Rain more important than windchill for insulation loss in Svalbard reindeer fur

Christine Cuyler[1] & Nils A. Øritsland[2]

[1]Greenland Institute of Natural Resources, P.O. Box 570, DK-3900 Nuuk, Greenland (chcu@natur.gl).
[2]Ovenbakken 14 B, 1361 Østerås, Norway.

Abstract: Heat transfer through dry and wet Svalbard reindeer (*Rangifer tarandus platyrhynchus*) summer and winter mid-back fur samples was studied in a wind tunnel. A light wetting water spray simulated heavy fog, mist or light rain, while heavy soaking simulated heavy rain. Wind velocities ranged from 0 to 10 $m \cdot s^{-1}$. Calf fur samples were from June, August and March. Adult fur samples were females from August and March. There was no evidence for increased heat loss from lightly wet fur relative to dry fur. Calm air conductance decreased for calf fur (P's < 0.05). Adult fur also decreased, however, the difference was not significant (P > 0.05). Further, wind coefficients and regressions for lightly wet fur were similar or below those for dry fur. A thin water film forming on the fur surface may have caused this. It is unlikely that a light rain, fog or mist would cause increased heat loss for Svalbard reindeer, and no increase of metabolic heat production would be needed to maintain thermoregulation. Only the simulated heavy rain dramatically raised heat loss from the fur samples examined regardless of age or season, *e.g.*, heavy soaking increased calm air conductance for all furs (P's < 0.05). This was likely due to the addition of evaporative heat loss from the fur surface and a reduction in the amount of trapped air within the fur. Windchill was of minor importance, since wind coefficients were generally close to zero, meaning increasing wind velocity only marginally raised heat loss even with the added effect of evaporative heat loss. Rain would cause greater insulation loss than increasing wind velocity in Svalbard reindeer of all ages, with the exception of calves under one month old, which could experience dramatic insulation loss from a combination of heavy rain and windchill. Dry or wet, Svalbard reindeer fur appears to provide better insulation than fur of others of their species.

Key words: conductance, heat loss, heat transfer, *Rangifer tarandus platyrhynchus*, thermoregulation, wind coefficient.

Rangifer, 24 (1): 7-14

Introduction

Forced convection by wind increases fur heat loss in Svalbard reindeer, *Rangifer tarandus platyrhynchus*, however the effect is not dramatic, (Cuyler & Øritsland, 2002a). A wet fur in combination with wind may have further increases in heat transfer. The fur of the high arctic Svalbard reindeer is its major barrier to heat loss. Any increase in heat loss requires counterbalancing measures, which can include an increase in metabolic heat production, to maintain heat balance. If a substantial decrease in fur insulation occurs when encountering rain with wind, potentially it could strain the animal's thermo-regulatory stability. Yet, *Rangifer* have been observed to swim wide fjords and survive winter rain and ice storms. Perhaps the insulation of wet fur is not dramatically different from dry fur.

If wet fur causes substantial increases in heat loss, calf survival may be threatened due to their small body size and high surface area to volume ratio relative to adult reindeer. Hart *et al.* (1961), studying infant caribou calves (*Rangifer tarandus groenlandicus*), observed that a combination of cold ambient temperatures, wind and wet fur increased the resting meta-

Table 1. Heat transfer through dry, light wet and soaked mid-back fur samples from Svalbard reindeer at zero wind velocity, with respect to age and season.

Season	Number of fur samples	Total observations (n)	Calm air Conductance[1] [$W \cdot m^{-2} \cdot °C^{-1}$]	Standard deviation (s)	Remarks	Water spray
Calving (June)						
Calf	3	10	2.94*	0.17	dry fur	none
	3	9	2.77	0.14	light wet fur	222 $g \cdot m^{-2}$
	3	3	9.18	5.29	soaked fur	2222 $g \cdot m^{-2}$
Summer (August)						
Calf	3	9	2.09	0.12	dry fur	none
	3	9	1.89	0.14	light wet fur	222 $g \cdot m^{-2}$
	2	2	4.52	1.19	soaked fur	2222 $g \cdot m^{-2}$
Adult female	3	13	2.56**	0.42	dry fur, lactating	none
	3	9	2.15	0.46	light wet fur	222 $g \cdot m^{-2}$
	3	3	6.07	3.54	soaked fur	2222 $g \cdot m^{-2}$
Winter (March)						
Calf	1	5	0.60***	0.05	dry fur	none
	1	3	0.43	0.01	light wet fur	222 $g \cdot m^{-2}$
	1	2	1.75	0.01	soaked fur	2222 $g \cdot m^{-2}$
Adult female	1	6	0.57***	0.08	dry fur	none
	1	3	0.51	0.01	light wet fur	222 $g \cdot m^{-2}$
	1	2	1.24	0.004	soaked fur	2222 $g \cdot m^{-2}$

