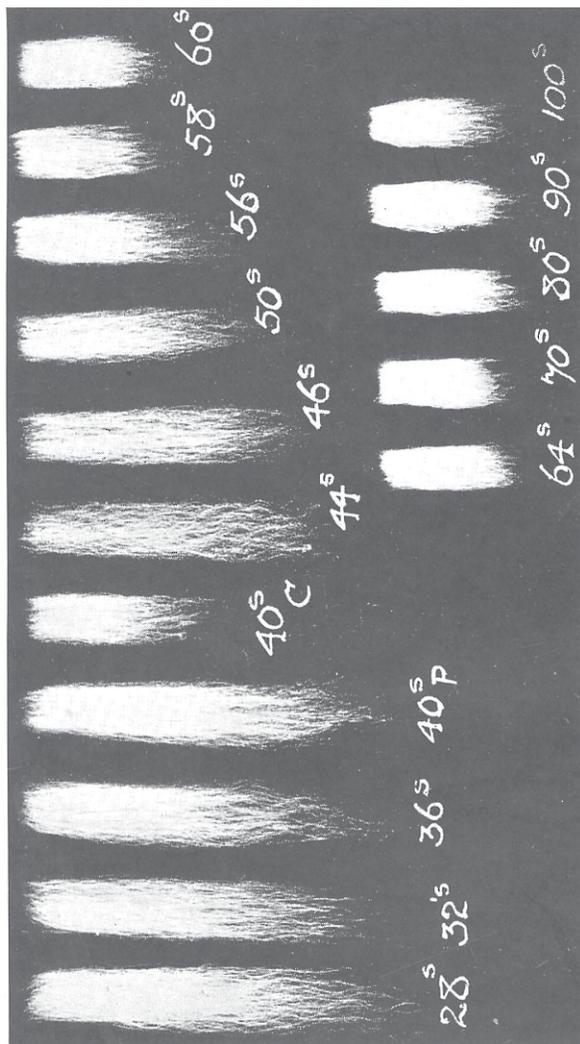


WOOL CARDING AND COMBING



Bradford Tops : Range of Standard Qualities

WOOL CARDING AND COMBING

WITH NOTES ON SHEEP BREEDING AND
WOOL GROWING

BY

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WITH 100 ILLUSTRATIONS

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PREFACE

OF the many books written on Wool Combing and Spinning, none has so completely held the field as W. S. Bright McLaren's "Woollen and Worsted Spinning." It appeared in 1884, and has been the basis of many text-books and practically all teaching up to quite recently.

Technical education, acting directly and indirectly, has resulted in a vast extension of the field of the technical and scientific knowledge appertaining to the Combing and Spinning industries, and McLaren's little work, good as it is, cannot now be considered other than inadequate.

After due consideration of all the points in question, the authors of the present treatise came to the conclusion that it would be necessary to so very materially extend the text for a new treatise, that it would be very desirable to publish such in two sections. They were further encouraged in this idea by reason of the demand for information on Wool, Wool Growing, and Wool Preparation from Australasians and others engaged in sheep farming, and also by the natural trade divisions observed in the industry, the wool comber taking wool up

to the "top" state, and then marketing it to the spinner. This volume therefore deals with this aspect of the subject and the early stages of the manufacture of wool, while a second, to follow shortly, will deal with spinning.

That this treatise is still in a sense inadequate, the writers are only too ready to admit. They hope, however, that it may at least serve as an efficient introduction to the very interesting sub-sections of the wool industry involved.

Their thanks are due to Professor T. B. Wood, of Cambridge University, for very kindly reading through the chapter on Mendelism ; to Messrs. Wm. Cooper and Nephew, for illustrations of sheep ; to Messrs. Dalgety and Co., and to the Bradford Chamber of Commerce for statistics which have been employed in this case as graphic illustrations ; and to many others who have directly or indirectly assisted them in the production of the work.

A. F. B.

E. P.

January, 1912.

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WOOL CARDING AND COMBING

CHAPTER I

WOOL AND HAIR PRODUCING ANIMALS

THE chief present-day wool and hair producing animals are the various breeds of sheep, the Angora goat, the Alpaca goat, the Cashmere goat, the camel, the cow, the horse, and the rabbit; while some few special wools or hairs are obtained in small quantities from such animals as the kangaroo, etc. Of these, the sheep holds by far the most important position with regard to numbers and quantity and quality of the fibre produced. The Angora goat, yielding mohair, and the Alpaca goat, yielding alpaca, come next in order of importance; while the camel, cow, horse, etc., yield but limited quantities of fibre suited only for very special purposes, camel-hair, for example, being largely employed for beltings, and rabbit-hair in hat manufacture.

Historical Sketch of Wool and Hair Producing Animals.—There are no records of the very early evolution of the sheep; but scriptural references are by no means uncommon. That flocks of sheep formed the chief possessions of the antediluvians there is abundant proof; and while our first parents, as Youatt suggests, ate as food the fruits of the earth rather

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than the flesh of sheep, there are many evidences that their drink consisted of ewes' milk and their clothing of sheepskins. In addition to the information in the Old Testament that proves the largeness of the flocks of the early pastoralists,* the first real improvement effected on sheep by breeding is recorded.† Jacob, it appears, anxious to recompense himself to the fullest extent under the conditions so selfishly imposed by Laban, whom he had served fourteen long years for the sake of his daughter, resorted to the peeling of rings from the stakes forming the fold in order that the breeding ewes might be influenced to bring forth speckled instead of darkish brown lambs, which former were to constitute his wages according to Laban's promise.

Various improvements in breeding followed in course of time, the most marked resulting in the final dominance of whiteness, wool eventually being compared with snow.

In the absence of more definite records it is questionable whether the many types of sheep of the present day are the progeny of one common ancestor or have arisen independently. It is probable that in the remote past one type only existed, and that modifications of this type, due to varying environment and selection in breeding, have formed the basis of all our modern breeds of sheep. This evolution, in a broad way, may be represented in three stages through three types, each of which is still to be found under natural conditions.

1. The Argali (*Ovis Ammon*), of Asia and America.

* Gen. xiii. 6; Gen. xxxvi. 7; Num. xxxi. 32-3; Job i. 3; 1 Chron. v. 21; 2 Chron. vii. 5.

† Gen. xxx. 37, 38.

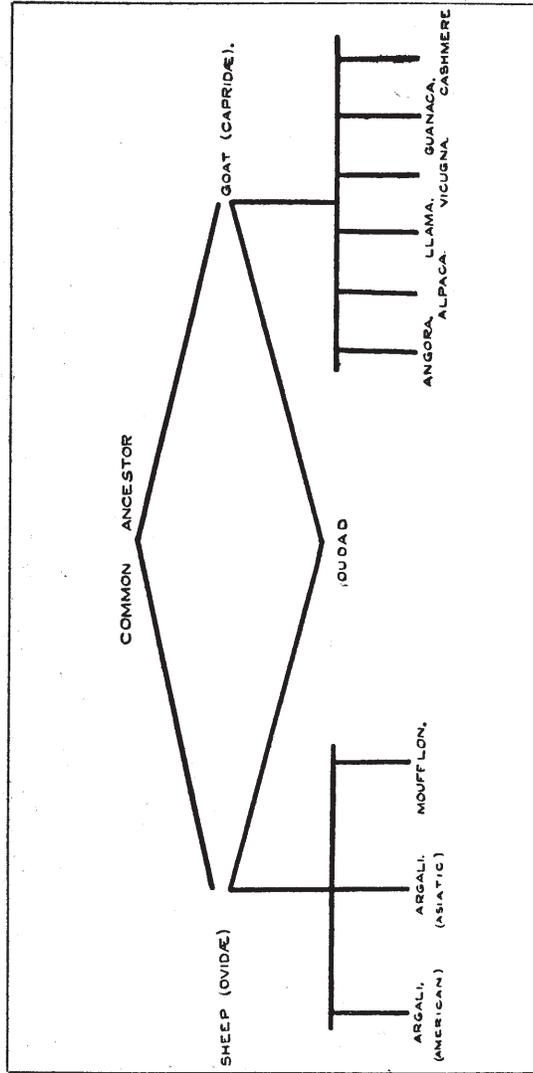


Fig. 1.—Diagram Illustrating the Evolution of the Early Sheep and Goat Tribes

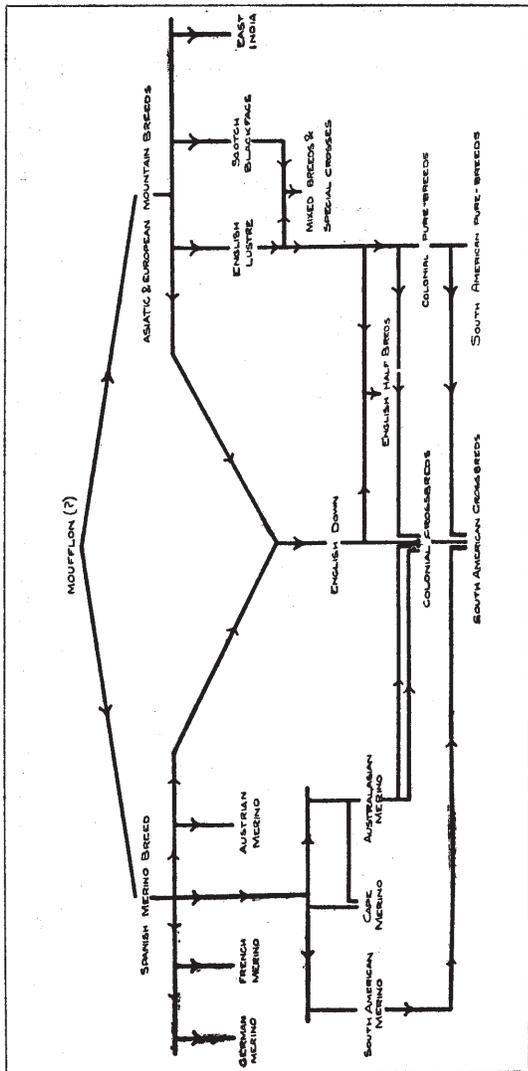


Fig. 2.—Pedigree of Present-Day Breeds of Sheep

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2. The Moufflon (*Ovis Musmar*), of South Europe and North Africa.

3. The Domestic Sheep (*Ovis aries*), of Europe.

A few notes here on each of these types will not be out of place. Reference should also be made to Fig. 1 which gives a probable explanation of the way in which the broadly defined types have been evolved.

1. **The Argali.**—This animal still inhabits the higher plains and mountainous regions of Central Asia. It occupies the higher levels in summer; but descends to the lower plains and valleys, where food is more abundant, in the winter. The Argalis are animals of great beauty and strength, particularly the males, which are of large size, often 4 feet high at the shoulders, with horns well curved and of great thickness and length. The covering of these animals in summer is of a furry character and reddish-brown in colour. In winter distinct hair is developed of a brownish-grey character, with an under-coat of white wool. Domestication of the younger Argalis is possible, and this under suitable conditions brings about a permanent reduction of hair and an increase in the quantity of wool. In their wild state these animals congregate in small flocks and ordinarily show much fear of man.

Generally regarded as being related to the Asiatic type is the North American Argali, sometimes termed the Big Horn, Rocky Mountain, or Californian sheep. Save in size and strength—features in which it is superior—this is not unlike the Asiatic variety.

An animal closely related to the Argali and showing characteristics of both the sheep and goat is the Oudad, known also as the Bearded Argali. This animal is found principally in North Africa, is of uncommon appearance, very rough and ugly, with much

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long hair of a reddish-brown colour growing on its front under parts.

2. **The Moufflon.**—This animal is found in Corsica and Sardinia and in such islands as Crete and Cyprus. In size it is smaller than the Argali, and its shorter horns turn inwards instead of outwards at the tips. Mountains not so cold as those occupied by the Argali form its native home, and these it seldom leaves. Like the Argali, it congregates in herds, but of greater number. The coat grown is of a short, brownish, furry nature, at the roots of which is a short, fine wool of a greyish colour. Domestication is said to have little effect upon this animal, the type appearing to be less subject to the influence of domestication than the Argali.

3. **The Domestic Sheep.**—While there is no definite history to prove that the various domestic breeds have originated from such animals as the Argali and Moufflon, in some such way as is explained in Fig. 2, it is by no means difficult to imagine that such may have been the case. The early use of the skins of animals slaughtered in the chase would gradually evolve the idea of greater comfort in clothing. Observations upon the effects of climate and physical surroundings would be made at an early period. Thus it would be observed that the change from the summer to the winter season would cause an increase in the wool or down (which is necessary for greater warmth) and in the hair (which forms protection for the wool), and this might conceivably lead to definite experiments in breeding definite types of wool or hair producing animals. Once this idea took root, it can well be imagined how environment and selective breeding would be employed to evolve from the rough, uncouth animals previously referred to the much more valu-

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able domestic sheep. It has been suggested that the nomadic races crossing the plains of Central Europe, and eventually arriving in Great Britain, brought with them the partially or fully developed sheep, and, finding suitable conditions prevailing in these islands, soon made their breeds world renowned. More definite particulars are on record of how Southern European civilisation—especially during the dominance of the Romans and the Moors—evolved the Merino sheep of Spain, from which all the fine-woolled Merino sheep of to-day directly or indirectly are derived. The differences between the various present-day breeds of sheep are most marked. Compare, for instance, the Australian Merino and the Border-Leicester breeds—and support of the idea of an evolution such as that suggested is obtained, notwithstanding the fact that representatives of the intermediary stages are not now to be found.

Angora and Cashmere goats have obviously been subjected to far less artificial improvement than the sheep, and the same remark applies to the camel and the various representatives of the camel race in South America, such as the Alpaca, Llama, and the Vicuna.

Natural History of Wool and Hair Producing Animals.—The chief wool and hair producing animals belong to the natural Order *Ruminantia* (cud-chewers), and constitute the fifth family, *Bovidae* (Latin *Bos*, meaning ox). Of this family there are :—

(a) **Sheep of the Genus *Ovis*.**—A grazier (grass eater) as distinct from the goat, which is a browser (shrub-eater). Some types of sheep are horned, and some are hornless. The skin or pelt is comparatively thin, and on it is produced in the case of animals in the wild state a mixture of hair and wool. As the varieties

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are so numerous and marked, special treatment is given to each later on in this volume.

(b) *Goat of the Genus Capra*.—This is an animal lighter in build than the sheep, very quick and sure-footed, and a browser. Many types are horned, and the male is frequently bearded. The fleece is heavy, and consists of hair with an undergrowth, in many types of a fine fibre of a woolly character. Environment seems to have little effect on the hair produced, so that breeding is the dominant feature in obtaining the quality of hair required. The following are varieties that claim special attention :—

(b1) *The Angora Goat* (Fig. 3).—A species descended from the animal *Capra Aegagrus*, the claimed ancestor of all *Capra Hircus* or domestic goats, inhabiting the hills and mountains of Southern Europe and Asia Minor. It is fairly large in size, and possesses horns of considerable dimensions. It grows a short, woolly fur of a greyish-brown colour during the warm season, and this, in winter, is covered with a larger and brighter hair. History is silent as to its early domestication ; but the goat doubtless existed in very remote times in the province of Asia Minor, where under suitable climatic and physical conditions it has for ages produced hair of remarkable length, lustre, and fineness.

(b2) *The Alpaca*.—Of the llama group (Fig. 4), a species somewhat allied to the camel (*Camelus*) family, this relationship being noticeable in the neck formation and in the carriage of the animal. This goat is indigenous to the lofty Andes in South America, and has never been successfully acclimatised elsewhere. It is the most important member of this group, the other members being the llama, the vicuna, and the guanaco, some of which are met with in both the wild and domes-

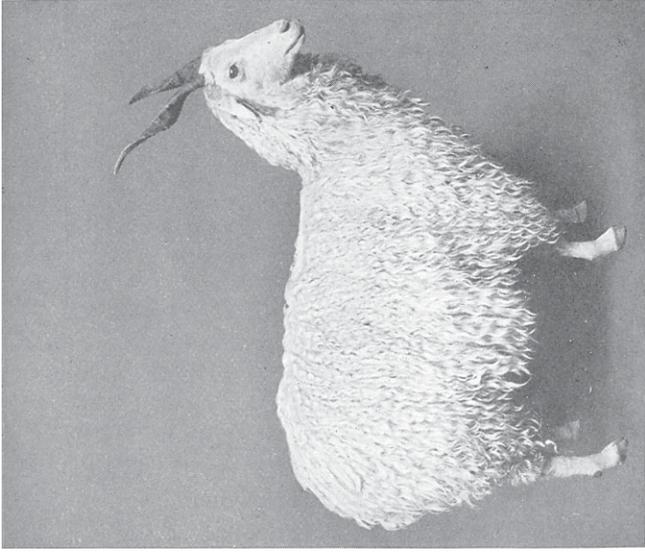


Fig. 3.—Angora Goat



Fig. 4.—Llama

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ticated states. Its covering resembles both wool and hair, being chiefly brown and black in colour, but occasionally fawn and white. It is interesting to note that as distinct from most sheep it will carry its fleece from two to three years, in which circumstances the staples attain a length of thirty inches and upwards.

Special note should be made of the short, fine, brownish-yellow fibre obtained from the vicuna, a wild animal of the group which exists in but small numbers in Peru.

(b₃) **The Cashmere Goat.**—An animal closely allied to the native Tibetan goat which inhabits the district of Cashmere (or Kashmir) in northern India. It is provided with enormous horns, and is covered with a coat of long, straight, and silky fibre, at the roots of which, on certain portions of the body, is to be found a small quantity of very fine wool of a brownish colour. This latter—the true cashmere of commerce—is the material from which are made the renowned Cashmere shawls—of which the Paisley shawl is a derivative—noted for their softness of handle, fineness in texture, and beauty in design and colouring. As with the alpaca, attempts at acclimatisation of the Cashmere goat in countries other than Cashmere have met with no lasting success. Possibly this localisation of the breed may also be due, as was the case at one time with the Angora goat, to the unwillingness of the present owners of flocks to promote their introduction elsewhere.

