



FIGURE 7—*A*—Ram 1 at 16 months of age. The face is hairless except for vibrissae near the eyes, nose and mouth; the legs are hairless and the wool growing area is covered with wool fibers. *B*—Ram 1 at 28 months; most of the fleece has been shed. *C*—Ram 1 at 40 months; small quantities of wool remain, chiefly on the hind legs. *D*—Ram 2 at approximately 13 months of age; a similar pheno-

type to that of ram 1. *E*—Ewe 2 at approximately 13 months of age; some shedding of wool on the tail has occurred, but otherwise is similar in appearance to ram 2. *F*—Ram 3, at five days of age, is the offspring of ram 2 and ewe 2. The face is naked except for vibrissae, while the legs have a normal covering of hair. This hair, however, is readily pluckable.

A Viable Hypotrichosis in Poll Dorset Sheep

C. H. S. DOLLING AND M. G. BROOKER

IN Australia, numerous sheep have been recognized in which pelage differs markedly from that considered normal for the population. The first reported case was of sheep with a mosaic effect in which the wool of the fleece grew longer in one or several small areas^{8,11}. Animals that became known as "Felting Lustre" mutants were later reported in Merino flocks¹². The wool of these sheep is lustrous, almost straight, soft handling, and of slightly lower diameter than the wool of normal Merino sheep in the same flocks. Both of these abnormal types may be identified readily by a casual inspection of the fleece. Other fleece abnormalities include those in which the secondary/primary (S/P) follicle ratio and wool production are reduced by "low ratio" genes, and those of Merinos with the "gog" gene that reduces wool production by 80 to 90 percent⁵.

The purpose of this paper is to report a viable hypotrichosis that appears likely to be a heritable character among Poll Dorset sheep. Cases of hypotrichosis are not uncommon among cattle^{1,6,7}, but only two reports are known to us in sheep. Among "black woolled sheep" a lamb was described as being hairless¹⁰, while a Karakul ram, totally hairless at birth, grew a fleece by 15 months of age⁹.

Observations

To date, the existence of nine hypotrichotic sheep is known to us. Six of these were born in one Poll Dorset flock, three of which were inspected as adults

by at least one of us. Wether 1 and ewe 1 were born in May and June, 1959 respectively; ram 1 (Figure 7A) was born in May, 1961. Wether 1 and ewe 1 were transported to this station in November, 1959; ram 1 was received in June, 1962.

Ram 2 and ewe 2 were born in a second Poll Dorset flock in the summer of 1963 and arrived at this station in July, 1964. Their offspring, ram 3, was born in September, 1964. Each of these sheep is shown in Figure 7.

The skin on the face and legs of each of the six adult sheep was free of the short white hair characteristic of the Poll Dorset, and the fleece had a low number of fibers per unit area. As a lamb, ram 3 lacked hair on the anterior part of the face at birth but had hair of normal length on all legs. The hair on the legs was readily pluckable, and soon wore off the knees following kneeling during suckling.

Greasy fleece weights

Greasy fleece weights at 7½ and 8 months of age for ewe 1 and wether 1 were 3.5 and 5.7 pounds respectively. With clean scoured yields of 24 percent and 40 percent, their clean-wool production was 0.8 and 2.3 pounds respectively. The breeder of the sheep stated that they had probably not been shorn prior to shipment to this station. If this was so, their daily wool production to this age was only 1.6 and 4.4 gm respectively. After shearing, neither sheep grew another fleece.

Wool fibers and follicles

Mid-side measurements of fiber diameter and of numbers of fibers or follicles per cm² are given in Table I for six hypotrichotic Poll Dorset sheep and for several normal sheep. The latter include one Poll Dorset ram and Dorset Horn and Ryeland ewe hoggets³. Data from Ryeland sheep were included because all Poll Dorset sheep in the two flocks of origin of hypotrichotic animals resulted from crossing the Dorset Horn with the Ryeland, backcrossing to the Dorset Horn for at least four generations, and then interbreeding.

With the exception of the wool follicle counts made on the young ram 3, those made on the other hypo-

The authors are affiliated with the Division of Animal Genetics, Commonwealth Scientific and Industrial Research Organization, National Field Station, "Gilruth Plains", Cunnamulla, Queensland, Australia.