[1] Empirical values are presented here, and not the *y*-intercepts of the regressions given in Table 2.
* June calf calm air conductance for dry fur was incorrectly written as 3.44 $W \cdot m^{-2} \cdot °C^{-1}$, ± 0.34 in Cuyler & Øritsland (2002a).
** Current August dry fur conductance value was calculated using just the three lactating cows with calves, as only these were studied using simulated rain. Therefore the value differs from Cuyler & Øritsland (2002a), which combined three lactating and three non-lactating females. Further, the three non-lactating August cows without calves had a mean calm air conductance for dry fur of 1.72 [$W \cdot m^{-2} \cdot °C^{-1}$], which was significantly lower ($P < 0.0001$) than for the three lactating cows.
*** Current March dry fur conductance values for both calf and adult were calculated using just the fur sample studied with simulated rain. Therefore the values differ from Cuyler & Øritsland (2002a), which combined data from three calves or nine adults respectively.
n is the total number of observations. Soaked fur results had high standard deviations in June and August because there was only one observation per fur sample and variation was high among fur samples.

bolic rate 5-fold. Lentz & Hart (1960) observed that adding water to 10-12% of the volume of caribou calf fur doubled the rate of heat transfer. Holmes (1981) studying the affects of a fine water spray, observed a 40% increase in the rate of heat transfer for 6 cm deep lamb's wool, and a 100% increase for 0.5 to 1 cm deep cattle calf fur. Kelsall (1968) reported that severe weather is often fatal for new-born caribou calves, and Markussen *et al.* (1985) observed that wetting reindeer (*Rangifer tarandus tarandus*) calf fur increased conductance by almost five times. Yet Tyler (1987) observed no evidence of significant mortality in Svalbard reindeer calves between 0 and 4 months over successive summers, and no evidence that more calves died during harsh weather.

The thermal properties of wet Svalbard reindeer fur have not been described. Previous investigations on caribou fur describe the effects of rain over only a narrow range of wind speeds. Rain may substantially alter the rate of heat transfer in animals whose primary insulation is fur. Further, wet fur, with added evaporative heat loss, may be more susceptible to windchill than dry fur. The climate of Svalbard (77°-81°N) includes mid-winter rainstorms followed by severe cold, and strong winds on a daily basis are typical year round. This paper examines the rates of heat transfer through adult and calf fur samples with respect to simulated rain and increasing wind velocities. Increases in calm air conductance or wind coefficient for wet fur relative to dry fur will reflect decreased fur insulation.

Material and methods

Fur samples

Whole pelts were collected from 4 adult females and 7 calves of Svalbard reindeer (*Rangifer tarandus platyrhynchus*). These were fleshed, dried and frozen. Mid-dorsal fur samples, measuring 30 cm by 30 cm, were cut from the whole pelts. Three adult females were collected in mid-August and the fourth in late March. All females had calves accompanying them, and the March adult was also pregnant. Three calves were collected in late June, three in mid-August, and one in late March. Svalbard reindeer calves are typically born in early June (Tyler, 1987); thus calf age ranged from under 1 month (2-3 weeks) to about 10 months.

Wind tunnel

A wind tunnel, as described in Øritsland *et al.* (1980), was used. Fur samples were mounted over a heat flow disc (which measured heat flow in $W \cdot m^{-2}$), and positioned at an angle with respect to wind direction. The heat flow disc, embedded in a layer of grease, was positioned over a steel chamber through which water of 38 ± 0.2 °C was continuously circulated. A grease layer sealed the fur sample to the steel chamber and assured uniform thermal contact. Thermoelements measured temperatures in the grease layer, at the skin surface, and above the fur. Fur samples were exposed to wind velocities of 0 to 10 $m \cdot s^{-1}$, and wind direction was in line with the grain of the fur. Heat flow was recorded when stable for *ca*. 30 minutes. A detailed account of the method for heat flow measurements is described in Cuyler & Øritsland (2002a). Detailed descriptions of the fur samples' physical characteristics are found in Cuyler & Øritsland (2002b).