(c) **The Camel.**—Of the true camel species there are two types—the Asiatic bactrian and the African dromedary, the former possessing one hump and the latter two. On the under portion of the body of the camel is found a quantity of rough, long, bristly hair, and underneath this a shorter woolly material. As the fibre is essentially a by-product, no attempts are made

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in any case to cultivate it. It comes chiefly from China, Russia, and Egypt.

(*d*) **Cattle.**—Home, colonial, and foreign breeds are of value as yielding fibre useful to the textile industries, although, as with the camel, this fibre must be considered relatively a by-product. Cow-hair, taken from the skins of slaughtered animals, is employed for the manufacture of cheap carriage rugs, plushes, low woollens, stuffings, etc.

(*e*) **The Horse.**—The horse yields hair of two types. The body hair is employed similarly to cow-hair, but the longer is woven by specially built looms into upholsteries of a very durable type.

(*f*) **The Rabbit.**—This hair, or fur, since the introduction of the rabbit into Australasia, now comes to us in great quantities. It is remarkable for its softness and fineness, and is largely used in the felt-hat industry, and, to a limited extent, in the woollen trade.

The other fibre-producing animals scarcely call for comment; but it seems rather strange that neither the sheep nor the goat has a rival in the same sense that ramie has been the rival of linen and cotton for, say, fifty years.

The Sheep of Great Britain.—The historical records of this country tend to show that the evolution of the wool industry followed the sequence which would naturally be expected. From the employment of the skins of sheep as clothing and as a covering in small sailing-boats in pre-Roman Britain, the evolution led up to the woollen factory at Winchester in Roman times, and from there through many vicissitudes of fortune the wool industry has been steadily evolved to its present-day efficiency. It seems possible that a fine down wool, possibly grown then as now, in

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the south of England, was the staple product worked with, as one Roman historian speaks of wool "often spun so fine as to be comparable to the spider's thread." This, however, was probably only a figure of speech; for when, centuries later, the wools of Britain came into competition with the wools of Spain, they were recorded as coarse, harsh, and uncouth in comparison. After many vicissitudes, the wool trade, encouraged in various ways by the rulers of our land (King Alfred, for example), who, no doubt, found it a valuable source of revenue, attained to considerable importance, and increasing quantities of wool were exported to Flanders to be manufactured and often returned to this country in the form of cloth. This led to endeavours to improve the manufacturing skill of our people, and legislation under several monarchs was undertaken with this end in view. Success finally attended these efforts, so that not only did England manufacture her own wool, but actually brought wool over from the Continent, and finally from Australasia, to be spun and manufactured into cloth. In part owing to the demand for a large carcass sheep, and in part owing to natural tendencies, the typical English sheep was finally evolved as a large sheep, producing long, lustrous wool, specially suited for spinning into "worsted" yarn. A finer-woolled sheep still flourishes upon "the Downs," and in other parts of the country, but this cannot compare in fineness with the wools of Australia; while, on the other hand, no country at present produces such beautiful long lustre wools as England.

In recent times fluctuations in the price of corn have markedly affected the proportion of land under ploughing, and consequently, indirectly, the number of sheep reared (Fig. 6). Upon the whole, however, sheep have always held their own—perhaps because

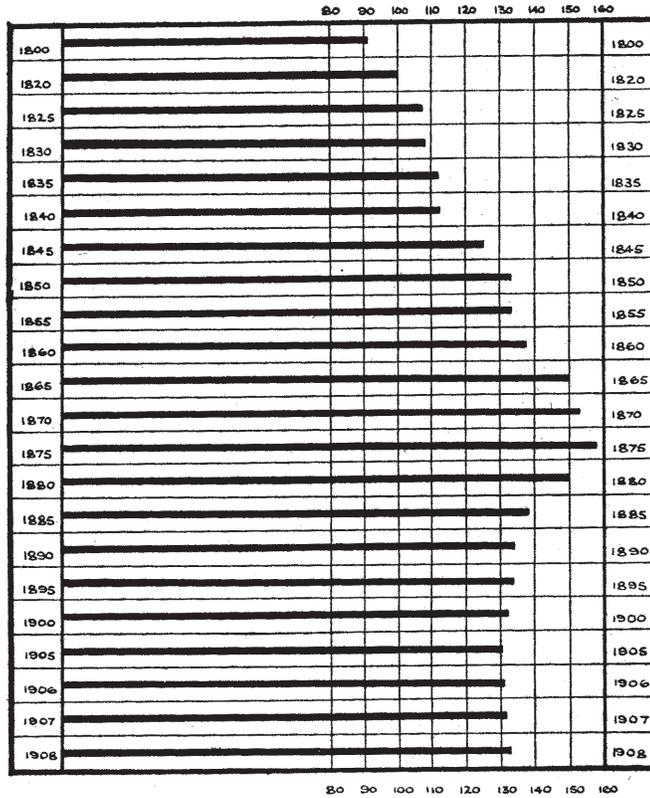


Fig. 6.—Production of British Wool (in millions of lbs.), 1800-1908

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corn and foodstuffs are more easily transported than sheep—and under the hands of skilful breeders both the sheep and the wool have been moulded to give the best return as a whole under the varying climatic and soil conditions of this country. Fig. 7* illustrates graphically the most recent returns of the number of sheep in Great Britain, and, indirectly, gives an idea, in conjunction with the particulars which follow, of the proportions of long and short wool grown.

The most convenient trade classification of the breeds of British sheep is as follows:—

1. **Long Wool Breeds.**—Lincoln, Leicester, Border-Leicester, Cotswold, Romney Marsh, Wensleydale, Devon.
2. **Short Wool Breeds.**—Southdown, Shropshire-down, Hampshire-down, Oxford-down, Suffolk-down, Dorset, Ryeland.
3. **Mountain Breeds.**—Blackface, Herdwick, Cheviot, Lonk, Dartmoor, Exmoor, Penistone.
4. **Highland Breeds.**—Short-tailed sheep, Welsh, Irish.

The first class consists of a type of large and well-proportioned sheep, severally occupying the heavy agricultural lands of England, and which yield wool of a long, strong, and lustrous type. Formerly these were reared in the midland and western counties only, but latterly they have been distributed over a much wider area. Much attention has been given to these breeds, with very satisfactory results both as regards wool and mutton. Cross-breeding has been extensively employed to produce distinctive features, so much so that it is now a matter of much speculation to locate the ancestral type.

* From the tables published by the Bradford Chamber of Commerce.

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The second class is represented by the oldest breeds of England—these being known to many as the ancient upland breeds—the various classes being depastured over the eastern, southern, and western portions of this country, including the Down range of chalky hills, long celebrated as the home of high-class breeds of sheep. In form this class was originally much smaller than the aforementioned type, and from the standpoint of quantity, either of wool or mutton, the breeds were not so valuable, but they occupied lands which to other sheep would have been less serviceable, and yielded a fine, white, and crisp handling wool of great value to the textile industry. To-day the Down breeds are by no means small in size, and are specially valuable as mutton breeds on account of their very early maturity.

The third class, as might naturally be expected, are of a poorer type; they are spread over the hills and moorlands of the country, are largely neglected, and consequently development of either form or covering is seldom favoured. The breeds, however, have their value; without them much land would be sheepless and unoccupied; and, moreover, the range of qualities and the variety of prices of fabric, so necessary to trade requirements, would be disadvantageously less if these breeds were absent.

Included in the fourth class are the wilder and more badly bred types which occupy the more outlying parts of the kingdom. With an environment so severe as in these remote districts, and with the scant attention they receive, it is small wonder that many of the types are still in the primitive condition—goat-like in character and yielding a light and uneven fleece of wool and hair that often varies very considerably in colour, even in individual sheep. In some few cases, however,

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special wool is produced, as, for example, Shetland wool, which is of a very soft handle

Class I.—Long Wool Breeds.—The Lincoln.—Reverting to Class I.—the long-wool breeds—the Lincoln (Fig. 8) is placed at the head. It is the progeny of an old Lincoln breed now almost lost sight of, which was crossed on an improved Leicester breed in order to produce greater symmetry of form or a greater propensity to fatten. No type of sheep is more massive and heavy than this or yields a longer and bigger fleece. The breed requires pasture of rich and abundant growth. Should it be stinted, it quickly loses condition, which it does not readily recover. In addition to being used either purely or as a cross in almost all English long-wool counties, it has found extensive employment in Australasia and South America, chiefly for crossing purposes.

Leicester (Fig. 9).—This is perhaps England's choicest long-wool breed. It doubtless represents the greatest application of scientific treatment. This is the breed on which the renowned Robert Bakewell of Dishley expended so much thought and care, and the breed which, while possessing all the good qualities of the Lincoln, such as size and hardihood of constitution, as well as those pertaining to the wool, is additionally valuable in that it is finer and more lustrous in staple and choicer in the quality of mutton. It has been widely used with other breeds, in all cases with much success; and no breed, it is stated, is more pronounced in the dominance it impresses of its own type upon its progeny. As a cross on the Merino it is specially serviceable, both as regards wool and mutton.

Border-Leicester.—This breed—a cross between the new Leicester and the Cheviot—proves the value of the former as a crossing breed; for on the Cheviot

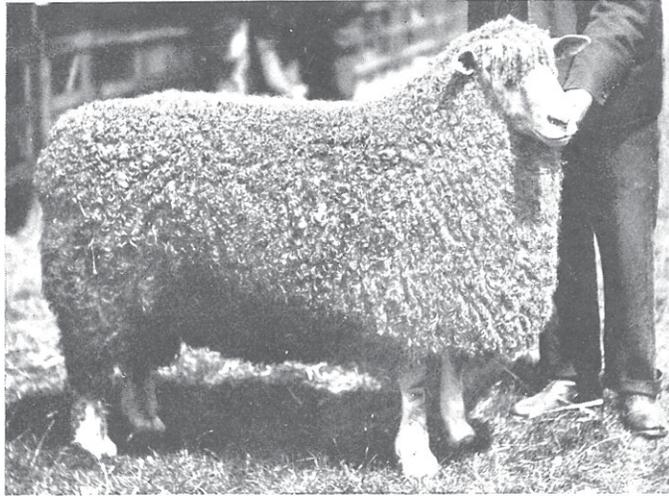


Fig. 8.—Lincoln Two-Shear Ram (about half wool growth)
(Photograph by permission of Messrs. William Cooper and Nephews, Berkhamsted)

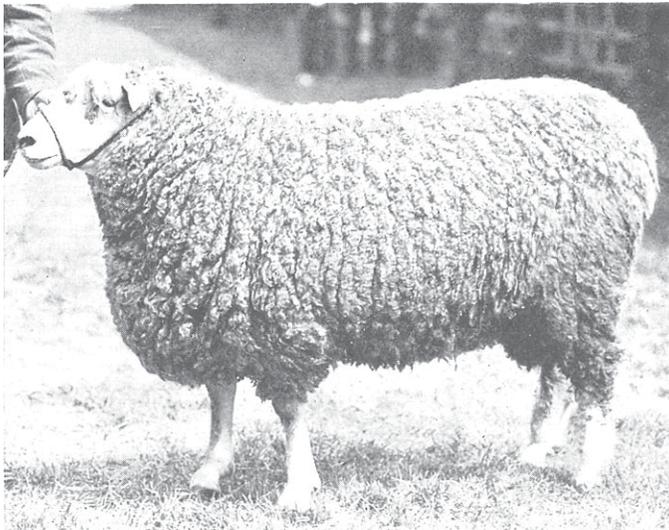


Fig. 9.—Leicester Sheep

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sheep—a native of the hills running through the borders of England and Scotland, from which it takes its name—it was used for the purpose of improving the carcass so successfully that the resulting type became quickly acknowledged as a standard breed. Over a very wide area in the south of Scotland this type finds considerable favour, as it also does in the Colonies. A cross from the Border-Leicester and Cheviot produces the wool known in bulk as “North.”

Cotswold.—In appearance this is one of the prettiest of all English breeds. It inhabits the hills in Gloucestershire and neighbouring counties which bear its name and which have long been its home. For withstanding hardship this breed is extremely serviceable; and as, further, it is remarkably prolific, it finds extensive employment, both as a mutton and wool producer. It is very satisfactory as a cross and formerly, more than at present, was extensively used on the finer breeds.

Romney Marsh (Fig. 10).—Of all breeds this is most suitable for marshy and boggy districts. From time immemorial it has been pastured on the bleak, low-lying marshland on the south coast of Kent, and has there developed qualities of constitution which have created it quite a distinct breed. No type can so successfully withstand foot-rot and fluke, and for much land in all countries of pastoral usefulness where the conditions favouring these diseases obtain, it is of the greatest service. It is not so symmetrical as the types previously referred to, though through an infusion of Leicester blood it is greatly improved; nevertheless, it is of useful size and of good quality in both mutton and wool, the latter being medium in fineness and demi-lustrous, and known in the trade as “Kent Hogs” or “Kent Wethers.”

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Wensleydale.—This breed is probably less famous than most of those already mentioned. It is of chief interest to the Yorkshire Dales farmer, though it is very common in Durham and in some parts of Scotland. It originated in the Tees Valley, the border line between Yorkshire and Durham, and was formerly ungainly and poor in fleece; but through the influence of the Leicester crossed upon it a change has been effected of a very useful character. It is hardy in constitution, thrives well on somewhat rough pasture, and yields good mutton and a good quality lustre wool. There are two types of which the "blue-faced" is the dominant breed.

Devon.—In Cornwall, Devon, Somersetshire, and the southern part of Hampshire a breed is found known as the Devon long-wool. The origin of this breed is the Bampton Nott (Bampton, a village on the borders of Devon and Somerset) and the Southam Nott, both of which have been greatly improved by crossing on the new Leicester. The latter variety is somewhat smaller.

A recognised Devonshire Southam breed, with physical characteristics somewhat resembling the Romney Marsh and Shropshire wool, and similar to the long lustre type, is found in South Devon, on the borders of Dartmoor and Cornwall. This breed contains much Leicester blood. It is only on the rich pastureland, however, that this sheep is to be found.

Class II.—Short Wool Breeds.—The Southdown. —The Southdown is typical of the short-wool breeds, and on account of the fineness, whiteness, and shortness of its wool might be termed the English Merino. This is an old English breed which has been the object of unremitting attention for a consider-

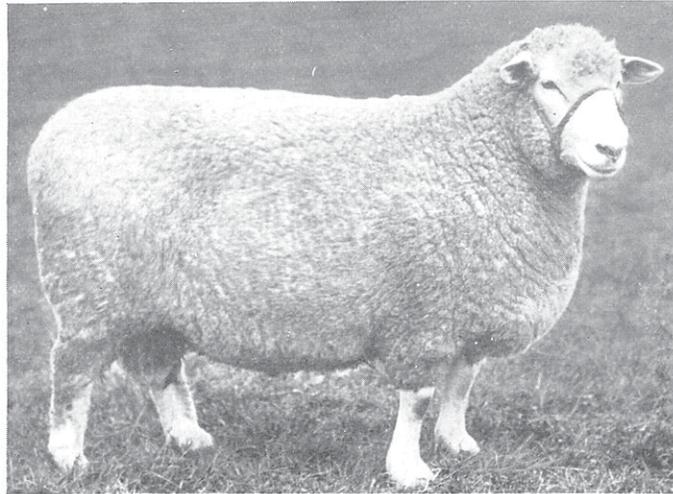


Fig. 10.—Romney Marsh Sheep

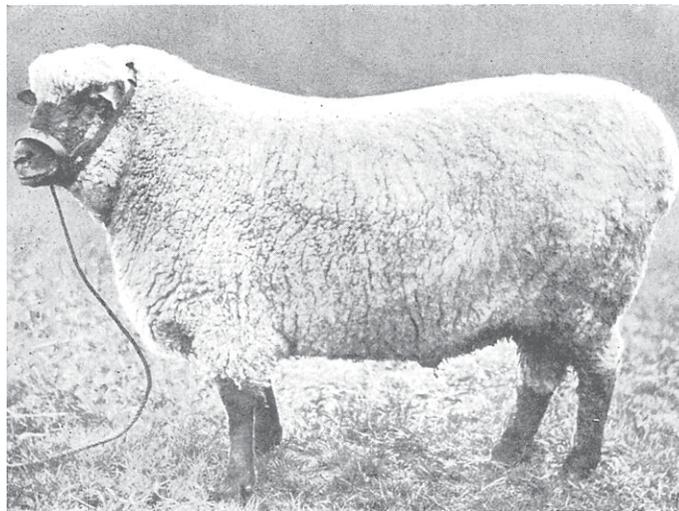


Fig. 11.—Oxford Down Sheep

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able period, and no other breed in this country has attained to such a standard of both mutton and wool. Its home is the Downs of England, but its adoption has extended far and wide, not only in Britain, but in the Colonies, the United States, and South America. As a Merino cross for mutton it cannot be surpassed. The wool, however, judged by the usual Merino cross standard, lacks character and is somewhat light and wasty.

Shropshire Down.—This breed (Fig. 12) is somewhat larger than the Southdown, and also hardier and more thrifty. Most likely this has been developed from an old "Morfe Common" sheep—named after the land in Shropshire on which they were reared—by the introduction of the Southdown and also the Leicester and the Cotswold long-wool types. From all standpoints it is highly satisfactory as a breed, and is most extensively reared both at home and abroad. As a cross on the Merino type it is especially serviceable.

Hampshire Down.—The Hampshire is larger than the Shropshire, but yields wool of the Southdown order. It is probably a development of the old Down-like breeds of Wiltshire and Berkshire, into which counties the Hampshire has extended, as aided by the Southdown. This breed well illustrates the power of the breed influence, for it possesses many distinct properties, all of which go to make an excellent type. As a Merino cross, though very suitable, it has not as yet attained the popularity of which it is worthy.

Oxford Down (Fig. 11).—This was produced by crossing Cotswold rams upon the ewes of an old Norfolk breed. It is a comparatively new type. In appearance this sheep is striking, being large and rounded off, while for mutton purposes it is very serviceable. The wool is bright and fine and is of fair length, but rather

open and wasty. It is not so good in colour as the Hampshire Down.

