STUDIES ON THE SCOTTISH

MOUNTAIN BLACKFACED SHEEP,

WITH SPECIAL REFERENCE TO THE INHERITANCE

of

CERTAIN BREED CHARACTERISTICS.

THESIS PRESENTED FOR THE DEGREE OF Ph.D.,

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TABLE OF CONTENTS.

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I N T R O D U C T I O N.

This thesis may conveniently be considered in two sections. First a survey is given of the history and distribution of the Scottish Mountain Blackface breed of sheep and the salient features of breeds related to it are considered. Its economic importance as a pure breed and as a foundation breed for further crossing are discussed. Secondly observations made during the past ten years on the writer's small flock of Blackface sheep will be discussed in detail. In this flock, kept on the north-west side of Loch Tay, every lamb was numbered soon after birth, details of its marking and fleece character were noted and its breeding capabilities recorded.

With the exception of papers by BARKER (1922), CREW and BLYTH (1923), BLYTH (1923) and DARLING (1932), - all of which deal with selected fleeces - there has not been a great deal of experimental work or detailed observation carried out upon the Blackfaced breed during recent years. So far as the writer is aware no records have been hitherto published which deal with the breeding/

breeding records of a flock kept under natural conditions and managed in accordance with existing hill practices.

It should be noted here that the breeding and management of a typical Blackface flock differ very considerably from those of other flocks of sheep. To a greater degree than almost any other domesticated animal in Britain Blackface sheep live under conditions which approximate to the wild, in that they graze upon hill pasturages in which the natural herbage grows uninfluenced by sowing, cultivation, manuring or other methods of agriculture. In fact, with the exception of cutting open sheep drains through exceptionally wet land, heather-burning and occasionally bracken-cutting, the typical hill pastures receive no treatment whatever. The importance of this is that Blackface sheep reflect the influences of natural environment and breeding more accurately than do other breeds kept under conditions where the practices of scientific agriculture play a very large part in moulding and altering the environment, as for instance with typical low ground flocks of other breeds or even with draft Blackface ewes removed to low ground.

HISTORY/

HISTORY OF THE BLACKFACED BREED.

The history of the breed is shrouded in obscurity and the lack of recorded facts is more than counterbalanced by the number of theories, plausible and otherwise, which have been propounded on its origin.

ORIGIN:

PEASE (1930) believes that, in common with the other breeds of a similar type, such as the Old Norfolk, Old Sussex, Old Berkshire, Old Hampshire, and the Old Shropshire, and their modern derivatives, the Blackface has descended from the so-called Danish Heath sheep - the European blackfaced, blacklegged, horned sheep. This in turn, he attempts to show, has descended from the domesticated Barwal of central Asia, which can be traced through the various forms of Ovis vignei to the Bharal. He attaches importance to the Roman noses possessed by each of these breeds and to their general behaviour in the hills; more definite facts are however necessary before this ancestry can be entirely accepted. It must be admitted that theory does suggest that the Blackface was introduced into Britain before the Norman Conquest. EWART (1914) traces the Merino and Blackface to Ovis ammon.

A second theory of the origin of this breed, propounded/

propounded by ARCHIBALD (1884), and WRIGHTSON (1919), inter alios, is that the Blackface has resulted from a cross between the native British sheep and animals from the wrecked galleons of the Spanish Armada. While the number of other British breeds for which this claim has been made suggests that it cannot be justified, it may be significant that the native sheep with which the Spanish sheep were crossed, were according to some writers, dunfaced (see later). To this day, in spite of culling, in all flocks of Blackfaced sheep, some with a brown tinge on the face can be found. This tinge is much disliked by breeders as it is believed to denote traces of an original, less thrifty breed. Moreover, sheep with a fleece somewhat resembling that of the Blackface are found on the north west Pyrenees. One would suggest that in the absence of more definite records it is more reasonable to assume a common ancestry for the Pyreneean sheep stocks and the Scottish Blackface from the Old European Blacklegged Heath Breed, than that the Armada - as recently as 1588 - played a part in the foundation of the breed, especially as many authors (see later) show that the breed must have been indigenous in Britain long before this date. Moreover it seems highly improbable that the limited number of sheep which could have been landed from the Armada/

Armada, could have impressed their type so rapidly and so widely.

DISTRIBUTION.