Simulated rain

To simulate rain, the 30 cm by 30 cm (0.09 m^2) fur samples were covered with a fine even spray of water. To simulate the conditions of a heavy fog or light rain, a mist spray of 20 ml (222 $g \cdot m^{-2}$) was used. The water did not appear to penetrate the fur surface. To simulate a heavy rain, 200 ml (2222 $g \cdot m^{-2}$) of spray was used. Following the latter, all fur samples were wet completely through, *i.e.*, soaked. When combining simulated rain with increasing wind speeds, drying by evaporation was a consideration. Therefore the wet condition of the fur samples was maintained for each wind velocity.

Soaked fur samples were examined only once, because the skin shrank and buckled when it later dried. The buckling made it impossible to obtain uniform thermal contact between the fur sample and the steel chamber for repeat trials. Further, it was assumed that fur sample shrinkage altered hair density and hence possibly heat transfer.

Theoretical considerations

In principle the rate of heat transfer from wet fur samples would result from a combination of convective and evaporative heat loss from the fur surface. Evaporative heat loss is affected by ventilation, *i.e.*, wind increases the rate of evaporation. The heat flow disk, described above, measured the combined heat transfer, in $W \cdot m^{-2}$, so an attempt to calculate each avenue of heat loss was unnecessary. Further, both convective and evaporative heat loss are functions of wind velocity and their equations have similar form. Therefore this study judged it practical to continue to employ the equation for rate of convective heat transfer to examine heat loss from the fur samples. The effect of evaporative heat loss may be attributed to observed increases in wind coefficients for wet fur compared to dry (although an increase in heat transfer by forced convection is implied) and much of any apparent increase in heat loss. Detailed theoretical considerations for convective heat transfer are given in Cuyler & Øritsland (2002a). The following is a brief overview.

The rate of convective heat transfer (Q) from a fur sample to the air is a function of the wind velocity (Tregear, 1965; Campbell *et al.*, 1980), and is given by the following equation:

$$Q = \overline{h_c}(T_S - T_a) = \overline{h_c}\,\Delta T \qquad [W \cdot m^{-2}] \qquad (1)$$

Where $\overline{h_c}$ = the mean surface coefficient for heat transfer $[W \cdot m^{-2} \cdot {}^{\circ}C^{-1}]$; and T_S and T_a = skin and fur surface temperature respectively [°C]. These may also be represented as the temperature difference ΔT [°C]. 1 W = 1 $J \cdot sec^{-1}$.

The $\overline{h_c}$ is dependent on many parameters within a boundary layer system and may vary from point to point over a surface and therefore one considers a local or average $\overline{h_c}$ (Kreith, 1976).

According to Cuyler & Øritsland (2002a), the relationship of the mean convective heat transfer coefficient, $\overline{h_c}$, to wind velocity for Svalbard reindeer fur is linear under the test conditions and may be written as:

$$\overline{h_c} = h + bV \qquad [W \cdot m^{-2} \cdot {}^{\circ}C^{-1}] \qquad (2)$$

Where h = calm air thermal conductance $[W \cdot m^{-1} \cdot {}^{\circ}C^{-1}]$ determined by extrapolating the line through zero wind velocity; b = experimentally determined wind coefficient, which indicates the importance of windchill, with large values reflecting a low resis-

