PROTECTION AFFORDED BY PLASTIC COATS TO SHORN SHEEP

B. A. PANARETTO*, J. C. D. HUTCHINSON* and J. W. BENNETT*

Summary

Tests were made of the survival of shorn Merino ewes exposed, with and without plastic coats, to a cold and wet environment. Measurements of heat loss in artificial wind and rain were made on other shorn animals with and without the coats worn. over dry or wet wool.

Fifty-five per cent of the sheep without coats, but only 5% of the sheep with coats, died. The moisture content of the short wool under the coats, about 10% both in the cold room and in the field, was not considered conducive to fleece-rot.

Coats reduced heat loss considerably whether worn over dry or wet wool. The increase in total thermal insulation of the sheep was 0.056, $°C.m^2.h.kcal^{-1}$ with the coat over dry wool and 0.034 $°C.m^2.h.kcal^{-1}$ over wet wool.

I. INTRODUCTION

In Australia, nearly a million sheep die each year during the first 30 days after shearing and many of the deaths are caused by inclement weather (Hutchinson 1968). Three-quarters of the loss occurs in the first fortnight after shearing. In an unusually severe storm, the loss averaged 8% of sheep shorn during the preceding 12 days on 17 properties in the Kybybolite area of South Australia (Geytenbeek 1963).

In this paper, we report on the protection afforded by plastic coats to newly-shorn sheep in a cold and wet environment. Tests of survival were made on wetted sheep in a cold room without wind. Quantitative estimates of protection were made by measuring heat losses in artificial rain and wind. We have also made preliminary observations to ascertain whether increased moisture in the wool of shorn sheep wearing the plastic coats was high enough to be conducive to fleece-rot.

II. METHODS

Non-pregnant, adult Merino ewes of known nutritional history and management were used. The fleeces were approximately 7.5 cm deep before shearing. The depth after shearing was 6-l 1 mm.

The coats (Figure 1) were made of "polythene" 0.002 inches (0.05 mm) thick.

(a) Survival experiments

(i) Experimental design and environment

Twenty sheep were exposed in each of two similar tests. They were randomized in each test into two groups of ten plastic-coated and ten uncoated (control) animals.

In the first test, the sheep were housed for 14 days and, in the second test, for 8 days before shearing, so that they might become accustomed to hand-feeding. To increase susceptibility to cold, they received a sub-maintenance ration of 300

*Division of Animal Physiology, C.S.I.R.O., The Ian Clunies Ross Animal Research Laboratory, Prospect, N.S.W.

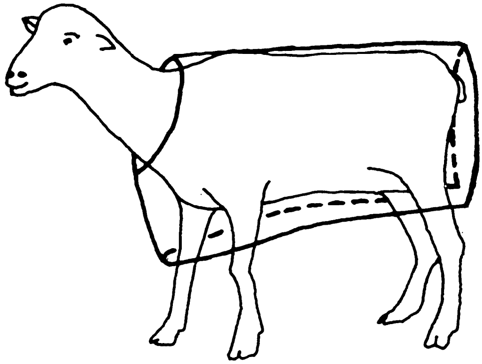

Fig. 1.—Plastic coat worn by sheep in the experiments. The coats were sealed across the chest but were open under the belly and over the hind end of the sheep. Two straps across the medial surfaces of the thighs were used to keep the coats in place.

g/day (approximately 10 g/kg body weight) lucerne chaff and oats (1 :1), both during the preliminary period and during exposure to cold. The animals were consuming all the feed at shearing. Water was freely available.

A few hours after shearing, coats were fitted and the sheep were placed in a room where radiant and air temperature were close to 3°C and the air movement was slight, being about 0.6 cm/sec. The animals were sprayed with tap water for 1 min three times a day over the first five days of the test.

(ii) Measurements

Rectal temperatures were recorded once daily in the morning before feeding. Moisture in the wool was determined at the end of the survival tests and on some of the animals wearing the coats in dry weather out of doors. Wool was clipped from a vertical strip (4 cm x 20 cm) on each side of the sheep. All strips finished at the spine. The samples were dried at 105°C in an oven (Allen ***et al.*** 1964).

(b) Heat loss experiments

(i) Experimental design and environment

The heat loss of three uncoated sheep was compared with that of the same animals wearing the coats, both when the wool under the coat was dry and when it had been wetted. Each sheep was brought in from the field and shorn one or two days before it was first tested. They received 400 g/day (about 13 g/kg body weight) of a mixture of lucerne chaff and oats (1:1), half in the morning before the tests and half in the evening after the tests.

Tests with and without the coat were made successively on the same day. Each test consisted of a preliminary period of ¾ to 1 h, long enough for the animal to reach thermal equilibrium in rain and wind, and this was followed by an experimental period of 1 h.