Suffolk Down (Fig. 13).—This is one of the prettiest sheep bred, being hornless and possessing a bright, clear, shiny black face. It is not large in body, and its wool is perhaps hardly equal to the fine Southdown wool.

Dorset (Fig. 14).—This very old breed—grown principally in the western portion of the county whose name it bears—is somewhat larger than the Southdown, is horned, and yields wool of a longer and plainer character. Its great value is for mutton, for there is no breed more prolific or more successful in the rearing of its lambs. This breed supplies the bulk of the Christmas lamb to the London markets. Being strong, hardy, and active, and a quick fatterer, it is now commanding considerable attention from the farmers, who, on account of the difficulty in growing wool so profitably as formerly, are in addition seeking to develop the mutton. As a cross it does well, being largely used on the Shropshire in this country and on the Merino in the colonies. A variety of this breed, though yielding coarse wool, is grown on the Falkland Islands, and another in Somersetshire, the fleece of the latter being more of a lustre quality.

Ryeland.—The Ryeland, named after lands on which rye is produced, has long been grown in Herefordshire; but it is now found in Shropshire, Monmouthshire, Gloucestershire, and Warwickshire under various names locally obtained. It is of small build and grows wool of remarkable fineness, which before the days of colonial Merino was much valued. This sheep has now ceased to be profitable, owing to the smallness of the carcass and the lightness of the fleece. Crossed on the Lustre breeds, it has been fairly serviceable, but little appears to have been done with it in relationship to the Merino.

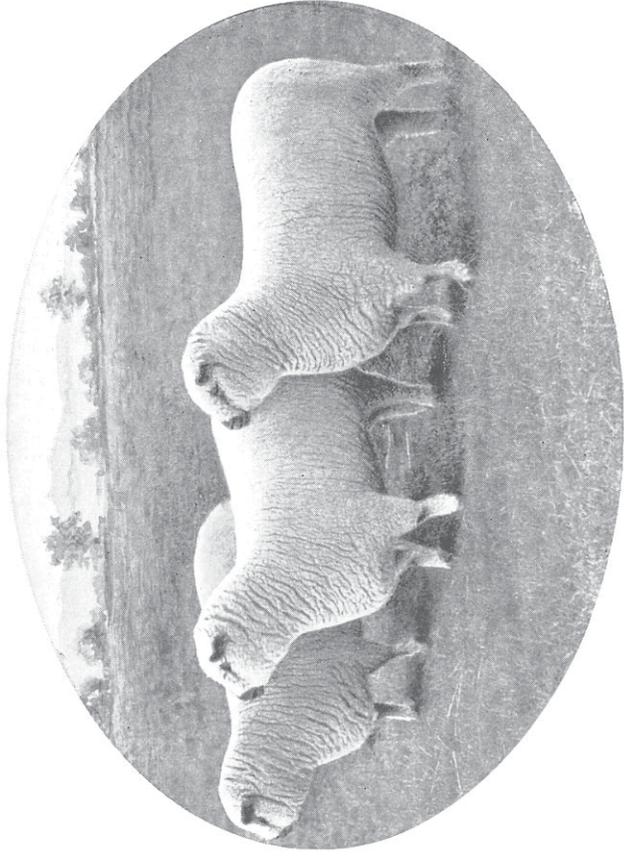


Fig. 12.—Shropshire Down Sheep

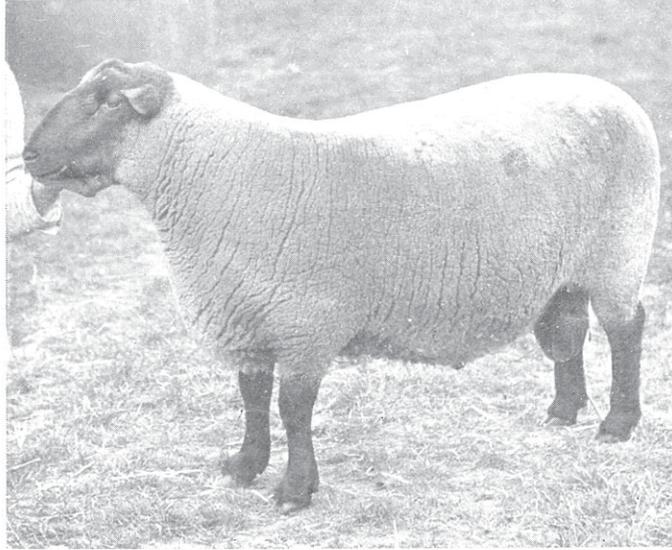


Fig. 13.—Suffolk Down Sheep

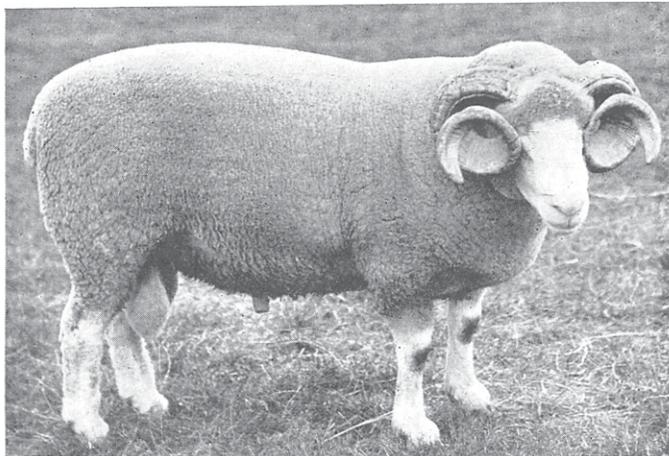


Fig. 14.—Dorset Sheep

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Class III.—**Mountain Breeds.**—Scotch Blackface (Fig. 15).—This is of quite a distinctive type. It is found on the Scottish hills and the elevated and unsheltered places in the English counties of Cumberland, Westmorland, Lancashire, and Yorkshire. In its pure or crossed state it forms the basis of the flocks owned by the Yorkshire moorland farmers. Usually the mutton is of fair weight and quality; but the wool is poor, being long, thick in fibre, and well intermixed with kemps, and light in weight of fleece. Generally it does not cross well, though distinct improvement has been wrought in it by carefully selected types of the Cheviot, Lustre, and Down varieties.

Herdwick.—Occupying the hills and mountains of Cumberland and Westmorland, this breed is remarkable for its hardiness and thrift. Like the Blackface, it provides useful mutton, but it is of slow growth, and the wool is of no particular value.

Cheviot.—The Cheviot is one of the most useful breeds extant. Grown on the Cheviot Hills running from Northumberland into Scotland, it is well suited to rough conditions, save those which are most extreme. This breed is very satisfactory as mutton, and it also supplies wool of a fine, dense, and white character, which is much valued. For its native locality crossing on it has been proved unsuitable, having weakened it constitutionally; but as a cross on other breeds to effect useful modifications it has been largely employed, particularly on the longer types. The two most remarkable of these are Leicester cross Cheviots and "North" or Border-Leicester cross Cheviots.

Lonk.—This, the product of the Cheviot crossed on the Blackface, is now an established breed, inhabiting principally the hills of Yorkshire and neighbouring counties. Considering the environment in which it

lives, the return given is exceptionally good, the carcass being large and the mutton palatable, while a heavy fleece of fairly fine and soft-handling wool is produced.

Dartmoor.—Fulfilling similar requirements to the foregoing breeds is the Dartmoor, named after the moorlands it inhabits in Cornwall and Devon. Though small, the mutton is excellent; the wool, however, is short and somewhat coarse and light in weight. Crossing the Leicester on this breed is said to have improved it considerably.

Exmoor.—These sheep are very small, but in other features they are similar to the Dartmoor, both showing certain relationship to the Dorset breed. They are known also as “forest breeds.”

Penistone.—For long ages this breed has existed in the West Riding of Yorkshire and on the Lancashire Border. It is extremely rough-looking, both in form and in the character of the wool produced; and it possesses a long and bony tail, which gives it a somewhat remarkable appearance.

Class IV.—Highland Breeds.—In the Orkney and Shetland Islands, and also the Hebrides, a wild race of animals, distinguished by a short tail, is found, exceeding in constitution almost all other breeds. The type somewhat resembles the goat. The fleece, which is very light, consists of wool and hair; and if the former is not shorn it will separate on its own account during the summer. No shearing as a rule is undertaken, but the wool is “roo-ed”—i.e. plucked by the hand. Improvement has been attempted by crossing, but only with the Cheviot has that quality of endurance been retained which is essential. As improvement in communication increases it is likely that the introduction of more profitable breeds will supplant the present type.



Fig. 15.—Scotch Black-face Ram

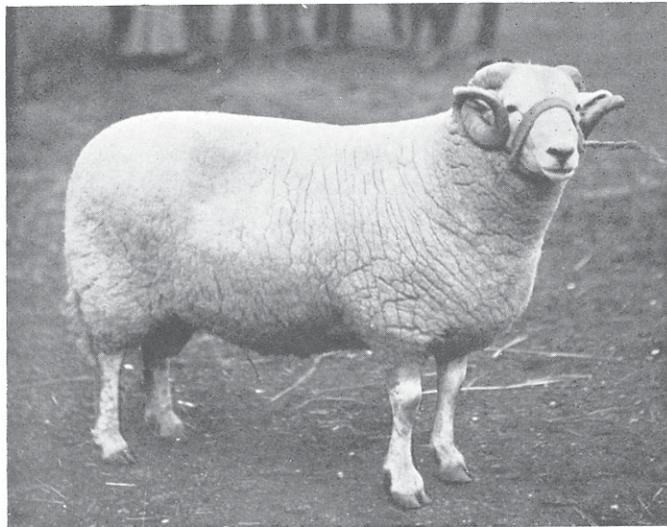


Fig. 16.—Welsh Mountain Ram

*(Photographs by permission of Messrs. William Cooper and Nephews,
Berkhamsted.)*

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Welsh (Fig. 16).—Generally two breeds prevail which are native to Wales, the first of which occupies the high mountains in the southern districts. It is not large, but of a wild and active order, yielding a fleece vari-coloured and of small weight. As mutton it is good. A characteristic of the breed, even in its improved type, is that of black hair, which covers the face and legs. A second breed—and the most important one—is known as the soft-woolled breed, this yielding excellent mutton and white wool (with which is mixed a proportion of hair), from which the celebrated Welsh flannels are made. This is a small, agile sheep, and, like the first-mentioned type, ordinarily inhabits the higher altitudes.

A Welsh breed of some trade importance is the Radnor, which is probably a development of the Welsh mountain sheep through the introduction of the Shropshire and other Down breeds. An old Radnor still exists which in fleece resembles the soft-woolled Welsh type; it is of a size similar to the mountain sheep.

Irish.—As is the case with Welsh sheep, two distinct varieties of sheep exist in Ireland—those of the mountain and those of the vale. Of the former breeds the chief are the Wicklow, which inhabit the mountains of that name on the east coast, and the Kerry, which are found chiefly in the western districts. They are similar to the Welsh soft-woolled type, those occupying the higher districts, however, showing much intermixture of hair. Crossing on the Southdown is carried on in many districts with successful results, both in wool and mutton, though there are evidences that the constitution is weakened through this procedure. The Kerry is distinctly larger than the aforementioned, and is somewhat ungainly. The mutton is excellent, but

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the breed is lacking in good wool characteristics and, further, is slow of development.

The vale sheep are of the long-woolled variety and are, of course, larger. Crossing has been effected with improved English breeds, largely of the Leicester type, with very satisfactory results, particularly in character and weight of fleece.

In Fig. 17 a general idea of the distribution of the various breeds in the British Islands is given.

Colonial and Foreign Breeds.—From ancient records it would appear that the Greeks, the Romans, and the Moors followed one another in conserving and developing the fine-woolled sheep from which all the Merino breeds of the world are derived. The evolution of the Merino sheep seems to have taken place along the shores of the Mediterranean, ultimately attaining its perfection in Spain.

Spanish Merino.—The home of the Merino is Spain—a country long celebrated for its wool, to which most of the important wool-growing countries of today are indebted for the new blood which has effected such marvellous improvement in their flocks. In Spain three types of sheep exist—the Chunah, a large, long-woolled sheep kept in small flocks by the Spanish peasants, yielding a fleece fulfilling local requirements; the stationary Merinoes—termed stationary, or *estantes*, along with the Chunah, because they remain on the same pastures; and the migratory Merino or *transhumantes*, which change pasturage with the various seasons. It is the latter which is the important breed, being the one from which the great colonial flocks are descended. In developing the Merino sheep, everything has been subordinated to fineness of character in wool; possibly as a consequence of this the form

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of the sheep is inferior to that of other types. For long ages this sheep was closely guarded by the Spaniards, its exportation being punishable by death. But in 1723 Sweden imported a small number, with, however, no very great success. France followed, failing altogether, though fifty years afterwards, under Government auspices, Spanish sheep were again introduced from which a celebrated Rambouillet breed was developed. Then Germany made the attempt, proving, with its importation to Saxony in 1765, very successful. Into Austria in 1775 a flock different from the Saxonian type was taken, which prospered remarkably. The breed in Saxony is known as "Escorial," as distinct from the term "Infantando" or "Negrette," applied to the Austrian type. An introduction of Spanish Negrettes took place into England in 1787 and 1791 at the instigation of George III., and although from various causes the venture was not a success as regards the development of the Merino, much improvement was effected in the Down and even in the long-woolled types by crossing the Merino upon these.

Australasian Breeds.—It is in Australia and New Zealand—both as a pure breed and a cross—that the Merino has achieved its greatest success.

Introduction to New South Wales.—The Merino was first introduced into New South Wales as already mentioned. From New South Wales the breed spread in a westerly and southerly direction and reached Tasmania and New Zealand, and as the colonies were developed, it became the foundation of a gigantic colonial industry and the basis also of the great woollen and worsted trades of the world. Sheep-farming is now a science. Endeavours are being made to understand the influence on sheep of the prevailing condi-

tions, and careful experiments have been and are being made to ascertain the most suitable sheep for the various districts. In some cases the fineness of the wool rivals that from the native source, and in all cases the weight and density of the fleece have been remarkably developed. As already intimated, while much of the land of Australia, particularly the interior sheep runs, will only carry a light sheep, much of the coastal regions will carry a much heavier sheep. Crosses of Leicester and Merino, Shropshire and Merino, etc., are here employed, the result being a sheep in its entirety more valuable, but a cross in which the wool is markedly affected. Thus New Zealand produces large quantities of cross-bred wool, such being almost a by-product of the foreign mutton trade.

American Breeds.—The first introduction of Merino sheep into the U.S.A. took place in 1801, and consisted of three sheep—one direct from Spain into the State of New York, and the other two from France into Massachusetts. It is probable that the latter were of the true Spanish blood. Following this, there were many importations from Spain, France, and Portugal, all of which are described as of first-class quality. Realising the marked suitability of many States for sheep-farming, and owing also to the great demand as sustained by tariffs for wool cloth since the days of the Civil War, much has been done to build up flocks of a first-class order. There are many varieties of Merinoes in the United States, the chief among which is the Vermont, a breed somewhat larger than the ordinary type and fleeced with a long, dense, though relatively coarse wool, heavily folded and thoroughly impregnated with yolk, enabling the sheep to combat the conditions of a somewhat severe winter. This

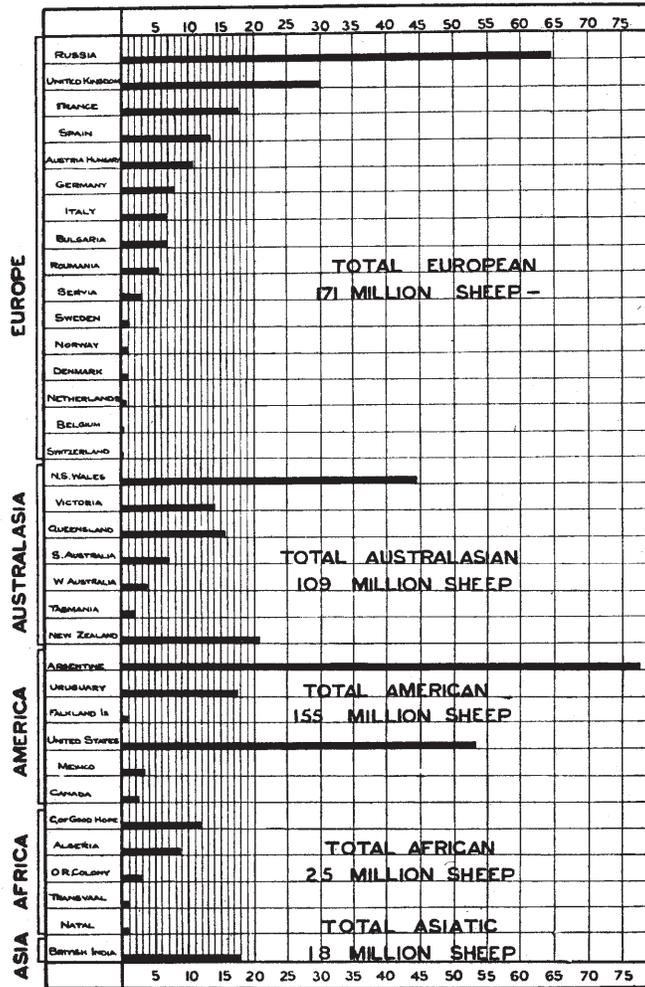


Fig. 18.—The World's Flocks in Million Sheep

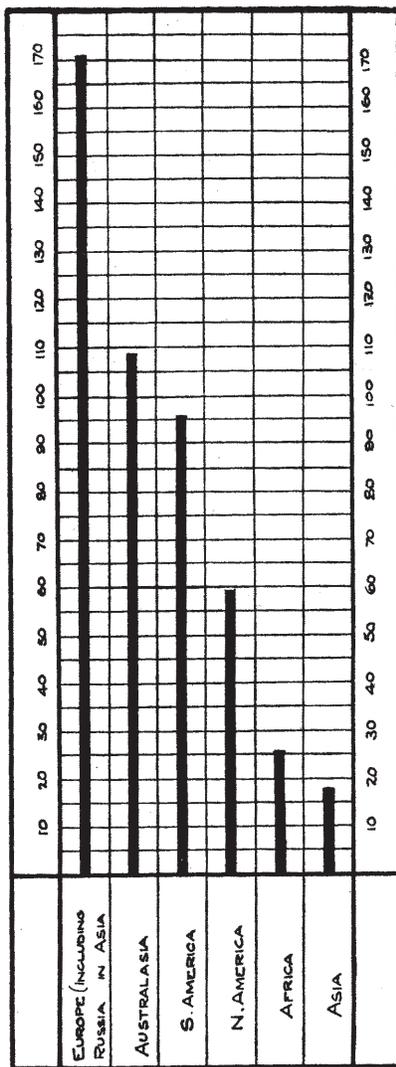


Fig. 19.—The World's Flocks in Million Sheep

breed has been crossed on the Australian Merino, and in some localities has proved very useful in increasing the weight of the fleece, which, in certain districts in New South Wales, for instance, through the climatical conditions obtaining, tends to become too light and fine.