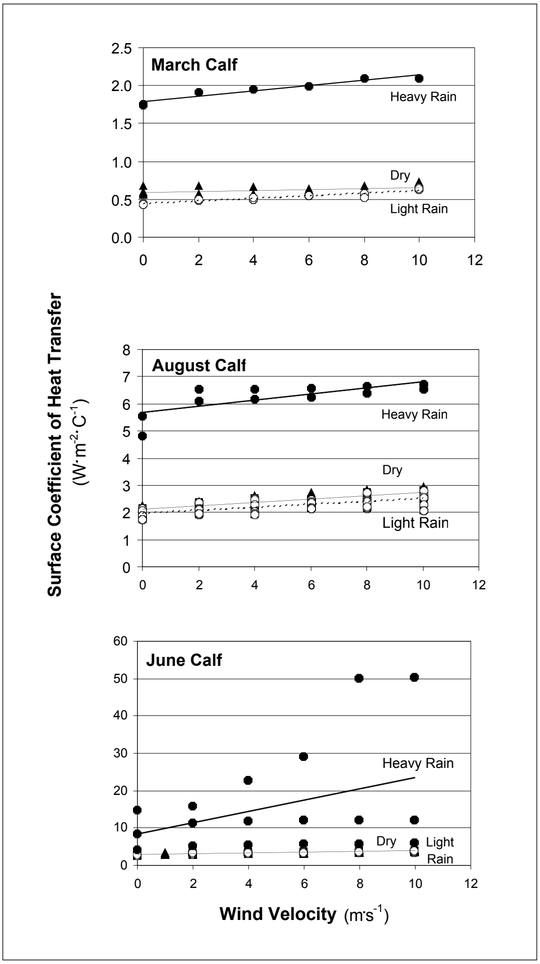

Fig. 1. Linear regressions of the surface coefficient of heat transfer on increasing wind velocity for dry and wet Svalbard reindeer calf fur samples from June, August and March. (● Heavy rain; ▲ Dry; ○ Light rain). All regression lines are calculated and drawn by Microsoft Excel.

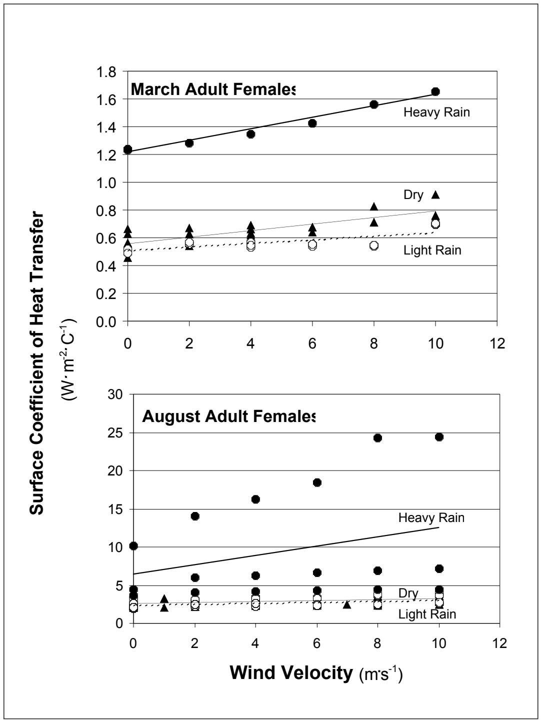

Fig. 2. Linear regressions of the surface coefficient of heat transfer on increasing wind velocity for dry and wet Svalbard reindeer adult fur samples from August and March. (● Heavy rain; ▲ Dry; ○ Light rain). All regression lines are calculated and drawn by Microsoft Excel.

tance to windchill (Øritsland, 1974); and V = wind velocity [$m \cdot s^{-1}$]. Linear regressions of heat transfer as a function of wind velocity were determined by the method of least squares.

Microsoft excel program package was used for both *t*-test statistics and linear regressions of heat transfer as a function of wind velocity (determined by the method of least squares) and for the regression line analysis.

Results

Simulated heavy fog, mist or light rain

Calf fur: Calm air conductance

The lightly wetted fur samples did not increase calm air conductance above dry fur values. Instead a light wetting significantly decreased calm air conductance in calves regardless of season (P < 0.015, 0.002 and 0.0005; June, August and March respectively) (Table 1).

Calf fur: Wind coefficient *(b)*

Mean wind coefficients (regression line slopes) of the lightly wetted calf fur remained basically unchanged from their dry values (Table 2). Calf fur wetted with simulated light rain did not increase the surface coefficient of heat transfer, $\overline{h_c}$, relative to dry values regardless of wind velocity or season, as regressions were similar (Fig. 1).

Adult fur: Calm air conductance

The light wetting did not increase mean calm air conductance (Table 1). Instead there was a decrease, however, the differences between dry and lightly wet adult fur samples were not significant (P = 0.08 and 0.066 for August and March respectively).

Adult fur: Wind coefficient *(b)*

A simulated light rain did not increase the surface coefficient of heat transfer, $\overline{h_c}$, relative to dry values. The regressions were almost identical (Fig. 2).