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trichotic sheep between 10½ and 48 months of age are all lower than the figure quoted by Carter for Dorset Horn ewe hoggets.

Both fiber- and follicle-number counts are available on four sheep. As the former count is taken from a sample of stretched skin and the latter from a sample of relaxed skin, follicle density is expected to be greater than fiber density. In normal Peppin Merinos, this difference is in the region of 20 percent (H. N. Turner, personal communication). As shown in Table I, the follicle count of the four hypotrichotic animals sampled is over 100 percent greater than the fiber count. This result is consistent with the shedding of a large number of fibers.

The mean fiber diameters of the four hypotrichotic sheep do not differ markedly from a normal Poll Dorset ram or Dorset Horn ewes. However, the number of fibers displayed per cm² are no more than half that of the normal Poll Dorset ram.

Characteristics of follicles

Skin samples were taken and sections made from the sides of animals and from either the cheek or foreleg where the skin was essentially hairless. The results are shown in Table II with some comparable measurements of the Dorset Horn and the Ryeland[§]. The outstanding features of sections from hypotrichotic sheep are:

a) Each section is characterized by a low S/P ratio, the range being from 1.0 to 3.4 on the non-wool-growing area and from 1.6 to 5.2 on the wool-

growing area. Ratios on both areas are each lower than the ratios from the corresponding areas of normal sheep.

b) In skin samples from the sides of sheep 18 months of age or less, only 1/3 to 2/3 of the follicles contain keratinized fibers. The samples from the non-wool-growing areas of all sheep contain very few keratinized fibers.

c) All sections are characterized by sebum-filled follicles. Almost all of these follicles lack fibers. Some follicles are distended by the sebum, some are not. The degree of distension varies greatly, the most distended follicle having a cross sectional area approximately one mm²; this is from the sample of ram 1 at 48 months of age.

d) The correlation between the percentage of follicles containing sebum and the percentage of follicles with keratinized fibers, for the 11 skin samples from the wool-growing area, is -0.86 (P < 0.01). Although only six sheep are represented, four having been sampled more than once at different ages, this observation is consistent with a filling of follicles with sebum after fibers have been shed.

Shedding of fibers

By the time ram 3 was 14 weeks of age, all the hair on the forelegs that was present at birth had been shed, as had most of that from the hind legs.

At 13 months of age ram 1 had a good fleece cover on arrival at this station, but he was not shorn in case it should reduce his chance of survival. In time

Table I. Wool fiber diameter and fiber and follicle number per cm² on the mid-side

| Sheep | Age (months) | Fiber number per cm ^{2*} | Follicle number per cm ^{2†} | Fiber diameter | | | Crimps per inch | |
|---------------------|------------------|-----------------------------------|--------------------------------------|----------------|--------------------|-----------|-----------------|-----|
| | | | | Mean (μ) | Coeff. of var. (%) | Range (μ) | | |
| Hypotrichotic sheep | wether | 6 | 210 | — | 32.3 | 16.2 | 15-50 | 4.3 |
| | | 11 | — | 750 | — | — | — | — |
| | ewe 1 | 5½ | 420 | — | 44.0 | 19.5 | 20-60 | 2.3 |
| | | 10½ | — | 890 | — | — | — | — |
| | | 30 | — | 1490 | — | — | — | — |
| | ram 1 | 45 | — | 1280 | — | — | — | — |
| | | 48 | — | 1300 | — | — | — | — |
| | ewe 2 | 6§ | 400 | — | 32.4 | — | — | 4.0 |
| | | 12§ | — | 920 | — | — | — | — |
| | | 6§ | 409 | — | 31.1 | — | — | 5.0 |
| | ram 2 | 12§ | — | 910 | — | — | — | — |
| | | 18§ | — | 1130 | — | — | — | — |
| ram 3 | 2 | — | 1720 | — | — | — | — | |
| | 5 | — | 2220 | — | — | — | — | |
| Normal sheep | Poll Dorset ram | 26 | 860 | — | 36.2 | — | — | 5.0 |
| | Dorset Horn ewes | 11-12 | — | 1850 | 34.4 | — | — | — |
| | Ryeland ewes† | 11-12 | — | 1580 | 31.5 | — | — | — |

* Fiber number determined by the cast method¹³.

† Follicle number determined by the skin section method².