Territory wool and its various crosses is perhaps best represented by the various Down crosses of England rather than by the cross-breeds of Australasia.

Other Colonial and Foreign Breeds.—These are :

1. Native to the country and are in their unimproved state ;
2. The native sheep developed through the use of the Merino as a cross ; or
3. Improved by crossing on the British breeds.

The breeds of the following countries, claiming recognition on account of the quantity of wool yielded, need brief description. Order of importance is observed :

Cape Colony.—In Cape Colony and Natal the fat-tailed sheep is native ; but the Merino has been introduced from Spain and cultivated with success. Much improvement, however, may yet be effected both in the form of the sheep and character of the fleece, the latter generally being of excellent fineness, but lacking strength. The wool is deficient in length also, owing to a system of double-clipping which prevails in many parts. Due to contact with sandy soil and the open condition of the fleece, considerable impurity is found in this wool. Great improvements are, however, being attempted, and much may be expected of Cape wools in the near future.

South America.—The wool grown here was formerly of the Spanish Merino type, and for a long time was

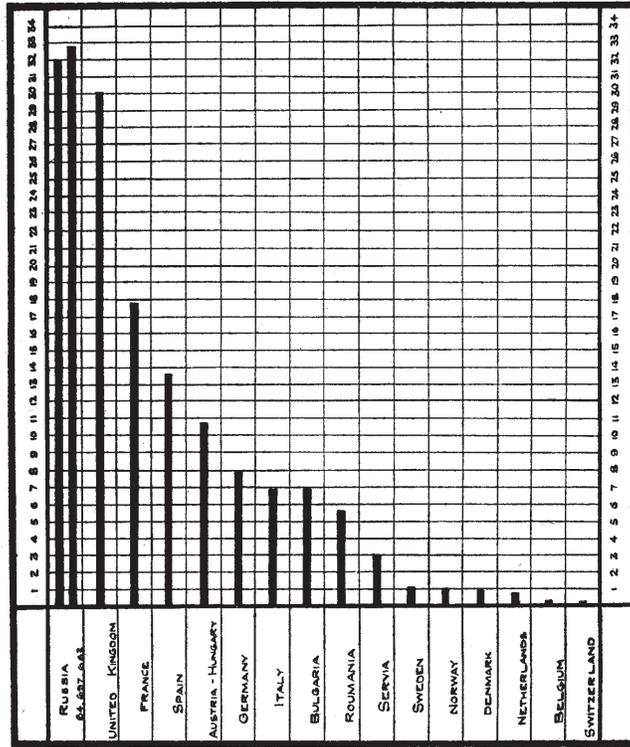


Fig. 20.—Production of European Wools in Millions of lbs.

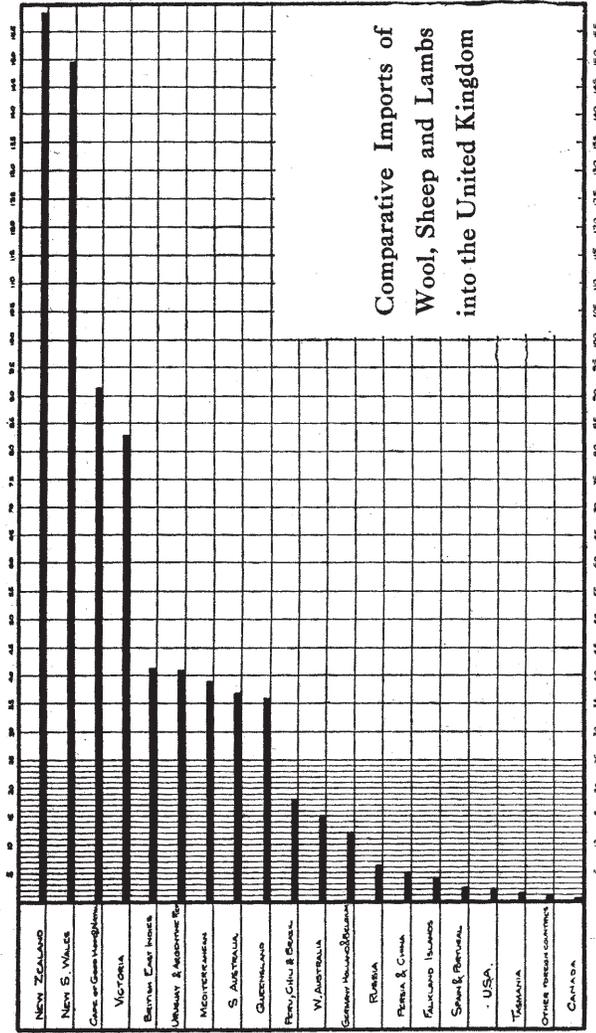


Fig. 21.

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allowed to degenerate. To-day wool-growing is considered of great importance in South America, and from a vast country, in most respects highly suitable for sheep, large quantities of very useful material are obtained. Many Merino sheep are reared, but the great export mutton industry centred in South America is responsible for a large number of cross-bred varieties of sheep, obtained by using the best English varieties of the Merino:

As an evidence of the numbers of sheep and the quantities of wool produced in the various wool-giving centres of the world, Figs. 18, 19, 20, and 21, which graphically illustrate the position of each, are well worth studying. They are self-explanatory. In Fig. 18 the sheep in each continental country are shown, and from this it will be readily noted which country possesses sufficient numbers to cause it to be important or otherwise as a wool producer. Fig. 19 shows the return for each continent in millions of sheep. In Fig. 20 the European wool production is illustrated, while from Fig. 21 the extent and character of the wool as manufactured or as bought for redistribution may be noted:

CHAPTER II

SHEEP-BREEDING AND MENDELISM

SHEEP may be bred simply as mutton-producing animals, or as wool-producing animals, or, as is more frequently the case, as both mutton and wool producing animals.

When, about 1902, the price of wool fell to something under 4d. per lb. for the rougher sorts of North Country wool, and to a proportionate figure for the finer and for the more lustrous kinds, the sheep-breeders in this country bred their sheep for the mutton and took little account of the wool; the same tendency was also to be noted in the Colonies about this time, particularly in the case of New Zealand, this colony having comparatively early developed the frozen-mutton trade.

As an example of a sheep bred for wool alone the Australian Merino sheep may be cited. This is a small carcass sheep, upon which is produced a quality of wool which so far has never been produced on a larger-bodied, good carcass sheep. But for the quality of its wool the full-blooded Merino could not exist for a day, save, possibly, in certain sandy tracts of the Australasian continent.

It is obvious that if a good carcass can be produced along with a characteristic wool a two-fold advantage will accrue; hence the many attempts at cross-breeding both in this country and in the Colonies. Sometimes, as in the case of the Australian Merino crosses, a larger

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imported Merino type is crossed with the pure Australian Merino type to produce a heavier fleeced sheep without marked deterioration in the wool. In other cases a larger, earlier-maturing male sheep is mated with smaller ewes to obtain earlier maturing and larger carcass sheep with a constitution still fitted to their environment, as in the case of the many Down crosses now to be noted in the north of England. It is obvious that most flocks of sheep will be bred to obtain the utmost total income from both carcass and wool. This aspect of the case will be better understood by taking such an example as that given on p. 62, which shows that, at least under certain circumstances, the sheep-farmer cannot afford to breed the finest wools, or, rather, that it will pay him much better to breed a medium fine wool of greater length of staple, and, consequently of greater fleece weight, upon a larger-bodied sheep, than a very fine wool of less fleece weight upon a comparatively small-bodied sheep.

It is thus evident that quality of wool, weight of fleece, and weight of carcass markedly influence the sheep-breeder in his search for the most suitable types upon which to found his flocks. When the further influences of environment, and of the necessity for adapting the animal to the conditions under which it has to live,* are taken into account, it is evident that anything conducing to a better understanding and controlling of sheep-breeding in its varying aspects should be welcomed in a whole-hearted manner by those interested.

It is here proposed to indicate briefly the principles originally evolved about 1865 by Mendel, and so use-

* An interesting converse case of this occurred in the crossing of the drought-resisting Australian Merino with the Vermont Merino. When the drought came, 75 per cent. of the cross-bred flocks in some cases perished.

fully extended by Bateson, Wood, Punnett, Biffen and others, in the hope that sheep-breeders both at home and abroad may be induced to examine more closely the principles upon which they base their crossings and selections. If this be done, it seems reasonable to hope that less difficulty will be experienced in getting any particular type of animal or of fleece required, and that the fixing of a useful type may be accomplished within a very short period. To-day there is a saying in Australia to this effect: "Two generations to find a type, seventeen generations to fix it." Mendelian principles show how every possible type may be evolved at the second generation, and, further, how pure breeds may be discovered with a few trials conducted on clearly defined lines, with the result that five or six generations may be ample to fix absolutely any required type.

General Principles of Sheep-Breeding.—Up to the present time it may fairly be said that the sheep-breeder has been working in the dark, and he is undoubtedly to be complimented upon the results he has produced with such inadequate means as those upon which he has relied. His methods are few and simple. To produce variations in accordance with his requirements, he crosses likely breeds. To make the most of his opportunities, he selects or "culls"—i.e. he selects the most likely individuals for breeding purposes, or he weeds out from his flocks unlikely individuals from which he does not wish to breed. Then, from time to time, he may notice certain mutations, or "sports," as they are termed, and upon these his hopes of a new breed may be founded.

That selection in some form or other is the basis of the sheep-breeders' art there is no gainsaying, and from this point of view it only remains to emphasise the

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necessity of the breeder keeping a true and useful type before him ; he must decide what he requires, bearing in mind the several main factors already noted, and also the limitations which his particular environment imposes.

It is in the effects of crossing and in the maintenance of type that the first real difficulties are encountered. Just as with poultry, pigeons, etc., the crossings of breeds frequently result in unthought of and unsought for varieties, and until Mendel's work was brought to light, these seeming irregularities were uncontrollable, and amenable to no known law. It will presently be our object to show that at least the greater number of the variations referred to may be scientifically explained, and that well-directed experiment will probably render possible the positive controlling of these variations.

The maintenance of stability of type is, perhaps, the greatest difficulty which the breeder has to encounter. Let us clear the ground at once, however, by stating that all such phenomena termed "reversions to type," "throwing back," and some apparent "sports" are readily explained by Mendel's laws, and with careful experiment should usually be readily controlled.

There is, however, another type of variation which is possibly not so readily controllable, and that is what may be termed acquired variation. Attention was first drawn to the possibilities of Australia as a wool-growing country by reason of the remarkable changes which the fleeces of comparatively rough sheep underwent : changes which could only be ascribed to the direct action of the environment through the individual. Take the Australian Merino sheep out of its natural environment, and it will lose its acquired characteristics. A similar example is to be noted in the lustre wool of Lincolnshire. Take the Lincoln sheep away from the

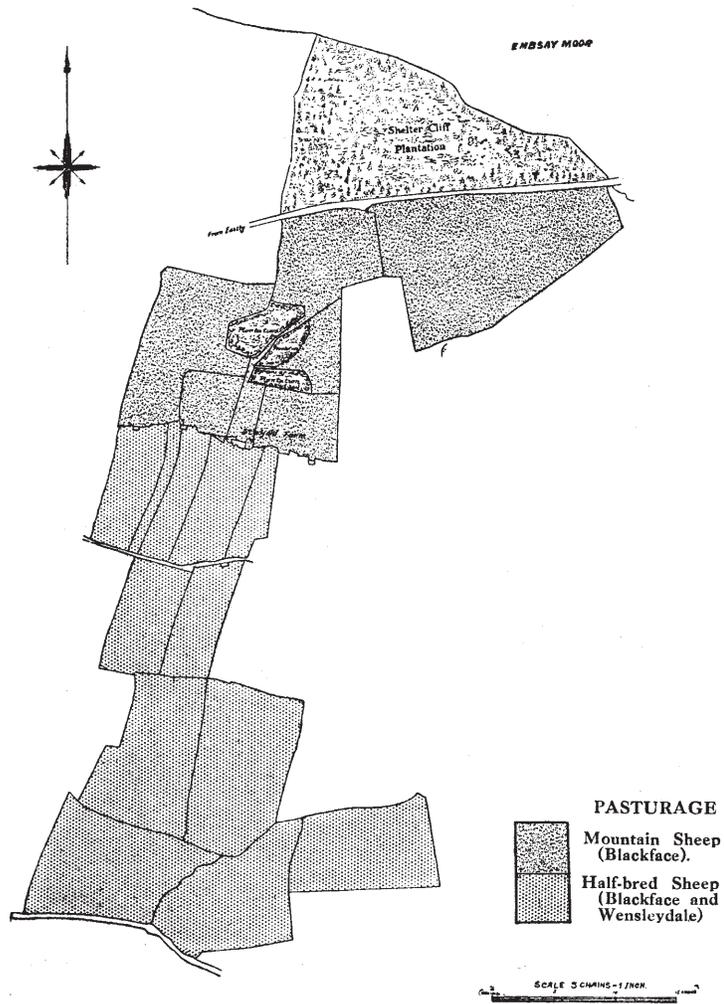


Fig. 22.—Plan of Sheep Farm

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rich pasturage and artificial feeding of Lincolnshire, and place it on the chalk downs of the southern counties, and its lustre is at once impaired. In both these cases it seems probable that by selection a type of sheep has been evolved whose constitution responds to the particular environment in question to the fullest possible extent, and by inference one would expect such a type to be impaired in its responsiveness to environment other than that for which it had been specially selected. There may be limits to the possibilities of selection, but it is not impossible—to take a trite case—that a Merino-woolled breed might be found whose constitution would respond to the environment of the English climate in such a way that Merino wool would still be produced. The fact that Merino rams have been kept by Professor Wood on the Cambridge University Farm for some years without marked deterioration in the quality of the wool, suggests that the last word has not been written on this matter. It seems possible that the stability of any breed may, in part, depend upon the time-factor—in other words, upon the length of time that this breed has been maintained in a state of equilibrium, and that breed may possibly dominate environment within reasonable limits.

Perhaps the foregoing remarks may be summed up in the three points specially noted by Professors Wood and Punnett:—

- I. The necessity of care in selection ;
- II. The occurrence of two kinds of variation, acquired* and genetic ; the latter only being inherited ;

* These writers' citing a fat heifer as an example of this is hardly conclusive, as the quality of fattening may only be genetic, and as such may be transmitted to offspring. However, there may obviously be individual variations dependent upon accidental influences, which may most truly and usefully be considered as most closely related to these influences, and, consequently, at least, not wholly genetic.

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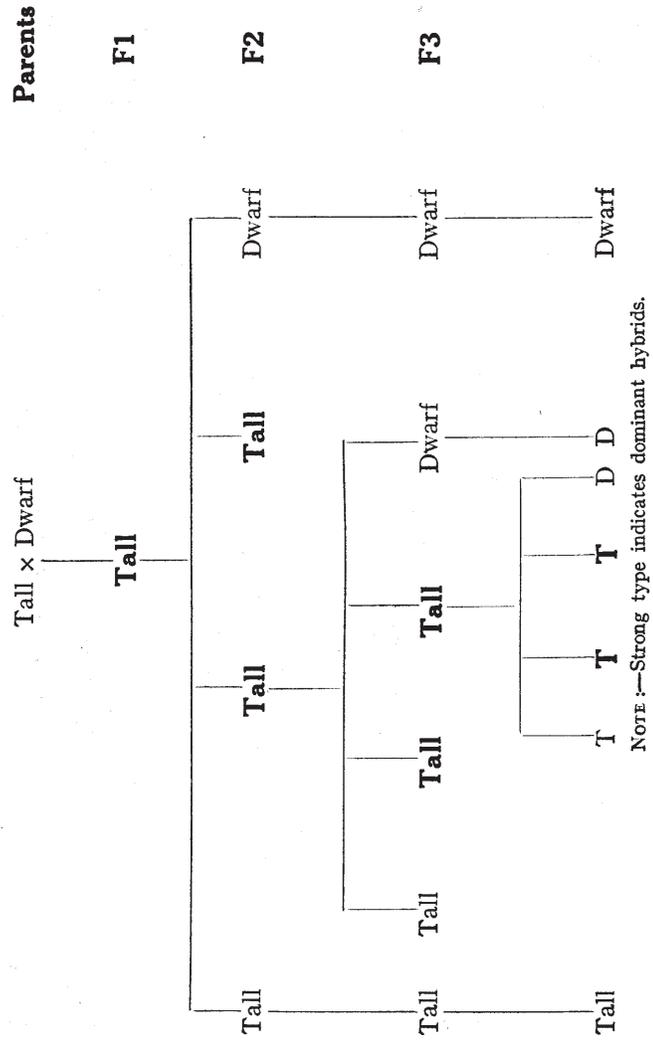
III. The need for applying an actual breeding test to any individual which it appears desirable to perpetuate before definitely deciding to keep it for stock.

Selection has been dealt with at some length. Mendel's principles of heredity must now claim our careful consideration.