It is suggested by numerous authorities, among whom are LOW (1842), MACDONALD (1884), WATSON (1932), inter alios, that the Blackface sheep entered Scotland from the Pennine chain where they had previously become firmly established. On the other hand Hector Boethius, writing about 1460, quoted by MACDONALD (1884) and MACDONALD (J), states that Blackfaces were the only sheep in the vale of the Esk, and infers they had been established on the Borders from time immemorial. If the statement is correct, that, in the middle of the fifteenth century, Blackfaces were the only sheep in the vale of the Esk, it refutes the belief that they were first imported by James IV, who established a flock in Ettrick about 1503, which is noted by YOUATT (1837), LOW (1842), ARCHIBALD (1884), MACDONALD (1884), MITCHELL (1922). Certainly Ettrick seems to be the focus from which they later spread. In Tweeddale and Lammermuir, by the end of the eighteenth century, they had been established so long that their origin had been forgotten, but it was only in the middle of that century, according to the evidence of LOW (1842), ARCHIBALD (1884), and WATSON (1932), that/

that they reached Argyllshire from Ayrshire, and about the same date they passed into Dumbartonshire and Perthshire, according to the same authors and to MACMILLAN (1915), WRIGHTSON (1919) and MITCHELL (1922).

MacKENZIE (1810) describes how about 1775, they were introduced into north Ross-shire by Sir John Lockhart Ross of Balnagowan, who bought them at West Linton. They were accompanied by Lothian shepherds, but owing to stealing, more stock had to be imported. In a few years, however, they became established and spread westwards.

Blackfaced sheep appear to have been called by a variety of names - many of them only local - before they became known by their modern designation. Thus they were known as 'Lintons' according to MACKENZIE (1810), ARCHIBALD (1884), MACMILLAN (1915), MITCHELL (1922) and other writers, since the Lothians with West Linton as the chief market, were the stronghold of the breed: LYDEKKER (1912) states it was called 'Colly', while YOUATT (1837), the MINISTRY of AGRICULTURE (1920), and WATSON (1932), note that it was called the 'Short' breed, while ARCHIBALD and MITCHELL, refer to it as the 'Forest' breed. 'Tweeddale' and 'Lammermuir' were other names. LOW (1842) designates it the 'Black-faced Heath' breed; and CULLEY (1807) knew it as the 'Heath Breed', although

both/

both names included the related breeds of Northern England. MITCHELL (1922) suggests that there may have been a Blackfaced breed in Perthshire and Fifeshire called the 'Lomond Hill sheep', which became incorporated with the sheep from further south, when these spread northwards.

WOOL CHARACTERS.

FLEECE WEIGHTS.

The history of the breed during the last 150 years is of some importance because of its bearing on present problems relating to wool. In 1788, it was suggested by MARSHALL (1788) that the Moreland sheep of Yorkshire may have been of Scottish extraction although they had not altered for years. They were clearly of the Blackfaced type; it is stated that "the covering of their buttocks is mere hair, resembling the shag of the goat rather than wool". This was regarded as a mark of hardiness and accordingly a coarse-woolled, shaggy tup was preferred. Judging from their dead weights, they must have been considerably smaller than the modern Blackface. Even allowing for this, it is evident that the length of the staple was not only short (in the Lammermuir sheep it was stated by ARCHIBALD (1884) quoting Nasmyth, to be only four or five inches in length), but very open since the fleece weights at the end of the eighteenth century are extremely light. In 1788, for example, the fleece weight of/

of a store Moreland ewe in Yorkshire was stated by MARSHALL (1788) to be 1½ lbs. and that of vale-fattened wether 2½ lbs. Eight years later, slightly higher weights are recorded, but as these were 'smeared' weights, the 2 lbs. and 4 lbs. mentioned for ewes and wethers respectively, may not represent any real advance. In 1799 according to Nasmyth quoted by ARCHIBALD (1884) and WATSON (1932), the fleece weights in Clydesdale, were 4 lbs. for wethers, 3 lbs. for hoggs, and 2.7 lbs. for ewes. Six years later in Argyll, at a time when presumably that county was in its optimum condition for sheep production, the average weight was given as 2.8 lbs. but CULLEY (1807) states the 'Heath' breed fleeces weighed 3 lbs. to 4 lbs. each. Some forty years later body weight had increased and fleece weight had reached about 3 lbs. according to YOUATT (1837), both were thus considerably lighter than those of the present day. This increase continued and by 1884 the average weights were stated by MACDONALD (1884) to be 2½ lbs. to 4 lbs. for ewes, 3 lbs. to 4 lbs. for hoggs and 3½ lbs. to 5 lbs. for wethers; and by ARCHIBALD (1884) to be even a pound heavier than these weights. Selection for heavier fleeces had however by this time commenced since MACDONALD (1884) states that in the better flocks weights were heavier; and the staple length had increased up to 9-10 inches with a maximum of/