Simulated heavy rain

Calf fur: Calm air conductance

The heavy soaking of fur samples significantly increased calm air conductance above dry fur values regardless of season (P's < 0.012, 0.035, 0.0005; June, August and March respectively). The greatest loss of insulation was seen in the June fur samples, from 2-3 week old calves, which had a three times increase in heat loss.

Calf fur: Wind coefficient *(b)*

Influence of windchill was greatest in the shorthaired June calf fur. The mean wind coefficient (slope of regression line) of soaked June calf fur was *ca.* 17 times the dry value. In contrast, the soaked August fur was only 2 times, and soaked March fur 4 times their dry values (Table 2). Interestingly, after one hour of 10 $m \cdot s^{-1}$ winds the soaked longhaired March fur dried sufficiently to return fur conductance to dry values.

Adult fur: Calm air conductance

The heavy soaking of fur samples significantly increased calm air conductance above dry fur values regardless of season (P < 0.021, 0.0005 for August and March respectively). Insulation was halved.

Adult fur: Wind coefficient *(b)*

Simulated heavy rain did increase the fur surface coefficient of heat transfer, $\overline{h_c}$, while the mean wind coefficient (slope of regression line) increased about 9-fold for the shorter haired August fur, but only 2-fold for the longer haired March fur. However, the wind coefficients continued to remain close to zero so windchill was of minor importance especially for winter fur.

Discussion

Hammel (1955) stated that heat transfer in fur was primarily due to natural convection of air in the fur. The amount of still air trapped between individual hairs within the fur therefore provides the major determinant of a fur's insulation. Since wet fur would likely have less trapped air, a simulated rain was expected to raise calm air conductance according to Lentz & Hart (1960) and Alexander (1962), since the conductivity of water is about 25 times that of air (Weast, 1971). Further, with wet fur the added heat loss of evaporation must be considered, specifically with increasing wind velocity. If wind coefficients increase for wet fur, compared to dry, this likely reflects the effect of evaporative heat loss. Where wind coefficients remain close to zero, the effect of windchill is diminished.

Simulated light rain, mist or heavy fog

A light wetting of Svalbard reindeer fur samples did not increase heat loss, and suggests that evaporative heat loss was not important. Rather, rates of heat transfer were typically lower than those for the dry fur samples. Compared to dry values, the mean calm air conductance actually decreased after a light wetting. Wind coefficients, which express the influence of windchill, remained close to zero and basically unchanged, indicating windchill was not important for lightly wet fur. Perhaps a water film formed on the fur surface and trapped air, already held within the fur, preventing both air movement and escape, while hindering wind penetration into the fur. Nevertheless, a light spray, even when compounded with increasing wind speeds, did not increase the rate of heat transfer from a Svalbard reindeer fur sample. This suggests that light rains, mists or fog, with or without wind and regardless of season, should not greatly alter an animal's heat balance, cause greater Svalbard reindeer calf mortality, or require compensatory increases in metabolic rates.

Simulated heavy rain

Simulated heavy rain was the major factor for heat loss from all fur samples. The increased heat transfer may be ascribed to the effect of evaporative heat loss and reduction in fur insulation. Insulation dropped about 2-fold, as evidenced by the significant increases in calm air conductance for all furs regardless of age or season. A probable physical cause was loss of trapped still air within the fur, which was replaced by water with its high conductivity. For a reindeer with similarly soaked fur, actual heat loss may be less than observed in this study. Scholander (1950) suggested animals would shake off excess water, restoring some of the trapped air layer and insulation value of their fur. Therefore, the present results for soaked fur samples may be maximums.

Although simulated heavy rain did increase heat transfer, soaked adult Svalbard reindeer winter fur, still offered considerable insulation relative to others of their species. At wind velocity zero, Moote's (1955) calm air conductance for dry adult winter caribou fur samples was 1.18 $W \cdot m^{-2} \cdot {}^{\circ}C^{-1}$, while soaked adult winter Svalbard reindeer was similar at 1.24 $W \cdot m^{-2} \cdot {}^{\circ}C^{-1}$. Further, Svalbard reindeer calves may also be better insulated to handle rain than others of their species. Even when 2-3 week old June Svalbard reindeer calf fur was soaked, calm air conductance relative to dry fur increased only three times versus a five times increase for new-born reindeer calf fur (*Rangifer tarandus tarandus*) (Markussen *et al.,* 1985). Also, Markussen *et al.*´s wet calm air conductance differed three times in magnitude from the present study's,

Table 2. Heat transfer through dry and wet mid-back fur samples from Svalbard reindeer measured in a wind tunnel. The linear relationship between surface coefficient of heat transfer ($\overline{h_c}$) and wind velocity, $\overline{h_c} = h + b\text{V}$ [$\text{W}\cdot\text{m}^{-2}\cdot{}^{\circ}\text{C}^{-1}$], with respect to age and season.