Mendel's Principles of Heredity.—If Darwin and Wallace in the domains of biology and philosophy dominated the thought of the latter half of the nineteenth century, Mendel has at least as fully dominated the thought of the early years of the twentieth century in the wonderful vistas he has opened up in practical biology, and more particularly in what is now termed "Genetics." Mendel's work is most readily apprehended by taking a simple example, such as that of the crossing of tall and dwarf peas, and representing it graphically as on page 41.

From this it appears that the result of crossing a tall and dwarf pea is in the first generation (F₁) an *apparent* tall pea. This is expressed by stating that the tall pea is dominant to the dwarf pea, and the dwarf pea is recessive to the tall pea. On crossing the F₁ generation with itself it will be noticed that in the second generation (F₂) the result is plants in the proportion of three tall plants to one dwarf. The main point to notice, however, is that of the tall plants one only will breed true, the other two being impure, and corresponding exactly with the tall in F₁ generation; while the one dwarf plant, the recessive, is also pure. This must be fully realised, as it forms the groundwork of Mendel's principles.

The explanation of these results may be expressed most convincingly by the following diagram (Fig:



NOTE :—Strong type indicates dominant hybrids.

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23) from Professor Punnett's well-known work on "Mendelism" :-

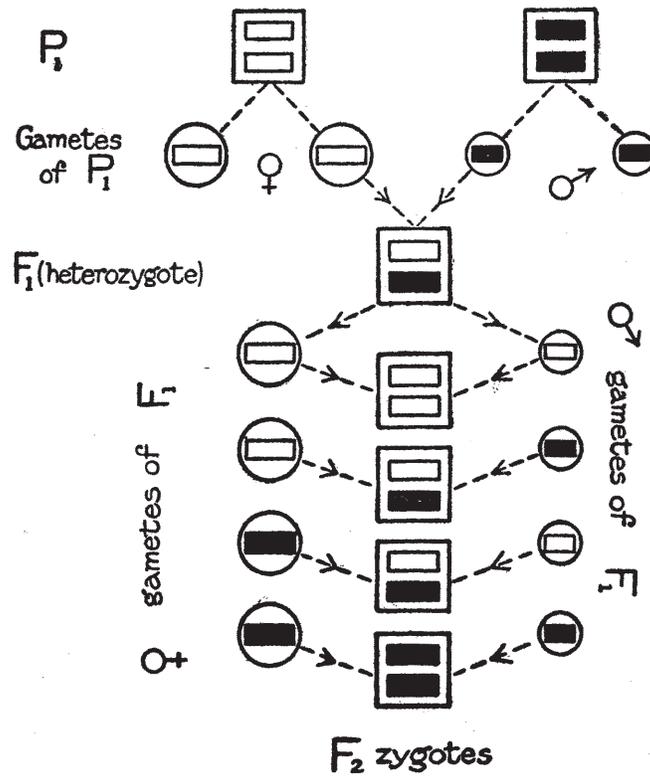


Fig. 23

From this it will be realised that if the male or female gametes of one parent be fertilised with the female or male gametes of the other parent, the result

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is that the F₁ generation of *plants* is heterozygous (although appearing like the original tall plant), and gives rise to equal numbers of tall and dwarf gametes, which fertilising one another, by the laws of chance, so to speak, give rise to three types of zygotes in the F₂ generation, of which two are homogeneous or homozygous and two heterogeneous or heterozygous.

The thorough comprehension of this diagram clears the way for the enunciation of the main principle which Mendel discovered—viz., what is termed *the segregation of the gametes* : i.e. whether a plant is heterozygous or not it produces gametes, each of which is pure. If the plant is pure tall, it naturally produces gametes pure tall only ; but if it be a hybrid, i.e. heterozygous, it produces pure tall and pure dwarf gametes *in equal numbers*.

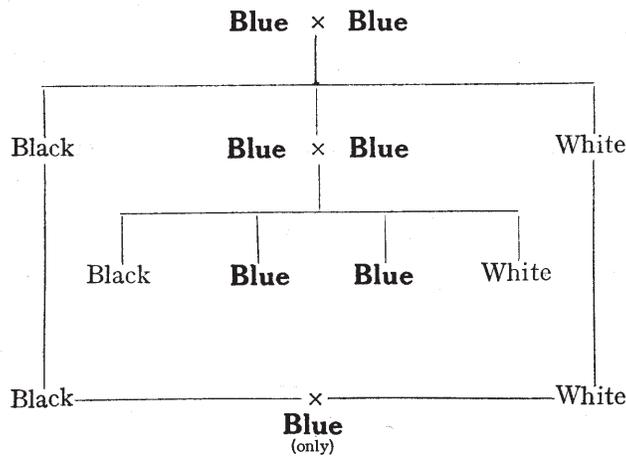
This is Mendel's discovery put in its simplest form, and it only remains for us here to touch briefly upon certain apparent complications, and then to deal with its application in sheep-breeding.

Perhaps the first real difficulty which occurs is in some such suggestion as this : Suppose a tall pure pea is crossed with a tall impure, or a tall impure with a dwarf pure, what is the result ? *Exactly what would be expected, working on the lines indicated by Prof. Punnett's diagram*. This has been tested many times and in many ways, and the results, even to the proportion of the several kinds, are always the same.

The next difficulty has reference to cases in which the F₁ generation is different from either parent, as in the case, for example, of the blue Andalusian fowls. This fowl can only be produced in the F₁ generation, its parents being either the heterozygous blues, or black crossed with white, or blue crossed with either the black or the white, the proportionate numbers being

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always what would be expected. This crossing is illustrated as follows :—



NOTE :—Strong type indicates dominant hybrids.

It will at once be evident that most of what are termed "sports" may be the result of some such combination as this : Thus, two white peas may give in the F₁ generation a pink pea, and a white and a pink parent primula may give a white in the F₁ generation. In the case of the two whites giving the pink, it is probable that one carries the colour factor, and the other the striking or, as it were, mordanting factor ; hence the colour in the heterozygous plant. In many cases a presence and absence theory seems to give the key to observed results, but there is not space here to go into the many tested and authenticated cases. *There is really nothing haphazard in these results.*

Perhaps the greatest difficulty of all lies in defining what may be termed "unit characters." Thus, in the

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first example cited, the gametes carries the factor of tallness to the exclusion of the dwarf characteristics, or the gametes carries the dwarf characteristics to the exclusion of the tall characteristics, and never carries both. If one could split up all characteristics into pairs of opposites such as these, many of the difficulties in the application of Mendel's principles would vanish. Unfortunately this can rarely be done. For example, it seems, with reference to sheep, that they either have horns or have not horns; here we have a pair of characters. On the other hand, it seems probable that the black faces of certain breeds of sheep is not a unit character, but is a compound of say black nose, black eye-rings, and so on. And in the same way it may turn out that the quality of the wool is not a unit character, but two or more characters compounded of length, fineness, etc.

In all breeding work intended to have an economic bearing, the first step is to carry out what may be called a Mendelian analysis. To do this breeds with and without the desired characters are crossed and the way in which the various points segregate in the second generation is noted. For instance, in the second generation from the Dorset-Suffolk Cross, it was noted that very few real black faces were obtained, but that the common forms had black noses or black spectacles, or both. Such an analysis shows that the black face is not a unit character, but is made up of black on nose, black round eyes, and so on. Having thus analysed the black face, it would then be possible to proceed to build it up again:

Another difficulty easily overcome in the plant world, but a real stumbling-block in the animal world, is the necessity of producing large numbers of crosses, so that every possible combination is produced; and

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more particularly in finally selecting the pure individuals to breed from. Some of these difficulties will be referred to in dealing directly with sheep-breeding, but so many have been overcome that it seems more than possible that the present seeming exceptions will ultimately be brought under the law. In order that the reader may not run away with the idea that these results are what the so-called practical man terms "theoretical," he is referred to the work of the Cambridge University School of Agriculture in the production of wheats, etc., which already have been successfully placed on the market.

Mendel's Principles Applied in Sheep-Breeding

—In sheep the difficulties of obtaining the type required are complicated by the number of factors to be taken into account. Professor Wood has already worked some interesting crosses out, and has kindly allowed his results freely to be drawn upon. Perhaps the most interesting is that in which the white-faced horned Dorset sheep has been crossed with the black-faced hornless Suffolk sheep. The results may be indicated diagrammatically as on page 47.

In Figs. 24 and 26 photographs of the actual results obtained are reproduced.

From these results the following two deductions have been made :—

- A. Every possible type that can result from any given cross appears in the second generation, provided that in this generation enough individuals are produced.
- B. Of the individuals of every one of these possible types a certain proportion are already fixed, and if these are picked out no further selection is necessary to establish the type.

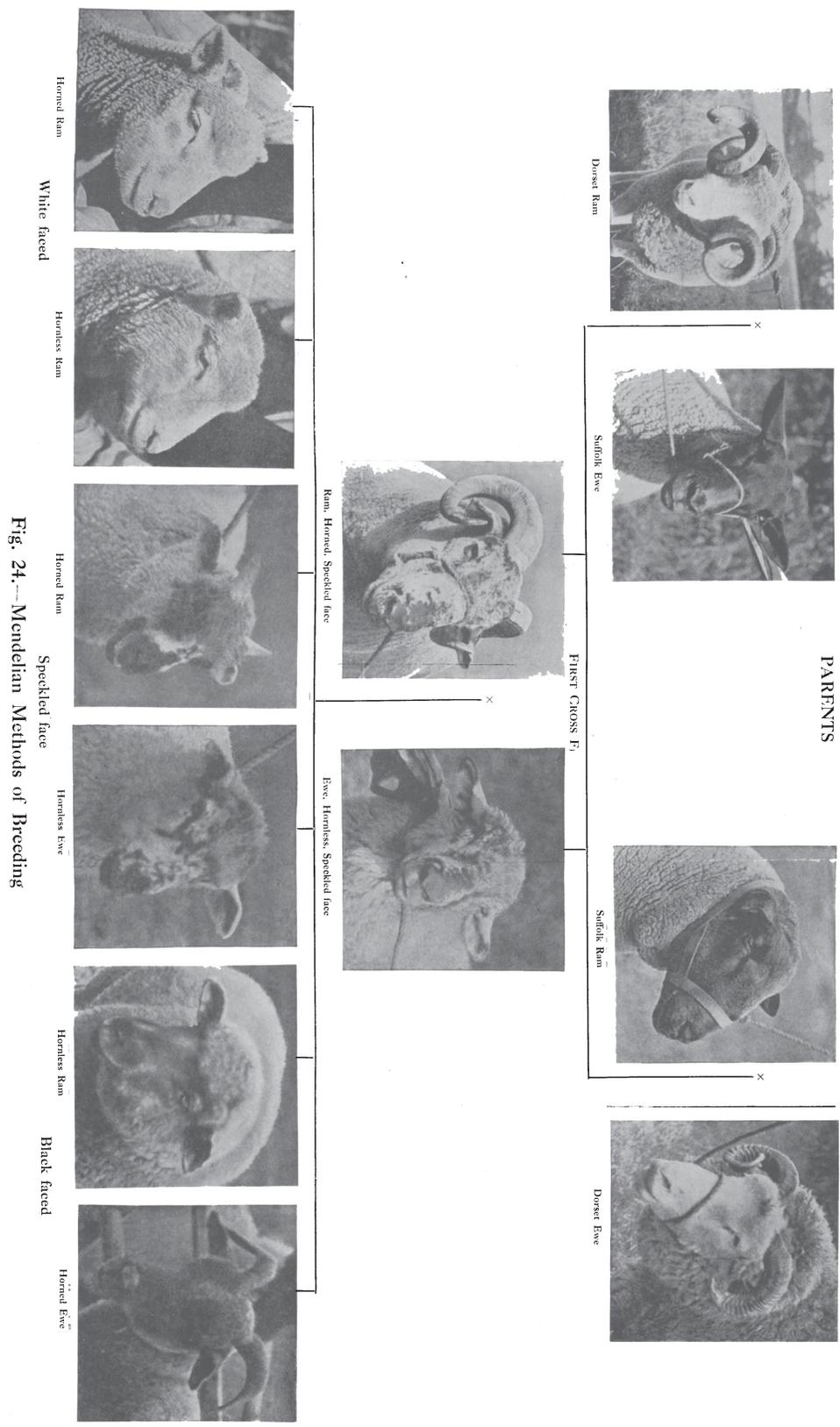
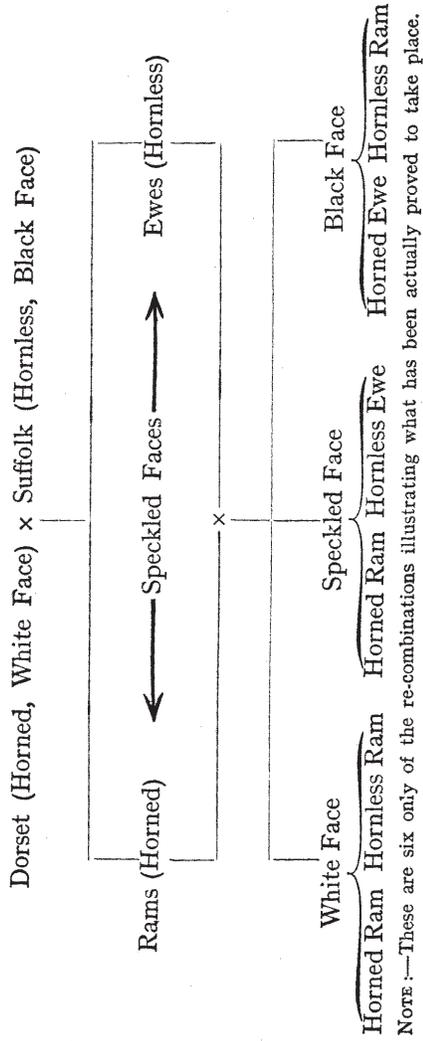


Fig. 24.—Mendelian Methods of Breeding

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These two deductions will be fully understood by reference to the diagram on the previous page of the crossing of the Dorset and Suffolk sheep.

Note should here be made, however, that the term "fixed" applies to unit characters only. Thus an animal may be fixed for one character but heterozygous for other characters.

The difficulty in picking out the pure-bred individuals is really the crux of the matter now. This may usually be done by mating with known recessives. But the whole question is so complex that the reader must be referred to the standard works now to be obtained on the subject.*

* * * * *

That the principles here briefly dealt with well merit the sheep-breeder's careful consideration will at once be conceded. When the value of definite breeds of sheep in particular situations and for particular purposes is considered, then it is evident that any means of controlling the type of sheep produced, and of fixing the type when produced, is of the greatest possible interest, and probable value, to sheep-breeders. Damp, low-lying districts require the foot-rot, fluke-withstanding Romney Marsh sheep. Some districts of Australia require a light sheep, and some will carry a heavy sheep. The mountainous districts of Scotland, Wales and Switzerland each requires its own type, and so forth. It will be a strange thing if in the near future the large sheep-breeders both at home and abroad do not employ to marked advantage the principles here given in outline.

In conclusion, reference may be made to experiments at present being conducted by Professor Wood on the Cambridge University Farm. In this case Merino rams have been mated with heavy-fleeced, large-bodied

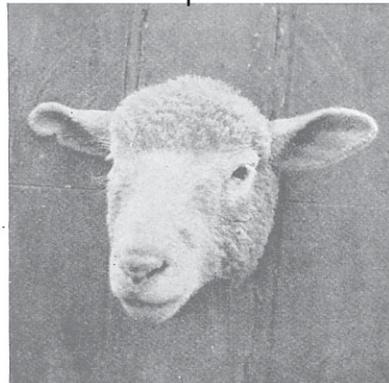
* See Darbishire's "Breeding and the Mendelian Discovery."



F₂* Ram



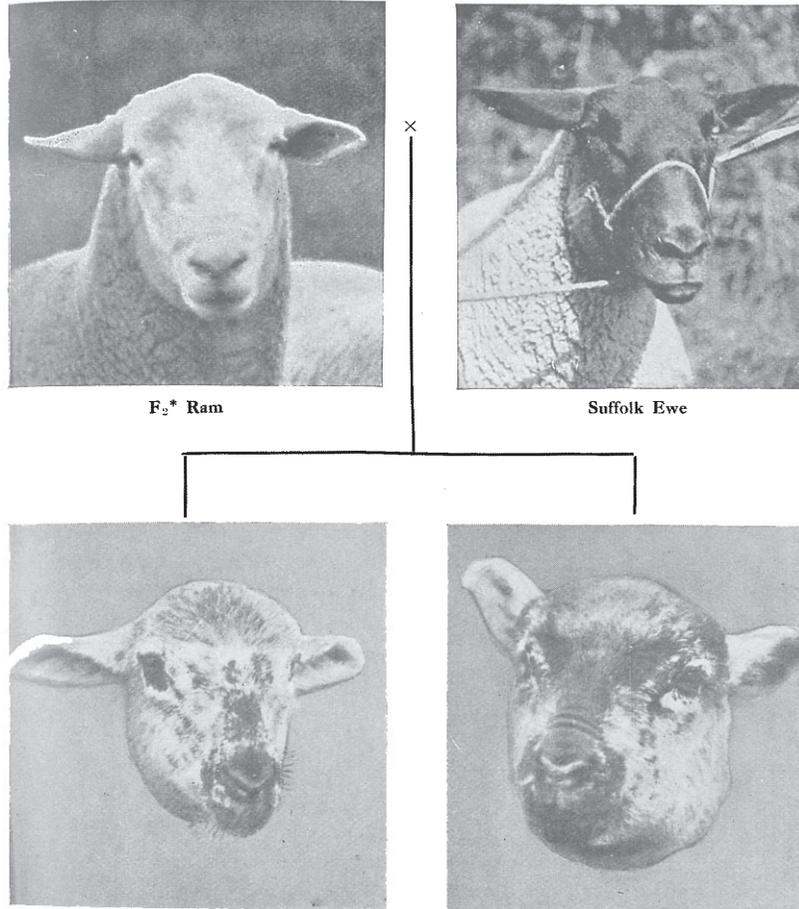
Dorset Ewe



Progeny all white faced

Fig. 25

*** The F₂ ram is pure hornless and pure white faced**



Progeny all hornless

Fig. 26

* The F₂ ram is pure hornless and pure white faced

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Shropshire ewes. In the F₁ generation there is a certain variation among both rams and ewes, showing that the allelomorphic pairs are somewhat complex ; but, upon the whole, both rams and ewes appear to be tending towards the Shropshire carcass and the Merino wool. The wool from both rams and ewes varies from about a 50's quality to a 64's quality, but the bulk would be considered a good typical "come-back." All the rams possess horns or scurs but the size of the horn varies considerably. From these slightly varying half-bred rams, a selection of two or three is being made, so far as possible fine-woolled heavy carcass individuals being chosen. Mating these with the half-bred ewes, every variety of Merino-Shropshire combination should appear in the F₂ generation. From a close examination of the types which appear it should be possible to draw some conclusions as to the mode of inheritance of wool and mutton, and possibly to analyse the unit characters on which these economic points depend. There will then remain the difficult task of selecting the fixed-bred sheep which possesses the wool qualities of the Merino with the carcass characteristics of the Shropshire. The testing of individuals of this generation may be most difficult, but there is every reason to hope that in the conducting of these experiments principles of great value to the sheep-breeder will be evolved.