‡ Data from Carter⁴.

§ Approximate age.

he shed his fleece however; most of it was shed before 28 months of age, while at 40 months only a small amount of wool remained (see Figure 7C).

Longevity

Ewe 1 died while lambing in November, 1960, at 17 months of age. Wether 1 died at approximately 19 months of age. Ram 1 died in May, 1965 at 48 months of age.

Ewe 2 and ram 2 were in good health in July, 1965 at approximately 23 months of age.

Horn growth

The considerable horn growth of ram 1 indicates that ram 1 is genotypically PP' ; it has grown an

aberrant horn which puts it at the upper end of the range of hornedness of PP' entires. Ram 2 could be either PP or PP'^4 .

Ewe 2 has strong horns and must therefore be $P'P'$. The presence of the gene P is therefore not a prerequisite for the appearance of hypotrichosis.

Discussion

All hypotrichotic sheep born in the two Poll Dorset flocks were born to normal Poll Dorset parents. The only mating to date of two abnormal parents yielded an abnormal lamb.

In the flock of origin of ram 1, wether 1 and ewe 1, the breeder identifies all lambs with their mothers at or soon after birth. There is only one ram that has

Table II. Wool and hair follicles

| Sheep and area sampled | Age (months) | Site | Total follicles counted* | | | Follicles Sebum filled follicles | | | Keratinized fibers | | | |
|--|-------------------|----------------|--------------------------|-----|-----|----------------------------------|-----|-------------------------|--------------------|-----|-------------------------|------|
| | | | S | P | S/P | S | P | As % of total follicles | S | P | As % of total follicles | |
| wether 1 | 11 | Left foreleg | 65 | 66 | 1.0 | 49 | 43 | 70.2 | 0 | 0 | 0 | |
| ewe 1 | 10½ 17 | Left foreleg | 113 | 83 | 1.4 | 55 | 37 | 46.9 | 0 | 0 | 0 | |
| | | Right foreleg | 93 | 65 | 1.4 | 70 | 48 | 74.7 | 0 | 0 | 0 | |
| Hypotrichotic sheep on face or foreleg | 30 45 48 | Right face | 142 | 61 | 2.3 | 139 | 60 | 98.0 | 2 | 0 | 1 | |
| | | Left face | 174 | 69 | 2.5 | 173 | 69 | 99.6 | 0 | 0 | 0 | |
| | | Left face | 100 | 65 | 1.5 | 94 | 60 | 93.3 | 1 | 0 | 0.6 | |
| ram 2 | 12† 18† | Right face | 145 | 61 | 2.4 | 98 | 57 | 75.2 | 44 | 4 | 23.3‡ | |
| | | Right face | 182 | 54 | 3.4 | 179 | 54 | 98.7 | 9 | 2 | 4.7 | |
| ewe 2 | 12† | Right face | 154 | 83 | 1.9 | 154 | 83 | 100.0 | 0 | 0 | 0 | |
| ram 3 | 2 5 | Right face | 133 | 117 | 1.1 | 49 | 50 | 39.6 | 78 | 54 | 52.8‡ | |
| | | Right face | 348 | 114 | 3.0 | 347 | 114 | 99.8 | 0 | 0 | 0 | |
| Normal sheep on face | Poll Dorset ram | 25† | Right face | 223 | 51 | 4.1 | 0 | 0 | 0 | 223 | 51 | 100 |
| Hypotrichotic sheep on side | wether 1 | 11 | Left midside | 84 | 52 | 1.6 | 32 | 38 | 51.5 | 36 | 9 | 33.1 |
| | ewe 1 | 10½ 17 | Left midside | 113 | 47 | 2.4 | 24 | 19 | 26.9 | 45 | 29 | 46.2 |
| | | | Right shoulder | 115 | 67 | 1.7 | 14 | 11 | 13.7 | 45 | 19 | 35.2 |
| | ram 1 | 30 45 48 | Right midside | 145 | 73 | 2.0 | 142 | 72 | 98.2 | 2 | 0 | 0.9 |
| | | | Left midside | 215 | 41 | 5.2 | 212 | 41 | 98.8 | 1 | 0 | 0.4 |
| | | | Right midside | 170 | 36 | 4.7 | 161 | 36 | 95.6 | 1 | 0 | 0.5 |
| | ram 2 | 12† 18† | Right midside | 116 | 44 | 2.6 | 60 | 29 | 55.6 | 52 | 16 | 42.5 |
| | | | Right midside | 174 | 37 | 4.7 | 136 | 27 | 77.2 | 36 | 11 | 22.3 |
| | ewe 2 | 12† | Right midside | 138 | 38 | 3.6 | 34 | 16 | 28.4 | 93 | 20 | 64.2 |
| | ram 3 | 2 5 | Right midside | 181 | 59 | 3.1 | 72 | 43 | 47.9 | 113 | 16 | 53.8 |
| Right midside | | | 315 | 66 | 4.8 | 255 | 62 | 83.2 | 71 | 4 | 19.7 | |
| Normal sheep on side | Poll Dorset ram | 24 | Left midside | 181 | 25 | 7.2 | 0 | 0 | 0 | 181 | 25 | 100 |
| | Dorset Horn ewes§ | 11-12 | | — | — | 5.4 | — | — | — | — | — | — |
| | Ryeland ewes§ | 11-12 | | — | — | 5.5 | — | — | — | — | — | — |