	Heat transfer regression										
Season Fur Sample[1]	Calm air conductance y-intercept (h)	$s_{\bar{x}}$*	95% confidence intervals lower	95% confidence intervals upper	Wind coefficient slope (b)	$s_{\bar{x}}$*	95% confidence intervals lower	95% confidence intervals upper	Regression statistics r^2	df	P
Calving (Jun)											
Calf dry	**3.03**	0.06	2.92	3.14	**0.09**	0.01	0.07	0.11	0.59	64	<0.0001
Calf light wet	**2.91**	0.04	2.83	2.10	**0.09**	0.01	0.08	0.11	0.77	53	<0.0001
Calf soaked	**8.21**	5.62	-3.71	20.13	**1.52**	0.93	-0.44	3.49	0.14	17	0.1202
Summer (Aug)											
Calf dry	**2.12**	0.03	2.05	2.19	**0.06**	0.01	0.05	0.07	0.69	53	<0.0001
Calf light wet	**1.98**	0.05	1.88	2.07	**0.05**	0.01	0.04	0.07	0.47	53	<0.0001
Calf soaked	**5.66**	0.20	5.21	6.11	**0.11**	0.03	0.04	0.19	0.54	11	0.0065
Adult dry	**2.59**	0.09	2.41	2.77	**0.07**	0.02	0.04	0.11	0.26	56	<0.0001
Adult light wet	**2.39**	0.12	0.02	2.62	**0.06**	0.02	0.02	0.10	0.16	53	0.0030
Adult soaked	**6.41**	2.87	0.33	12.50	**0.60**	0.47	-0.40	1.61	0.09	17	0.2219
Winter (Mar)											
Calf dry	**0.57**	0.02	0.53	0.61	**0.01**	<0.01	0.01	0.02	0.59	22	<0.0001
Calf light wet	**0.44**	0.01	0.42	0.46	**0.02**	<0.01	0.01	0.02	0.90	17	<0.0001
Calf soaked	**1.78**	0.03	1.72	1.85	**0.04**	<0.01	0.02	0.05	0.93	6	0.0005
Adult dry	**0.55**	0.02	0.52	0.59	**0.02**	<0.01	0.02	0.03	0.68	26	<0.0001
Adult light wet	**0.51**	0.02	0.47	0.55	**0.01**	<0.01	0.01	0.02	0.52	17	0.0007
Adult soaked	**1.22**	0.02	1.17	1.26	**0.04**	<0.01	0.03	0.05	0.97	6	<0.0001

[1] the number of fur samples for each season is given in Table 1.

* denotes standard error of the mean. Soaked fur results had high $s_{\bar{x}}$ values in June and August because there was only one observation at each wind speed per fur sample, and variation was high among fur samples.

being 28.7 $\text{W}\cdot\text{m}^{-2}\cdot{}^{\circ}\text{C}^{-1}$ for the former and only 9.18 $\text{W}\cdot\text{m}^{-2}\cdot{}^{\circ}\text{C}^{-1}$ for the latter. The different values from the two studies may be partially explained by the 2-3 week age difference between each study's fur samples. Further, while our results measured steady-state heat transfer, Markussen *et al.* (1985) estimated conductance from the cooling rates of a fur-copper bar assembly after pre-heating to 40 °C.

Windchill had little influence on heat loss from soaked Svalbard reindeer fur. Although wind coefficients for soaked fur rose relative to dry fur they also typically remained close to zero. The exception was the shortest haired 2 to 3 week old June calf fur. When June calf fur was thoroughly soaked, the wind coefficient increased 17-fold, which suggests a severe evaporative heat loss. Given the steep slope of the regression line, soaking June fur made it susceptible to windchill, which it was not when dry or lightly wet. This indicates that young Svalbard reindeer calves in heavy rainstorms would be extremely vulnerable to windchill. Their increased heat loss would require counterbalancing measures, such as increased metabolic heat production to maintain thermoregulation. Although windchill was usually of minor importance for heat loss, the drying effect of high winds might quickly restore fur insulation. This was indicated by the return of the soaked longhaired March calf fur sample to dry fur conductance values after 1 hour of 10 $\text{m}\cdot\text{s}^{-1}$ winds.