Details of the environmental conditions are given in Table 2. The conditions selected were colder than those of a thermoneutral environment so that the thermal insulation of the tissues might be at a maximum. In order to minimize loss of stored heat, the conditions were not made cold enough to stimulate the maximum heat production. Continuous artificial rain was produced in a wind tunnel by jets giving a fine but hard-driven shower. The rainfall measured was that falling on a horizontal surface 60 cm above the floor. Wind speed was measured with a cup anemometer at a height. of 60 cm. The sheep was tethered facing away from the wind at an angle of 30° to its direction. For technical reasons, the relative humidity of the room was about 97%, which is higher than the 80-90% usually found during a rainstorm in the field.

It was uncertain whether the fine artificial rain made the wool as wet as it would have been after several hours of exposure to the larger drops of heavy rain in the field. Therefore, before tests without the coats, sheep Nos. 2 and 3 (Table 2) were wetted thoroughly on the head, neck, back, rump and sides and, to a lesser extent, on the belly. Before tests with coats, the head, neck and rump only were wetted because it was thought that in the field the coat would protect the belly from becoming wet through. When the coat was worn over wet wool, the belly was wet from the preceding tests without the coat.

(ii) Measurements

Respiratory gaseous exchanges were measured with a Pettenkofer type of apparatus provided with a face mask. The effluent gas was analysed continuously with a paramagnetic oxygen meter (model F3, Beckman Instruments Inc.) and an infra-red gas analyser (model SB2, Sir Howard Grubb Parsons and Co. Ltd.) for determination of carbon dioxide and methane.

The rectal temperature was recorded continuously with a thermocouple.

Heat loss was calculated as follows:

$$H = \frac{M + S}{A}$$

where H is the heat loss in $kcal.m^{-2}.h^{-1}$ and M is the heat production in kcal/h calculated from the respiratory exchanges by the equation of Brouwer (1965). S, the loss of stored heat in kcal/h, was calculated approximately as 0.83 x W x At,, where 0.83 is the specific heat of the tissues, W is the body weight in kg and Δt_r is the rectal temperature in °C at the start of the experimental period minus the rectal temperature at the end. A, the surface area of the animal in m^2, was calculated from the formula of Lines and Peirce (193 1) for adult sheep.

The total thermal insulation of the animal was calculated as follows:

$$I = \frac{t_r - t_a}{H}$$

where I is the sum of the thermal insulation of the tissues, clothing assembly and air in $°C.m^2.h.kcal^{-1}$ t_r is the mean rectal temperature in °C, and t_a is the environmental temperature in °C.

The sensible and latent heat lost by respiration is included in H, as are also the effect of evaporation from the wool or plastic coat and the loss of heat from warming of rain water by the sheep.

III. RESULTS

(a) Survival experiments

During the preliminary period, body weight decreased by 1.5 kg in the 14 days before exposure in the first test and by the same amount in the 8 days before exposure in the second test. The means for body weight immediately after shearing were about 27.5 kg and 29.5 kg in the first and second tests, respectively. In the cold room, body weight decreased more rapidly in both tests.

In the two tests combined, 11 out of 20 control sheep died, five in the first test and six in the second, but only 1 out of 20 coated sheep. Statistical analysis by the method described by Paulson and Wallis (1947) showed that the difference in mortality was significant ($P<0.001$). Rectal temperatures are plotted in Figure 2 which also shows the approximate time of death.

Moisture in the wool under the coats was low both in the cold room and out of doors (Table 1). There was a little condensed water on the wool tips in the cold room, but none out of doors. In the cold room, the moisture content of the wool was 5 % higher with the coats.

(b) Heat loss experiments

The coats decreased heat loss by 31-43 % when the wool was dry and by 25 and 34% when the wool was wet. The gain in thermal insulation averaged $0.056°C.m^2.h.kcal^{-1}$ over dry wool and $0.034°C.m^2.h.kcal^{-1}$ (Table 2).