CHAPTER III

WOOLS, HAIRS, AND THE RE-MANUFACTURED MATERIALS

British Wools and their Uses.—No country supplies a greater range of wool qualities than Great Britain. These are suitable for a large variety of fabrics, and four classes may conveniently be made.

1. Long and lustrous wools.
2. Short wools.
3. Mountain-bred wools.
4. Highland wools.

1. **Long and lustrous wools.**—These wools are characterised by length and lustre, and are usually remarkable for strength and soundness. As an example of degree to which the latter qualities are present the use of Lincoln and Leicester wools for covering the squeeze rollers, which have to do most heavy work, in scouring machines may be cited. These wools are typical worsted materials, being straight-fibred and capable of conversion into a parallel fibred yarn of marked smoothness and lustre. They are, naturally, mostly used in the production of bright fabrics, which are most durable, and which possess most excellent draping properties.

2. **Short Wools.**—These differ markedly from the foregoing. Their striking feature is a firm and clearly defined curliness, which makes them specially suitable

for hosiery fabrics in which fullness and softness are very important characteristics. These wools are usually of a good colour, and as they are fine fibred, they admit of the production of light-weight goods. They are not remarkable for strength, but except in fleeces which are exceptionally weak this is not a serious disadvantage in the fabrics for which they are suited. Although they do not usually felt well they are employed to a considerable extent in the woollen industry, as they give fullness and springiness to the fabric.

3. **The Mountain-bred Wools.**—These have not the nature or character of either the long or short types previously mentioned. Owing to careless breeding and the severe climatic conditions under which they live, they lack brightness, and they are very irregular in fibre and staple. Marked differences are also noticeable in staples from the various positions of the fleece, which cause considerable trouble to both staplers and spinners. Almost all these wools are markedly characterised by kemps which affect both the spinning and the dyeing of the material. The fibre, further, is rough, wiry, and poor in cohering qualities, and consequently it neither spins well nor handles kindly. Still, for low, thick yarns and fabrics of both the woollen and worsted types, these wools are cheap and serviceable. Cheviot wool is the most important of this class, having made its name in connection with Scotch tweeds, with reference to which it is useful to note that what may be termed the defects of the wool have been made the basis of a most useful class of yarn and fabric.

4. **Highland Wools.**—These partake of the nature of Down breeds, but lack character and trueness. Save in Irish wools—which are somewhat better than the other types—they are irregular and wasteful in staple, thick in fibre, and contain many kemps. Their spinning

VARIATIONS OF BRITISH TYPES OF WOOL

Type of Wool	Length Inches	Strength	General Appearance		Handle	Weight of Fleece (Average)	Quality (Average)	Uses
			Form of Staple	Colour or Lustre				
LINCOLN	12	Very strong	Very firm, straight-tapered	Very lustrous	Fairly soft	12	36's	Plain and fancy lustre and demilustre dress fabrics; also imitation serges.
LEICESTER	10	"	Firm, straight-fibred and tapered	"	"	10	40's	
COTSWOLD	8	Strong	Firm, deep-grown, slightly curly	Lustrous	Soft	8	44's	
BORDER-LEICESTER	10	"	Fairly firm, slightly curly, tapered	Very lustrous	Fairly soft	10	44's	
WENSLEYDALE	9	"	Fairly firm, tapered, curly	Lustrous	Not soft	9	36's	
DEVON	10	"	"	"	Soft	10	36's	
(BAMPTON)		"	"	"	"	9	40's	
DEVON	9	"	"	"	"	8	46's	
(SOUTHAM)		"	Fairly firm, slightly curly	"	"	7	46's	
NEW OXFORD	8	"	Full and open, curly	Whitish, medium lustre	Very soft	7	46's	
ROMNEY (KENT)	6	Fairly strong						
SOUTHDOWN	3	"	Thick, dense, and curly	Very white	"	4½	56's	
SHROPSHIRE-DOWN	4½	"	Fairly dense and curly	"	Soft	6	50's-56's	
HAMPSHIRE-DOWN	3½	"	Thick, dense, and curly	"	"	5	50's-56's	
OXFORD-DOWN	4	"	Fairly full and open, curly	White	Very soft	6	50's	

VARIATIONS OF BRITISH TYPES OF WOOL—(continued)

Type of Wool	Length Inches	Strength	General Appearance		Handle	Weight of Fleece (Average)	Quality (Average)	Uses
			Form of Staple	Colour or Lustre				
SUFFOLK-DOWN	5	Fairly strong	Full and open, curly	White	Soft	6	50's	Dress fabrics, ho-series, flannels
RYELAND	3	Strong	Thick and dense, curly	Very white and silky	Very soft	4½	56's	
DORSET	4	Fairly strong	Fairly full and open, fairly curly	White	Soft	4	50's	
BLACKFACE	10	Weak	Straight and shaggy, un-uniform (kempy)	Grey, poor lustre	Harsh	4	32's	Tweeds (Cheviot wool type), woollens, carpets, low hosteries, blankets
CHEVIOT	4½	Fairly strong	Full and thick, curly	Fairly white ("Blue" wool)	Fairly soft	4	46's-50's	
LONE HERDWICK	5	Weak	Full and open, tapered	Fairly white	"	4	46's	
"NORTH"	8	Weak	Rough and open (kempy)	Grey, poor lustre	Harsh	3½	32's	
FENISTONE	7	Strong	Full, uniform, curly	White and bright	Soft	7	46's	
EXMOOR	8	Fairly strong	Royal and open, straight	Whitish, fairly bright	Harsh	4½	32's	
WELSH	4	"	Full and open	"	Soft	4	36's	Flannels, hosteries low woollens, "homespun" hat fabrics.
IRISH	6	"	Rough, un-uniform, kempy	White	"	3½	36's	
SHEPHERD	7	Strong	Clearly dened	"	Fairly soft	6	46's-50's	
SHEPHERD	7	Fairly strong	Rough, un-uniform (kempy)	White and bright	"	4	36's	

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capacity is consequently poor, but they are suitable for thick goods of low quality. They form very largely the raw material upon which the home industries in flannels, dress goods, and tweeds is based.

The lists on pp. 52 and 53 give all the variations to be found in the British types. This should be studied along with Fig. 27, in which the staples from a representative series of these breeds are illustrated.

Continental Wools and their Uses.—Of the Continental wools the Merino is by far the most important. Produced originally in Spain, the growing of this wool gradually spread through Germany (Saxony and Silesia), France, Italy, Austria, and Russia. The quantity coming to England is now very small, the bulk being manufactured in the nearest industrial centre to that in which the wool is grown.

Spanish Merino was formerly pre-eminent, but during the middle of last century it was rivalled by the Saxony and Silesian types of wools, which in fineness are exceeded by none. French Merino wool is very fine, but is not so dense as the foregoing; while Italian Merino, though good, is slightly lower in general quality. Of the Russian type, Odessa wool, from the Crimean district, is worthy of note. All these types possess good spinning qualities, are excellent in colour, and are very suitable for milling purposes.

Other Continental wools are not very important as regards British trade. They are yielded by (1) native breeds, (2) native breeds as improved by Merino of the Spanish type, and (3) English crosses on native breeds. In Spain the Chunah breed produces long wool, evidencing Cotswold blood—this is employed in the production of low woollen goods. France produces wool of a mountain-breed type, which in some cases

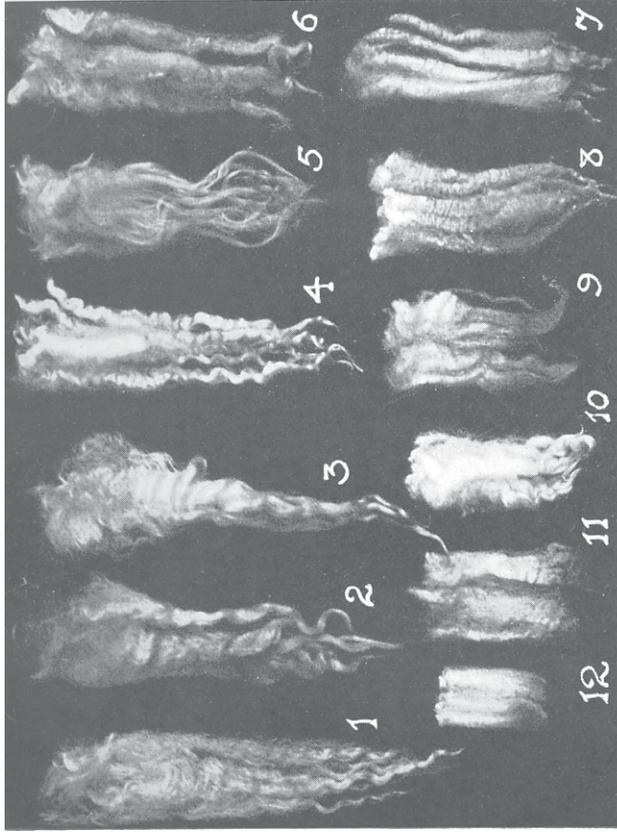


Fig. 27.—Range of British Wools

- 1 Lincoln Hog 2 Leicester Hog 3 Nottingham Hog 4 Irish Hog 5 Blackface 6 Half-bred
- 7 Staffordshire 8 North Hog 9 Lonk 10 Kent 11 Shropshire 12 Southdown

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resembles the English medium-wool breeds so far as softness is concerned. Germany produces wool from crosses of the Merino and also the long-wool sheep with the native breeds, the bulk being of the Merino cross native. In Holland and Belgium many varieties of middle and long-wool types exist. Russia produces many varieties of wool, ranging from the coarse hairy type to the typical medium wool of England, the British type having been crossed on the native breed. The wool of the Wallachian sheep is extensively grown in the Danubian principalities. It is of fine and soft character, but is much deteriorated by the presence of strong hairs. It is mostly manufactured locally, and forms the chief covering of the peasants. Crossing with the Spanish Merino has effected valuable improvements in this wool.

Iceland wool is of a low quality ; it forms a species of down at the base of a longer hair covering. It is useful for low fabrics, rugs, blankets, etc. Wools from Sweden, Norway, and Denmark are similar in character—that is, they are coarse and open and much mixed with strong hair. Crossing has been carried out with both the Merino and English long wool, more especially the former, with fair success. Large quantities of these wools are now available for manufacturing purposes ; some of it finds employment in this country and much in Germany:

Asiatic Wools and their Uses.—In Asia varieties of the flat-tailed and fat-rumped sheep abound, giving a coarse, rough, and matted wool, which is only suitable for carpets and low fabrics. Such are of considerable importance to this country. Large consignments from Bagdad, which have been grown in Palestine, Syria, and Persia, are shipped to Europe,

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while large quantities are also grown in India and China. These latter probably come to us as East Indian wools. Fine wool, but brown and grey in colour, is grown in Persia (Kerman district), some of which finds local employment in the high-class fabrics, carpets, etc., and other in the European soft-goods trade. Chief among Indian wools is the previously mentioned Cashmere.

African Wools and their Uses.—Save in the case of Cape Colony (to be dealt with later), where much useful wool is grown, Africa cannot be included among the important wool-producing countries of the world. Of the sheep, the fat-tailed varieties extensively abound. On the Red Sea borders and East Coast much coarse hair is produced. In Egypt and in Abyssinia softer and silkier wool is grown, the type being more Persian in character. From the mountain breeds of many horned sheep long and coarse wool is obtained. In the western parts of the continent, in Guinea and in Angola, a variety of breeds yield a corresponding variety of wools ; from Angola, soft and short brown hair, with fine wool underneath, is obtained, while on the Congo very fine and variegated wool and hair are grown. The Guinea breeds, as a rule, give long, strong hair, usually white, but sometimes variegated. On the West Coast towards the north, in Morocco, Algiers, Tunis, and Tripoli the wool is generally poor in character, being grown upon badly-bred sheep of the Guinea breed. Through the improvement of breeds and European influence, wool of a somewhat better type may now be expected. These wools are of little practical value to Europe, those which do come being employed for felts, low blankets, and rugs.



Fig. 28.—Pure Australian Merino Sheep



Fig. 29.—Australian x Vermont Merino Sheep

Colonial Wools and their Uses.—Australian wools.—Australia may reasonably be called the world's wool farm, although it is interesting to note that South America is now an important competitor. No other country produces wools of such length, strength, fineness, colour, and milling properties. With wools grown under such varied conditions as prevail on the Australian continent—that is, variations in soil, climate, and rainfall—it is impossible here to make more than a very general reference to differences that exist between types. Formerly Merino wool was exclusively grown; to-day, largely owing to the frozen mutton trade, there is a very considerable proportion (roughly about one-fourth) of cross-bred wool grown. Pure English-bred wools, such as lustres, Downs, Romney Marsh, etc., are also to be found.

Merino Wools.—Of the Merinoes two breed types are to be noted, namely pure Australian (Fig. 28) and Australian × American (Vermont) (Fig. 29). The introduction of the Vermont-Merino into Australia is a very interesting economic study. In certain districts of Australia in which heat and dryness are dominant—the Riverina district of New South Wales, for example—great difficulties were experienced in obtaining a profitable weight of fleece and in preserving the strength of fibre. Crossing with the Vermont was introduced to prevent deterioration in respect of these qualities. It is interesting to note that the Vermont breed was developed in the State of that name in the North American continent, and was naturally bred very heavy and dense in fleece, and extremely yolky, to withstand the rigorous winters then prevailing. Possibly some of the Vermont characteristics must also be attributed to the rich food and natural environment. When crossed on the fine Austra-

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lian Merino, the Vermont affected both the constitution of the resultant sheep and the character of the wool. (See No. 6, Fig. 30, and compare this with No. 7, which is pure Australian Merino.) In some cases disastrous results were produced through the too marked dominance of the Vermont, the wool being reduced from a Merino to a fine cross-bred type. Worse still, however, the constitution of the sheep, which might have withstood the rigours of a North American winter, naturally was unable to withstand heat and drought. Thus, in the drought of 1897-8 millions of these unacclimatised Merino crosses died off. Some Australian breeders, however, have made a marked success of this cross, through a very careful and gradual introduction of the Vermont. Thus they have been able to keep the quality of the wool within reasonable limits, to avoid too much yolk and at the same time to increase the weight of the fleece by at least one-third. The best type of Australian-Vermont wool has been in great demand, as being a very useful general purpose wool, which in many cases has almost equalled the price of the pure-bred Australian Merino, the fleeces of which weigh considerably less. It is thus natural for the wool farmer—at least, in some cases—to look favourably on the Vermont cross. At present the tendency is to breed back to the fine-wool types. This tendency is also to be noted in the United States of America. Possibly this is due to the general feeling that on the whole the price lost in quality can hardly be compensated for by the gain in extra weight.

Consequent on the natural endeavour to breed sheep specially suited to particular localities, and also to the natural effect that environment, in conjunction with breed, has on the wool, three classes of Merino wools are now in evidence. These are respec-

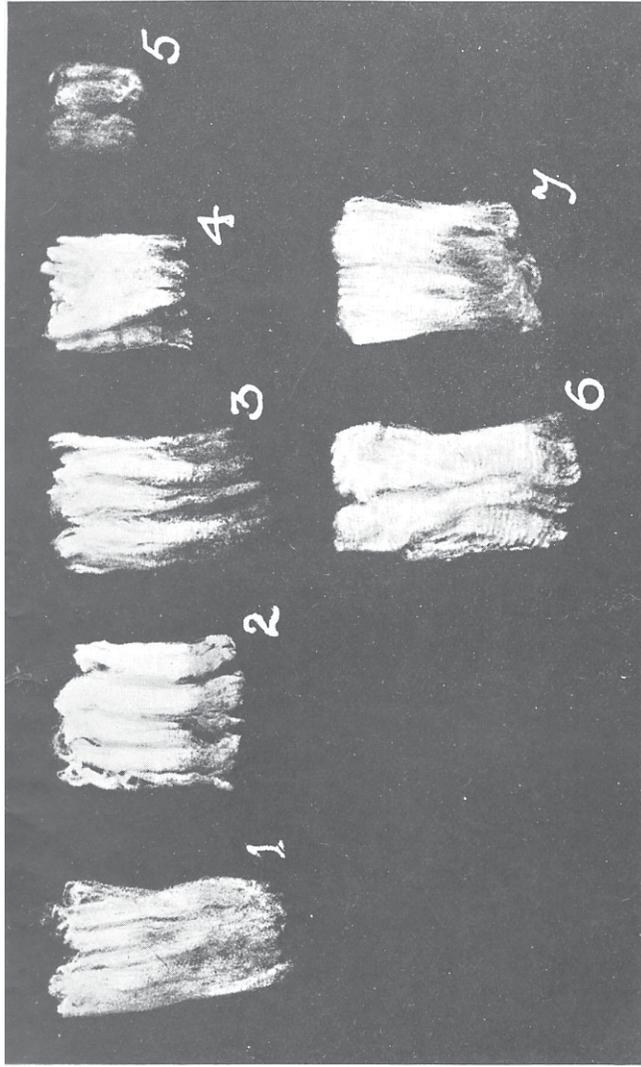


Fig. 30.—Types of Merino Wools

- 1 Australian Combing
- 2 Tasmanian Combing
- 3 Cape Combing
- 4 Monte-Video Combing
- 5 Cape Clothing
- 6 Vermont-Australian Merino
- 7 Pure Australian Merino

tively fine, medium, and strong, of which the second class is by far the largest. The following are details of these types :— (List)

The combing varieties of the first class are employed for Cashmeres, Italians, and worsted coatings, while the shorter, or "clothing," are made into the finest woollens and billiard cloths. Of the medium class the longer varieties go into worsted coatings and dress goods, and the shorter varieties into woollens, army cloths, etc. The stronger Merinoes are employed similarly to the medium class for cheaper fabrics, and are used for blending with cross-breeds and for hosieries.

