loss at T_a —30°C and 87.7% at T_a 0°C). At a T_a of 25°C, however, the importance of evaporative heat loss increased to 44.6% of total heat loss. During exercise in winter, ca. 90% of total heat loss occurred through evaporation and convection at T_a's —30 and 0°C. No measurements were made on the winter insulated reindeer exercising at T_a 25°C, as the animals refused to run at this temperature. The resting summer insulated reindeer lost heat according to a pattern similar to that found in the resting winter insulated animal. However, during summer, the importance of evaporative heat loss was smaller than during winter, evaporative heat loss never representing more than 16% of total heat loss in the resting summer insulated animal. In the exercising summer insulated reindeer the importance of radiant heat loss was approximately twice the value found during exercise in winter.

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