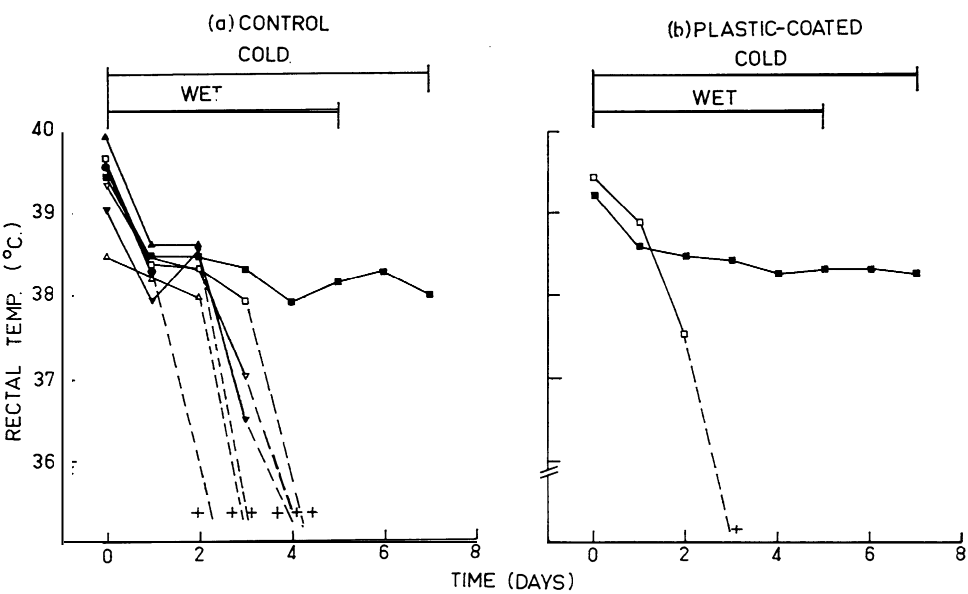

Fig. 2.—Rectal temperatures during the survival tests. (a) ■, mean for survivors; ●, mean for 6 animals that died within 24-48 h; □, ▼, ▽, △, ▲, individual sheep that died later. (b) ■, mean for 19 survivors; □, the coated sheep that died. The symbol + represents the approximate time of death in both diagrams. The broken lines joining the + symbols to the last recorded temperatures represent the course of hypothermia that would be expected on the basis of many previous tests.

TABLE 1

Moisture in the wool

Time of Sampling	Coat	Number of Sheep	Dry Bulb Temp.* (°C)	Water v.p.* (mm Hg)	Mean Moisture Content ± S.E. (% on dry wool)
After one week in cold room (survival test 1)†	On	8	3.0	2.3	9.6 ± 0.7
After one week in cold room (survival test 2)‡	On	7	2.7	3.1	11.2 ± 0.7
After one week in cold room (survival test 2)†	Off	4	2.7	3.1	5.7 ± 0.2
Two weeks after shearing; coats worn for one week in field in dry weather	On	10	21.1	9.7	10.0 ± 0.2

*Environmental conditions at the time of sampling.
†Sheep had not been sprayed for at least 48 h.
‡Sheep sprayed 90 minutes before sampling.

IV. DISCUSSION

Survival tests and the measurements of heat loss demonstrated that the coats had considerable protective value. For example, it can be calculated that the environmental temperature of the uncoated sheep would have to be 9°C warmer to obtain the same heat loss as the coated sheep with dry wool under the coat, and 6°C warmer with wet wool under the coat.

The moisture in the wool of the coated animals in dry weather out of doors was low, being equivalent to the value for clean wool at a relative humidity of 40%. A high moisture content at skin level is believed to be necessary to produce fleece-

TABLE 2

*Heat loss and total thermal insulation in wind and rain**

Sheep	Coat†	Condition under Coat	Fleece Depth (mm)	Rainfall (mm/h)	Heat Loss (kcal-m^{-2}.h^{-1})	Insulation (°C.m^{-2}.h.kcal^{-1}) Value	Insulation Increase with Coat on
1	on‡	dry	11	43	133	0.184	0.056
	off‡	—	11	43	192	0.128	
2	on	dry	6	43	162	0.143	0.059
	off	—	6	43	280	0.084	
3	on	dry	7	18	176	0.126	0.052
	off	—	7	18	308	0.074	
2	off§	—	7	18	220	0.109	0.032
	on	wet	7	18	164	0.141	
3	off	—	7	18	324	0.069	0.036
	on	wet	7	18	213	0.105	

*In different tests, the mean dry bulb temperature ranged from 15.3 to 15.7°C and the wet bulb depression from 0.2 to 0.4°. Wind speed averaged 7 m/sec (15.6 m.p.h.), corresponding to a wind speed of about 14 m/sec as measured at a height of 10 m by a meteorological station.
†This column also indicates the order of successive tests on any one day.
‡Sheep not wetted before test.
§Belly not wetted before test.

rot (Hayman 1953). We have not yet examined the moisture content of the fleeces of sheep already wet before the coat is put on.

The cost of losses after shearing in Australia, averaged over all sheep shorn, is of the order of 4 cents per head, if a sheep is valued at $6.00 (Hutchinson 1968). The cost of the plastic from which the coats were made was 2-3 cents per coat. To this must be added the cost of fastenings and of labour for applying and removing the coats. Work is in progress to find the cheapest way of manufacturing and fastening the coats. The final cost cannot yet be estimated, but it seems that the total must be greater than the average cost of losses unless the coats can be recovered for re-use. However, it may be profitable to use the coats where a heavy loss- is expected, for example, when the weather deteriorates during shearing, or when it deteriorates after shearing if the sheep are accessible in the paddock, even though fleeces may be wet.

V. ACKNOWLEDGMENTS

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