Types Produced in the Various Australian States.— In New South Wales the conditions under which sheep are reared are many and various. In the hilly districts of the eastern portions they are such that fine-bred sheep yielding the highest class of wool may be carried in large numbers.

DETAILS OF TYPES OF MERINO WOOLS

Class	Quality	Length in Staples Inches	Fineness	Softness	Colour	Waviness	Impurity	Appearance of Staple
*FINE	70's-90's	2½	1-1600 in. and upwards	Very soft	Very white	26 crimps per in.	48-52 %	Clearly defined, dense, and uniform
†MEDIUM	60's-64's	3½	1-1200 in.-1-1400 in.	Soft	White	20 crimps per in.	50-54 %	Uniform, bold growth, and robust
‡STRONG	58's	4	1-1000 in. and below	Fairly soft	Fairly white	16 crimps per in.	52-56 %	Fairly uniform, open; not distinct

* See No. 7, Fig. 30.

† See No. 1, Fig. 30.

‡ See No. 6, Fig. 30.

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In the central division, which is flat and warm, medium and strong types, producing a useful wool, are most in evidence. In the western portion, which is open, hot, and dry, the medium and strong types of wool are produced, principally the latter. The wool is somewhat dry and open in staple, and proves very wasteful. Compared with the very best Australian types, New South Wales wools are not quite so good; they are somewhat dryer and liable to weakness, and, consequently, do not yield the finest counts. Again, a number of these wools are very heavy in sand, which makes it difficult to estimate the yield. The wool of New South Wales is largely classed and sold in Sydney, but much also crosses the border to Melbourne and is sold at Port Philip; while some passes to South Australia and is sold as "Adelaide" wool.

Victorian wools are best represented by the well-known Port Philip wool, in which district are to be found conditions favouring growth of fine and strong wool of an unrivalled character. No flocks have received more careful attention. The length and fineness of these wools are exceptional, and combined as they are with soundness, a perfect whiteness and an excellent milling capacity, they enable the spinner to produce the finest tops ranging up to 90's to 100's quality. The fleeces are usually in a very clean condition; they yield well, and the amount of impurity or "sinkage" can be accurately judged.

In South Australia—chiefly noted for Adelaide wool—a staple of the stronger class is produced. These wools, however, occupy a foremost position in their class. In length and soundness they are exceptional, and, further, are fairly dense and full, and of marked fineness. Such wools, however, contain much yolk and often are very sandy. While clips from most other

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States for the year 1889 were below the average, owing to the adverse climatic conditions, this clip retained all its characteristic features, and proved very attractive.

The Queensland Merinoes vary considerably, but strong and fine types are well represented. The qualities differ greatly; some wool, for instance, grown in the southern portions of the State in which there is an infusion of Tasmanian blood, is excellent and spins well; but other wools, though of good appearance, lack character and strength, possibly through lack of sufficient nourishment. The flocks reared in the more central and northern districts are of this latter type, and their wool is usually dry, open, and somewhat wasty. These wools scour readily, giving a colour which is all that can be desired. A considerable portion of this clip is taken by the woollen and hosiery trades. Of late the seasons have been good and a marked improvement in the flocks has taken place, due to careful selection for breeding purposes.

Western Australia is chiefly noted for its Swan River wool. The conditions for rearing sheep in this State are very varied, but, upon the whole, are inferior to those of other States. The strong type of Merino is most in evidence, being best suited to the typical conditions. The wool is of good length, but it is dry in handle, and contains enormous quantities of red earthy impurity. Wool-producing in this country has not yet reached its final development, for the sheep are not so well bred, nor is the wool so satisfactorily marketed as is the case elsewhere. Marked progress, however, is being made.

Tasmania produces wool second to none. The fine Merino is the sheep principally reared, yielding wool which for length, fineness, softness, density, and milling power cannot be surpassed (an example is given

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in No. 2, Fig. 30). The wool is grown under most suitable conditions, and is the object of unremitting care on the part of the producer, who, as a rule, owns only a small flock. This wool is useful for the highest class combing and clothing purposes. Its "yield" (clean wool from scouring) is excellent.

New Zealand accounts for a very small number of Merinoes, 10 per cent. only of the total flocks being of that type. A strong Merino sheep, yielding long, strong, but soft wool, is most in evidence. These wools are rich in yolk, but upon the whole they "yield" satisfactorily. They spin well, and are principally employed for worsteds.

Cross-bred wools.—Cross-bred wools owe their marked dominance largely to the development of the frozen mutton trade. Large-bodied sheep are bred for this trade, and it follows, in consequence, that the wool is of a coarser character than that yielded by the small Merino. This, of course, is entirely a matter of the profit to be made, of which an estimate is as follows :—

CROSS-BRED		
Carcass, worth, say	£1 1 0
Wool, worth, say	0 12 0
		£1 13 0
MERINO		
Carcass worth nothing	£0 0 0
Wool, worth, say	0 8 0
		£0 8 0

Another factor of importance is this: that as the land is developed, it becomes more suitable for the pasturing of cross-breds. The competition in fine wools

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due to the expansion of this trade in South America and the Cape, may also partially explain the tendency to grow cross-bred at the expense of Merino wool.

In some few cases there can be no doubt but that a stronger sheep than the Merino is suited to the more exposed climatic conditions.

In Australia about 75 per cent. Merino to 25 per cent. cross-bred wool is grown, and the tendency is for the cross-bred proportion to increase slightly. In New Zealand the tendency is for cross-breds to supplant Merinos altogether, largely because both soil and climate favour this. Twenty years ago the proportion was 25 per cent. cross-bred to 75 per cent. Merino; in ten years it had grown to 90 per cent. cross-bred and 10 per cent. Merino, and to-day the quantity of Merino is only 5 per cent. of the total growth. For Australasia and River Plate the combined proportion is about 47 per cent. cross-bred, to which amount it has dropped from 52 per cent. in 1904. This reduction, however, may be only a fluctuation due to the swerve of fashion favouring fine wools. Up to 1904 there had been a marked increase in the cross-bred percentage for about ten years.

Types of Cross-breds.—These may well be considered under two heads: (1) There is the true half-bred type, which is produced by crossing two distinct breeds of sheep, usually a long wool and a Merino breed. (2) There is a type variously known as quarter-bred and come-back (in the U.S.A. spoken of as “three-quarters blood,” etc.), produced by subsequently re-crossing the half-breds back towards the Merino. These types are well represented in the diagram on the next page:

It will thus be evident that complete ranges of

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wool qualities may be produced, varying from the half-bred towards either the long-wool sire or the short-wool dam.

Breeds Employed as Crosses.—Most English breeds have been crossed with the Merino, but a few only

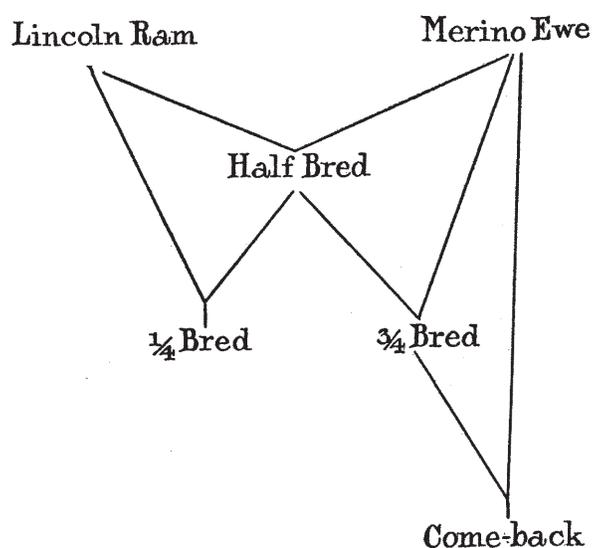


Fig. 31.

have become popular. Of these the Lincoln, Leicester, and Border-Leicester are the most popular of the long-wool class, and the Shropshire and Southdown of the short-wool class. Possibly this latter class owes its popularity to the fact that two lambing seasons may be got into one year, and that the mutton produced is of a superior quality.

It will thus be evident that there are two types of

DIFFERENCES BETWEEN TYPICAL EXAMPLES OF CROSS-BRED WOOLS

Type	Quality	Length	Strength	Colour or Lustre	Fineness	Softness
LINCOLN-MERINO	40's	9 in.	Strong	Yellowish, very lustrous	1-600th in.	Fairly soft
SHROPSHIRE-MERINO	50's	4½ in.	Fairly strong	White	1-800th in.	Fairly soft

Type	Elasticity	Waviness	Appearance	Shrinkage	Uses
LINCOLN-MERINO	Elastic	Slightly wavy in fibre	Tapering staple	30 %	Demi-lustre fabrics, and as blended with pure English for lustre fabrics
SHROPSHIRE-MERINO	Weak	10 crimps per in.	Fairly uniform in thickness	45 %	Fine serges and hosieries and a substitute for Botanics

cross-bred wools—namely, the Lustre × Merino and the Down × Merino. The list on p. 65 indicates the differences between typical examples of these two classes, while the variation in appearance of the low, medium and fine types is shown in Fig. 32.

Cross-bred Types Produced in the Various States.—In New South Wales cross-bred wool is being grown in increasing quantity, particularly in the eastern and south-eastern portions of the State. On the richer lands the Lustre-Merino cross is favoured, and on the other lands the Down-Merino cross is most popular. Upon the whole, the Lincoln cross is mostly in evidence, as the mutton produced is of equal importance to the wool grown. Leicesters and Border-Leicesters, however, are employed to a certain extent. Of the Down breeds the Shropshire is the favourite, as it produces an early maturing lamb and a useful wool. These cross-bred wools, as grown in New South Wales, are very valuable. They spin well and yield fabrics of very desirable characteristics.

Victorian cross-breeds, however, are as superior as Victorian Merinoes. In this case the Leicester and Shropshire crosses have been most successful. The wool is deep and dense in staple, has a bright and uniform fibre, with marked Merino characteristics, and is of first-class spinning capacity. A wide range of qualities is produced, from a typical cross-bred to a 58's come-back wool.

South Australia is not really of much importance as regards cross-breeds; but Shropshire-Merino crosses are receiving increasing attention and producing a useful type of wool of a sound and medium-fibred character.

In Queensland little attention up to the present has been given to cross-bred wools. Shropshire crosses

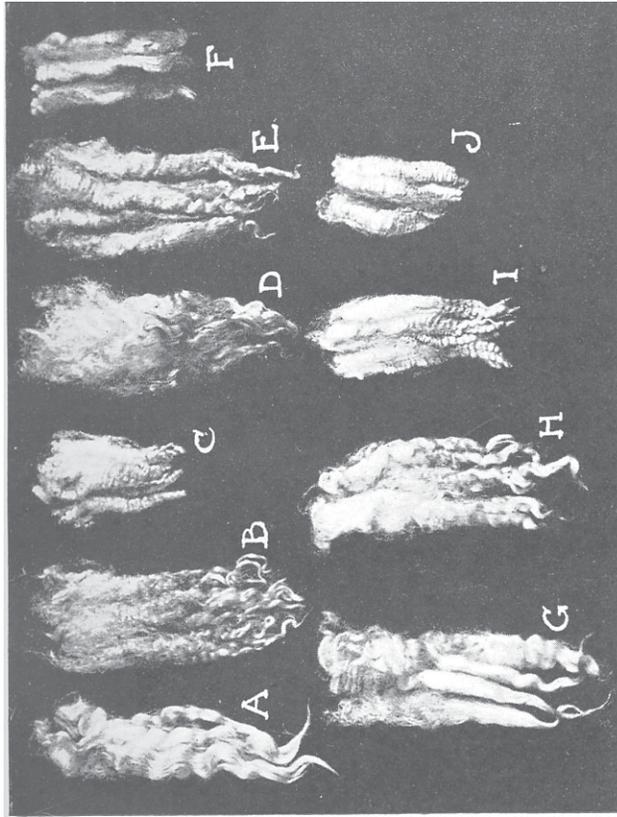


Fig. 32.—Quality Range of Cross-Bred Wools

New Zealand Cross-Breds—A, 32's ; B, 40's ; C, 56's. Australian Cross-Breds—D, 32's ; E, 40's ; F, 50's.
South American (B.A.) Cross-Breds—G, 40's ; H, 46's. ; I, 50's ; J, 56's.

have been introduced, but chiefly from the mutton point of view. For crossing with the Shropshire a robust, well-woolled Merino sheep is desirable, or the inherent weakness of the Shropshire wool, due to the chalkiness of its native soil, is transmitted to the progeny. Thus the more northerly grown Queensland Merino sheep, yielding a wool staple of only moderate strength, is not suited for crossing with the Shropshire.

In Western Australia only a few fine cross-bred sheep are grown. In Tasmania fine cross-bred wools of the true type, with a tendency towards the come-back, are produced. These wools occupy a foremost position among cross-breds, being of a strong, shafty, and uniform staple, and of good colour.

New Zealand is the greatest cross-bred colony of Australasia, the types of cross-breds here grown being unrivalled in strength, soundness, fineness, softness, lustre, and colour. An enormous range of qualities is produced, owing to the many types of sheep employed and to the various degrees of crossing. These wools are extremely yolky and, consequently, are well nourished and sound.

Colonial Pure-bred Wools.—Pure-bred English sheep are not uncommon in the Colonies. Unfortunately, the Lustre breeds to a certain extent lose their lustre and tend to become shorter; but they are improved in fineness, softness, and flexibility, and, as a result, are much sought after. They are chiefly grown in Victoria, but are invariably known as cross-bred wools.

The Romney Marsh sheep is to be found in New South Wales, Victoria, and New Zealand, its hardihood in withstanding foot-rot and fluke specially fitting it for much low-lying land rich in herbage, but possibly

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with little natural drainage. It is a useful mutton producer, and the Colonial grown wool is soft and full and of satisfactory length, strength, and fineness, ranging from 46's to 50's quality. In New Zealand not only is it crossed with Merino, but also with the Lincoln and Leicester breeds.

The Wools of Cape Colony.—Cape Colony and Natal are essentially fine wool producing countries. Sheep farming is here a very old industry, the pastoralists being among the pioneers of fine wool growing. The country, upon the whole, is not so suitable as Australasia for sheep rearing, the natural vegetation being a shrub (*karoo*) which grows more or less in dirty sand, and as a consequence the wool is dirty and yields badly. Until recently little attention has been devoted to the development of the Merino breed, and the wools produced have been very negligently prepared for the market. Double clipping is often in evidence, causing the wool to be suitable only for weft and hosiery yarns, while bad skirting and pressing, and even dishonest packing, are sometimes in evidence. Of late earnest endeavours have been made to improve the Cape flocks. The best Australian stud rams have been introduced, and the reorganisation of the flocks definitely taken in hand.

Cape wool is very fine and silky, but usually short and of "clothing" quality, yielding from 60's to 70's quality (Nos. 3 and 5, Fig. 30). The yield of pure wool is often as low as 30 per cent., but the wool scours readily and is of perfect whiteness when thoroughly cleansed. Thus Cape noil is worth $\frac{1}{2}$ d. per pound more than Australian noil, simply on this account. The fibre is lean in appearance and handle and is not generally strong, but it suits the clean-faced, slippery handling

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cloth into which it is made, this being an acknowledged trade line. The German worsted spinners use considerable quantities of the wool for lace-making purposes. In Bradford it is often blended with ordinary or average Australian, or even B.A. wools, for the purpose of bringing up the quality. As a milling material it is very unsatisfactory. Owing to the demand for fine Merino wools there is undoubtedly a future for Cape Colony and Natal if the flocks are developed on right lines.

South American Wools and their Uses.—

South American wools are chiefly produced in the Argentine Republic, Uruguay, Punta Arenas (in Chili), and the Falkland Islands. Argentine wool is known as B.A. (Buenos Ayres) or River Plate. Uruguayan is known as M.V. (Monte Videan). In each case the name is taken from the chief port at which selling and shipment take place. Punta Arenas and Falkland Island wools retain the names of the places where they are grown.

The vegetation and the climatic conditions of South America naturally vary very considerably; but in most cases they are very suitable for sheep rearing. Tremendous flocks are carried; thus in 1907-8 South America accounted for over 90 million sheep. In the past, cattle and grain, being more valuable, obtained more attention than wool; this latter commodity, therefore, has deteriorated and is weak and wasty, owing to bad growing; it has, moreover, been badly marketed. During the past few years, however, most marked improvements have been introduced. Thus in 1906, £160,000 was paid to British breeders for the best stud sheep, and wool-buyers' requirements have been much more carefully studied. Unfortunately, the

natural herbage is very burry and seedy, and, as a consequence, these wools are liable to contain a large percentage of vegetable matter.

South American Merinoes.—The Merinoes of South America were originally developed from the Spanish type with the Vermont Merino introduced later. M.V. wools are very largely of the Merino type, varying from 58's to 64's in quality (*see* No. 4, Fig. 30 for an example of 60's to 64's quality). They yield well, being short and loose in staple, are full and spongy to the handle, and most suitable for hosiery and dress fabrics of a soft character. They are also used for blending purposes with Australian wools to cheapen the resultant top. At one time there was a distinct prejudice against these wools in this country. To-day they are largely used both here and on the Continent; in the latter case they are often treated unblended on the dry-combed principle. These, in their pure state, cannot be spun on the Bradford machinery to very fine counts, and are indifferent milling wools.