* The letters S and P refer to secondary and primary follicles; S/P is the ratio between them.

† Approximate age.

‡ The sampling site on the face was, for ram 2 at 12 months of age and for ram 3 at two months, in the wool-growing area rather than the non-wool-growing area.

§ Data from Carter⁵.

appeared as a common ancestor to all six abnormal sheep born in this flock. All descendants of the common ancestor were culled, and at the two lambings subsequent to this, no abnormal sheep were born.

Matings are in progress to test the hypothesis that the character results from the action of an autosomal recessive gene in homozygous form. Ram 1 has been joined and has proved fertile.

The main feature of the abnormality could prove to be the shedding of fibers, different fiber types being shed at different ages. Ram 3 shed the hairs on its legs soon after birth; it is possible that the hairs of the face were shed before birth. Ram 1 shed its fleece gradually with increasing age. From Table II one sees that the mid-side sample taken from this ram had a lower percentage of follicles occupied by keratinized fibers than did corresponding samples from younger sheep, and that each of the three sheep sampled twice had a lower percentage of fibers at the second sampling.

These observations, coupled with the negative correlation between the percentage of follicles that are sebum-filled and those containing fibers, are consistent with the explanation that a decreasing number of fibers are available to accommodate a constant production of sebum, which results in sebum accumulation in the follicles. Also, the low clean-scoured yields of fleeces of wether 1 and ewe 1 could reflect an abnormally low number of fibers

available to accommodate normal production of sebum.

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Gene Dosage Effects at the *ae* Locus on Amylose Content of Corn Endosperm

V. L. FERGASON, J. L. HELM AND M. S. ZUBER

SEVERAL studies have been reported on gene dosage effects of various endosperm mutants in corn. Crane¹ has reviewed the literature briefly and has determined the relative effect of $3n$

versus $3n + 2$ (from trisomic 5, bearing the *ae* locus) constitution in endosperms homogeneous for the *ae* allele (*ae ae ae* versus *ae ae ae ae ae*). He found that extra doses of *ae* beyond the triploid complement ($3n$) did not significantly affect amylose content of total starch, although an apparent trend toward lower amylose levels in the pentaplex ($3n + 2$) was noted. Haunold and Lindsey² reported that heterozygous genotypes (*Ae/ae*) from a cross between Cassel, an open-pollinated variety, and a relatively homozygous high-amylose inbred line gave intermediate amylose percentages. The present study was designed to determine the relative amylose percentage of corn endosperm starch in the nulliplex, simplex, duplex and triplex constitutions for *ae*.

The *ae* allele was incorporated into the inbred line, K55, by an alternate backcrossing-selfing program.

The senior authors are assistant professor and instructor, respectively, Department of Field Crops, University of Missouri; the junior author is research agronomist, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture and Professor of Field Crops, University of Missouri. Cooperative investigations of the Department of Field Crops, University of Missouri Agricultural Experiment Station, Journal Series Number 3044, and Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture. The research reported herein was supported in part by a grant from the Corn Industries Research Foundation, Incorporated, New York, New York. The amylose analyses were conducted by the Northern Utilization and Development Division Laboratory, U.S. Department of Agriculture.

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