Two factors may contribute to Svalbard reindeer calf survival during inclement weather. Wet Svalbard reindeer calf fur appears more resistant to heat loss than other reindeer calf fur, and Svalbard reindeer are sedentary in behaviour (Tyler, 1987). Barren-ground caribou calves may move long distances in adverse weather (Hart *et al.*, 1961), which results in metabolic costs for both movement and thermoregulation given the maximized surface area to volume ratio. In contrast, Svalbard reindeer calves remain on the calving sites, and whenever necessary may utilize the lying position, which reduces the surface area to volume ratio and hence exposure to wind, rain or temperature. The relatively better insulation of wet fur and opportunity for lying may explain the lack of Svalbard calf mortality in years of harsh weather reported by Tyler (1987), in contrast to observations on caribou calves from Kelsall (1968).

Conclusions

Light rains mists or fogs probably would not affect a Svalbard reindeer's metabolic rate, or heat balance. With the exception of 2 to 3 week old calves, the influence of windchill appeared minimal, since insulation remained substantially unchanged when encountering rain with wind. Overall, rather than increasing wind velocity, simulated heavy rain was more important for increasing heat loss. Likely causes were primarily evaporative heat loss followed by the loss of still trapped air within the fur. The results suggest that whether dry or wet, calf or adult, Svalbard reindeer fur provides better insulation than others of their species. The excellent protection provided by their fur may be largely responsible for the Svalbard reindeer's continued survival and thriving population on this high Arctic Archipelago.

Acknowledgements

This research was funded by the Norwegian MAB (Man and the Biosphere) Svalbard project, as a contribution to the UNESCO MAB program and was administered by the Norwegian Polar Institute.

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Manuscript received 30 September, 2003
revision received 22 May, 2004
accepted 15 June, 2004

Abstract in Danish / Abstrakt:
Varmetab fra tørre og våde Svalbard rensdyr (*Rangifer tarandus platyrhynchus*) blev studeret fra midtrygs pelsprøver fra henholdsvis sommer og vinter. Pelsprøverne målte 30 cm x 30 cm og blev undersøgt i en vindtunnel. En simuleret tæt tåge eller støvregn blev dannet ved at fugte pelsprøverne med vandsprøjtning, mens gennemblødning simulerede kraftig regnvejr. Vindhastighed varierede fra 0 til 10 $m \cdot s^{-1}$. Pelsprøver fra kalve blev indsamlet i juni, august og marts, og fra voksne simler i august og marts. Der var ingen tegn på øget varmetab fra let fugtige pelsprøve relativ til de tørre pelsprøve. Vindstillekonduktansen var reducerede i kalvepelsprøve (P's < 0.05). Samme tendens blev ligeledes observeret i pelsprøverne fra de voksne dyr, men ingen signifikant forskel (P's > 0.05). Desuden var vindkoefficienter og regressionslinjer fra let fugtige pelsprøve meget lig de tørre pelsprøve, eller mindre. Dette kan være forårsaget af en tynd vandhinde på pelsprøvens overflade. Formodentlig vil der ikke forekomme øget varmetab hos Svalbard rensdyr ved tæt tåge eller støvregn, hvilket betyder at stofskiftet ikke øges for at bibeholde termobalancen. Kun kraftig regn, øgede varmetabet fra samtlige prøver uanset dyrets alder eller årstid. Dette blev påvist ved at vindstillekonduktansen var steget (P's < 0.05), antageligt forårsaget af det tilføjet fordampningsvarmetab fra pelsens overflade, samt en reduktion af indfanget stilleluft i selve pelsen. Vindchill var af meget lille betydning idet vindkoefficienter generelt var lig nul. Dette medfører at øget vindhastighed kun øger varmetabet meget lidt i våde pelsprøve. Kraftig regnvejr giver større tab af isolation end en øgning i vindhastighed for Svalbard rensdyr, undtagen kalve under en måneden gamle, som bliver udsat for et dramatiske isolationstab som følge af en kombination af kraftig regnvejr og vindfaktor. I både tør eller våd tilstand har Svalbard rensdyr tilsyneladende en bedre isolation end andre underarter af rensdyr.