South American Cross-breds.—Both the Lustre-Merino and Down-Merino crosses are in evidence. There are, naturally, wide ranges of qualities, but the wools in all cases are broader stapled, shorter, lighter and fuller in fibre than the Australian types. A range of these qualities is shown in G to J, Fig. 32. Thus a B.A. top is about half the weight of a New Zealand top of the same size, being lighter fibred, spongier, and more springy. For worsted cross-bred styles they are more economical than Australian or New Zealand cross-breds, and as they are short and springy they give more body to the fabric than the latter; but great care must be taken in the finishing processes as applied to the fabrics into which they are made.

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Punta Arenas wools have latterly markedly increased in favour. They are exceptionally light, blobby, and springy, and are in great demand for hosiery and soft dress goods. They are of the Down-Merino type, 4 to 5 inches long, yielding well, and producing a top of from 50's to 56's quality.

As Falkland Island wools are largely grown by Scotchmen they are, naturally, of the Cheviot or Cheviot-Merino type. The qualities are generally somewhat lower than the Punta wools, say 46's to 50's.

Skin and Slipe Wools.—Since the development of the frozen mutton trade, the trade in skin and slipe wools has markedly developed. The skins of slaughtered sheep may be dealt with locally; but, at least in the case of Australia, New Zealand, and South America—countries which control the bulk trade—sheepskins are dealt with from special centres, of which Mazamet, in France, is the most noted.

The methods by which the skins are “de-wooled” give their names to the wool taken off. Thus, if the wool is simply “sweated off”—the method most largely employed in Mazamet—the wool is termed “skin-wool.” If the older and, until quite recently, the more frequently employed method of de-wooling the skins by means of lime has been used, then the wool is spoken of as “slipe.” If sulphide of sodium has been employed, the wool is usually recognised as a “Colonial skin wool.”

The “sweating method” depends for its efficiency upon the development of bacterial action, probably with ammonia as a secondary product, within the skin, resulting in the destruction of the soft connecting tissue between the cuticle, or outer skin, and the corium,

or true skin, and also of the soft bulbous root of the wool fibre.

The "lime method" depends for its efficiency upon the dissolving of the cuticle and the soft gelatinous matter in the skin by the lime employed. In this case the agent acts from the wool side of the fleece invariably, and owing to its dissolving properties partially dissolves useful portions of both the wool and the skin.

The "sulphide method" depends for its efficiency upon the wonderful power possessed by the agent used in dissolving the wool fibre and the closely allied cuticle. On the other hand sodium sulphide improves the corium or skin proper, and, consequently, may be applied to the inside of the skin, acting from within outwards. It is obviously most desirable that the sulphide or other agent employed should be kept from the wool, as it very rapidly disintegrates it. As the wool may be "pulled" before the action of the sulphide has penetrated to the outside, the "wool-pit," or portion of the cuticle surrounding the fibre, will frequently be pulled away with it.

There is one other method of de-woolling skins, and that is by burning off with an electrically heated platinum wire. This is claimed to leave the skins more intact and to yield wool equal to sheared wool, save for the burnt ends. Up to the present this method has only found a very limited employment.

With reference to the quality of skin wools, this obviously depends in the first place upon the different natures of wool clipped from the live animal and taken from the dead skin. The argument is that as wool or hair grows upon a dead body or skin, there is no difference. Some hold, however, that there is a difference—that skin wool has lost some of its nature; while, on the other hand, the fact must not be lost sight of that

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the Shetland people "roo," or pull the wool from the living sheep, believing that in this form the wool is softer. It is thus evident that each parcel of skin or slipe wool must be judged on its merits. Upon the whole, "skin wools" yield better than would naturally be expected; but slipes must obviously be regarded with suspicion, as scouring difficulties will arise according to the amount of free lime present.

The Various Hairs and their Uses.—Turkey Mohair.—To-day this hair is not of the quality it once was. Formerly it was brilliant, lustrous, and of remarkable length and fineness, being grown under ideal conditions—that is, in a dry climate with rich aromatic herbage and much natural shelter afforded by large forests. The deterioration noted has, no doubt, been brought about by crossing on the common Kurd goat, for the latter only yields a long, coarse, and kempy hair, ordinarily used for tent and sackcloth. This deterioration took place principally from 1820 to 1860, the result of an unexampled demand on the part of Europe for this fibre, possibly brought about by the introduction of mechanical spinning. A cessation of the demand about the year 1880 resulted in discontinuation of this crossing to a very great extent, the breeding back to the true Angora type taking its place. Still, the modern Angora goat is not so satisfactory in fleece as the original goat, but owing to the Kurd influence it possesses a very strong constitution. Still Turkey mohair, compared with the mohair of other countries, is of the very best, being of excellent length, of superior lustre, of a clear colour, and in weight of fleece very satisfactory.

The mohair area in Turkey is from 60,000 to 80,000 square miles, in the provinces of Angora and Kasta-

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monni. This area is divided into goat districts, considerable divergence of type being noticeable in these. The following list gives an idea of the variations which may be expected. The views of the actual material in Fig. 33 should also be consulted.

	<i>Turkey Fine</i>	<i>Turkey Fair Average</i>	<i>Turkey Bey-bazar</i>	<i>Turkey Kas-tamboul*</i>
Length .	6 in. to 7 in.	6 in. to 8 in.	7½ in. to 9 in.	8 in. to 10 in.
Lustre .	Very lustrous	Fairly lustrous	Lustrous	Very lustrous
Fineness .	1-800	1-400	1-600	1-600
Handle .	Very soft	Fairly soft	Soft	Very soft
Appearance	Good colour, wavy, clearly defined	Fair colour, not clearly defined in staple	Good colour, clearly defined in staple	Good colour, wavy, clearly defined in staple
Cleanness .	Very clean	Fairly clean	Fairly clean	Clean
Uniformity	Very uniform	Uniform	Uniform	Uniform

* In addition to these there are lower qualities, such as "good yellow" and "good locks."

Great improvement could be made in the growth of Turkey mohair if the ignorance and superstition of the growers could be overcome. Breeding is still conducted on the crudest lines, while a lack of cleanliness, and the absence of sorting or classing and the prevalence of dishonest packing all militate against the development of the industry. In fact, reform is desirable from both the producer's and the user's standpoint. The proportion and quality of hair yielded by Turkey is a very strong factor in the trade, and with the increased railway facilities promised in the near future it is to be hoped that the Turkish grower will endeavour to bring himself more into line with the user's requirements, to the ultimate benefit of both.

Cape Mohair.—The difficulties experienced in establishing flocks of the Angora goat in Cape Colony were

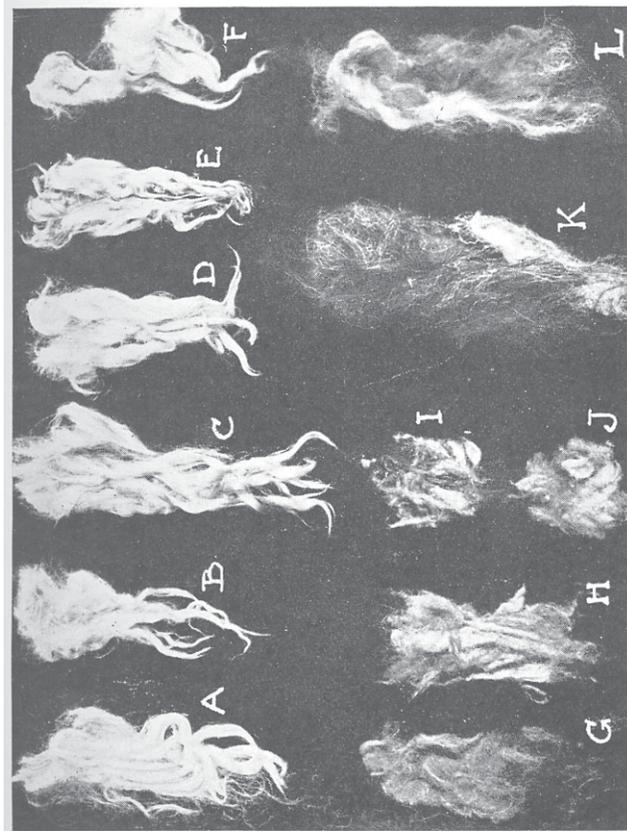


Fig. 33.—Types of Hair.

1. *Mohair*—A, Fair Average Turkey; B, Good Turkey; C, Cape Long Blue Firsts; D, Cape Somerset Firsts; E, Cape Summer Firsts (eight months' growth); F, Cape Winter (four months' growth).
 2. *Alpaca*—G, Low Arequipa Alpaca; H, Fine Arequipa Alpaca. 3. *Cashmere*—I, Seconds Cashmere; J, Firsts Cashmere. 4. *Camel's Hair*—K, China Thirds; L, China Firsts.¹

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very great, as it was necessary to cross the Angora with the common South African goat on similar lines to those described with reference to Turkish flocks; and the progeny of this cross required much attention and considerable time to bring up to the condition in which a reasonable standard of mohair was yielded. Evidences of this first crossing are even now to be seen in some types, but great improvement has been effected, and to-day large quantities of African mohair equal in many respects to Turkey mohair are produced. It is thus evident that Cape Colony provides suitable conditions for the development of the Angora goat, and it is most satisfactory to note that to-day the flocks total up to four million goats, yielding half the world's supply of mohair. If, however, the best is to be made of the possibilities of development the following matters require attention. Firstly, if possible the necessity for double clipping must be avoided. Clipping the goat twice during the year—summer and winter—necessarily implies a short staple, and although occasionally the winter growth (short) has brought a higher price than the summer growth (long), still, as a general rule, the condition obtained that the longer the staple and the more lustrous the yarn into which it is spun, the more valuable it is. If, as is sometimes stated, double clipping is necessary to prevent the shedding of the fleece, then it is obvious that this improvement cannot be looked for. The greater proportion of waste in dealing with the shorter mohair is also a factor which should be taken into account.

Secondly, the fineness of the fibre is not all that can be desired, and the proportion of kempy mohair is too great. Fineness can obviously most readily be developed by careful breeding, while the elimination of kemps may also be effected in a similar manner.

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Thirdly, uniformity in staple is too often conspicuous by its absence; the fibres are thick and long, while at the bottom of the staple there is too much short fibre.

Fourthly, bad classification is too much in evidence, there being many mixed bales in which are to be found untrimmed and dirty pieces. The baling itself also leaves much to be desired.

In the list on page 77 a fairly complete range of Cape mohairs are included, from which it will be noted that Cape kid and Cape firsts are valuable products, the former being remarkable for fineness and the latter for length. Unfortunately, the amount of these is small.

U.S.A. Mohair.—On the North American continent the Angora goat is chiefly cultivated in California. It is highly valued as a scrub clearer. Most of the yield is at once consumed by the home manufacturer. These flocks have been built up partly by means of a cross with the native Kurd goat, but many more pure Turkey Angoras were imported than was the case in Cape Colony. The quantity grown is comparatively small, say $1\frac{1}{2}$ million pounds per annum from about 800,000 goats.

Australian Mohair.—This industry is in its infancy, there being probably only some 30,000 goats in New South Wales and a similar number in Queensland. It seems probable that these numbers will be improved upon, but the development is likely to be slow, as Australia is essentially a wool country, and the Angora goat is only likely to be useful where scrub requires keeping down. The staple is said to be equal to average Turkey mohair, and is favourably reported upon by users.

Special Qualities and Uses of Mohair.—The fibre is harder, stiffer, and yet more elastic than wool, a special feature being that it is impossible to tie a knot on the

RANGE OF CAPE MOHAIRS

Type	Length	Lustre	Fineness	Handle	Appearance	Cleaness	Uniformity
CAPE KID	5 to 7 in.	Very lustrous	1-800 in.	Very soft	Yellowish colour, clearly defined staple	Clean	Very uniform
CAPE FIRSTS	6 to 8 in.	Very lustrous	1-600 in.	Soft	Fair colour, clearly defined staple	Fairly clean	Fairly uniform
CAPE WINTER	5 in.	Fairly lustrous	1-600 in.	Fairly soft	Fair colour, fairly defined staple	Fairly clean	Fairly uniform
CAPE SECONDS	5 in.	Fairly lustrous	1-600 in.	Fairly soft	Bluish colour, kempy, fairly defined staple	Dirty	Not uniform
CAPE MIXED	4 to 5 in.	Poor in lustre	Irregular—coarse	Harsh	Varied: disorganised in staple; strong and "wiry"	Dirty	Not uniform

staple. The physical qualities of the fibre render it the most suitable for permanence of embossing in upholsteries, and for strength of pile as developed in pile fabrics. It is most lustrous, in this respect rivalling silk, and, better still, permanently retains this quality. Except in the case of kempy fleeces the fibre is never weak, and thus valuable fabrics, as regards strength, may be made from it. Its absorption of moisture is less than that of wool, but it is indifferent to felting, and therefore must be used for such fabrics as require little milling. Its draping properties are excellent, as instanced in the many beautiful lustre goods produced in the Bradford district. One special use of mohair is for braids, for which there is a large trade.

Alpaca and its Uses.—The ordinary Alpaca clip yields a length of, say, 9 inches, but much is allowed to grow for two or even three years, when it reaches 30 inches in length. This, however, is liable to cause weakness in the fibre staples, resulting in wastiness in the manufacture. Various qualities are available, three divisions, as a rule, being made, namely “low,” “medium,” and “fine.” Alpaca is known as Arequipa Fleece, Arequipa being the Peruvian port from which it is shipped. It is specially used for dress goods, linings, and facings for overcoats.

Camel-hair and its Uses.—True camel’s hair is a fine, downy material, about 5 inches long, of a yellowish or brownish shade. Long, strong fibres are invariably found with this, which come from the under-parts of the camel; these must be combed out. There are many types of camel-hair—Chinese, Persian, Russian, etc., but all are classed as firsts, seconds, or thirds, the firsts being freer from coarse fibres and more uniform, and so on. True camel-hair is not strong, as it seems to lack

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nature. It thus needs careful treatment or waste will be excessive.

The fine fibre is employed for dress fabrics and linings; while the coarse, which is exceptionally strong, is used for beltings and stout fabrics.

Cashmere and its Uses.—As the Cashmere goat is not bred in great numbers, and as each goat yields only a small weight of true cashmere, the total weight of cashmere available is very small. The best cashmere is recovered as noil in the combing operation: The length is from 2 to 3 inches, and the qualities are classed as "first" and "seconds," brown or white. As the fibre is very light and fluffy, it needs much care, and must be suitably controlled in the spinning. It is used for shawls, dress fabrics, and hosiery of soft handle and light weight characteristics:

On p. 80 is a comparative list of the various hairs, which should be studied in conjunction with Fig. 33:

Re-manufactured Materials.—These materials are of remarkable importance to the woollen trade. A hundred years ago fibre once spun into yarn and woven into cloth could not be used again even for the production of inferior materials. To-day there is a huge industry largely located in the Dewsbury, Batley, and Ossett districts of Yorkshire, based entirely upon the production of fabrics from materials which have already played a part as fabrics. Thus, these materials find employment as wefts in cotton warp goods, as backing material in the worsted trade, and as material to mix with wool, cotton, etc., in the woollen trade. It is true that these materials have neither the character nor durability of the true wool fibre. Nevertheless, they are re-manufactured into fabrics, which,

COMPARISON OF HAIRS

Type	Length	Strength	Lustre	Colour	Fineness
MOHAIR	9 in.	Very strong	Very very lustrous	White	1-700 in.
ALPACA	12 in.	Fairly strong	Very lustrous	Vari-coloured	1-800 in.
CAMEL'S HAIR	5 in.	Fairly strong	Lustrous	Brown and yellowish grey	1-800 in.
CASHMERE	3 in.	Fairly strong	Lustrous	Brown and white	1-1200 in.

Type	Handle	Form of Staple	Uniformity : (1) in thickness, (2) in length	Uses
MOHAIR	Fairly soft	Straight-fibred ; wavy in staple	Uniform	Dress fabrics, linings, and upholsteries
ALPACA	Soft	Straight-fibred ; staple disorgan- ised	Uniform	Dress fabrics and lin- ings
CAMEL'S HAIR	Soft	Fairly curly, staple disorganised ; thick hair present	Fairly uniform	Dress fabrics
CASHMERE	Very soft	Fairly curly, staple disorganised ; thick fibre present	Fairly uniform	Shawls and hosieries

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considering the price at which they are placed on the market, are truly wonderful.

The principal re-manufactured materials are noil, mungo, shoddy, extract, and flocks.

Noil.—Noil is the short material removed from the wool during the operation of combing. There are several classes which take their origin in the wools from which they are combed. These classes, briefly, are: English (Lustre), Cross-bred, Botany, and Hair Noils. The length of noil varies from about 2 inches in the case of hair noils to under $\frac{1}{2}$ inch in the case of short botany noils. Owing to their shortness, noils are only suitable for use in the production of woollen yarns and for felting purposes. As will naturally be expected, vegetable impurity is often present; this is removed prior to carding by carbonisation on the chemical principle.

Botany noil is the most valuable, and is placed on the market in various qualities, such as 60's, 64's, and 70's. It is fine in fibre and generally whitish in colour, varying in length from $\frac{3}{4}$ to $\frac{1}{4}$ inch. This noil is of excellent milling property, but, as a rule, is very burry. Cape noil of this class is the most valuable because of its superior colour. This noil is employed in woollens, shawls, blankets, and hats. There is a considerable trade done at Bradford in the purchase of noils from the combers, forwarding them to commission carbonising and carding firms, and afterwards selling them into the Leeds, Batley, and Dewsbury districts, also to the Cheshire hat manufacturers, and to Continental woollen spinners.

Cross-bred and English noils are of lower quality than Botany noils, the fibre being longer, smoother, and stiffer, and of less satisfactory spinning capacity: As a rule, the lustre is good, but the colour is of a