of 15 inches, according to ARCHIBALD (1884). LYDEKKER writing in 1912 gives the average fleece weights as $3\frac{1}{2}$ to $4\frac{1}{2}$ lbs. which weights were confirmed by MALDEN and also THE MINISTRY of AGRICULTURE & FISHERIES (1920). WATSON & MORE (1924) state that 4 lbs. is an average clip, while 5 lbs may be obtained under hill conditions, MACDONALD (J) confirms this. But MACMILLAN (1915) giving a wider and probably more accurate estimate, stated that the average for the coarser woolled districts was 4-$5\frac{1}{2}$ lbs. and 3-4 lbs. from Argyllshire, Inverness-shire and Ross-shire for ewe fleeces; with one pound heavier for hogg fleece and up to 6 lbs. for 3-year wether fleeces.

CAMERON gives the average from ewes at $4\frac{1}{2}$ to $4\frac{3}{4}$ lbs. and $5\frac{3}{4}$ to $6\frac{1}{2}$ lbs. from wethers and hoggs; and MITCHELL (1922) gives 4-5 lbs. which may be considerably exceeded under suitable conditions, and up to 7 lbs. respectively, the latter is also the weight given by MALDEN and the MINISTRY of AGRICULTURE and FISHERIES (1920) as an average wether fleece weight.

From these figures it is clear that the greatest advance in breeding heavier weights of wool has occurred during the last 80 years. In all probability the breed is still capable of immense increases in the amount of wool yielded since it is not very unusual/

unusual to obtain a fleece weighing 9 lbs. from certain individuals in a flock under hill conditions, while rams in particular may considerably exceed this figure. At the same time it must be emphasised that the easiest method of increasing fleece weights in Blackfaces is to select for a longer staple. The conditions under which ewes are kept on the hill and wether lambs are folded on turnips for fattening on the low ground, are such that too long a fleece of this nature may be a serious handicap. Excessive wool length on hill ewes results in an undue amount of 'snow-balling' in winter, and by becoming entangled in long heather in spring and summer results in a considerable loss through the wool being torn off. Similarly too great a length of wool in wether lambs folded on arable crops causes 'mud-balling' in wet weather.

FLEECE COLOUR.

In 1796, according to ARCHIBALD (1884) the number of self black lambs was stated to be one in every thirty-six and others had black spots on the body, this is confirmed by CAMERON, who states that at the end of the 18th century not only did black lambs constitute three to five per cent of the lambs born, but that grey fleeces and black spots in the fleece were very common. At the present time the percentage of self black lambs is probably well under one per cent/

cent, with a tendency to be highest where choice of selection is most limited. This is particularly noticeable in districts where through disease, low fertility or other causes there is difficulty in keeping up the ewe stock. Where general mortality is high and rearability is low the whole of th ewe lambs - coloured or otherwise - have often to be kept on to become breeding ewes.

The same considerations apply to black-spotting. Black-spotting varies considerably in commercial importance according to the situation of the spot or spots, those spots which are situated on the edges of a shorn fleece being more easily cut out than spots in the centre. Black spotting is commonest on the tail - at both the tail tip and tail head - the former is of no commercial importance and the latter is easily cut out. A spot at the back of the neck or even a collar is common. The scrotum is frequently covered with black wool, and there is often an extension of pigmentation from the hair-bearing skin of the legs upwards into the wool-bearing skin of the forearms and thighs. This is often only seen when the sheep is turned up and the wool specially parted. Body spots are less frequent, but still quite common. Black is much the most common colour of the spots, but a brown-red is sometimes found. The correlation between face colour/

colour and black spotting is dealt with fully later.

GENERAL OBSERVATIONS.

At the beginning of last century, when the breed was spreading through the Highlands, there were complaints that the Blackface was debasing the indigenous breed - a soft woolled, white or dun-faced sheep - with which crossing must have taken place. All writers agree, that only 60 or 70 years ago, Blackface sheep were very different from modern animals. Shortly before this time, LOW (1842) stated that they resembled Persian sheep. Their fleeces were coarse and open, comparatively short stapled, while the face was 'muffy', a characteristic which is now regarded as denoting softness in constitution and fleece and a greater capacity to fatten. It is also believed to be correlated with a good covering on the abdomen and milk-producing capacity above the average. It is also of interest to note that some writers CULLEY (1807), YOUATT (1837), refer to the displaced breed as dunfaced, others, ARCHIBALD (1884), WRIGHTSON (1919), state that it was white faced while MACMILLAN (1915) describes it as either dun or white faced. A few writers, including WATSON (1932) have suggested that there were two native breeds or even more. Little seems to be known of the areas these native sheep covered although it is possible that their blood is at least partly responsible for/

for the different types of Blackface fleeces which are found in Scotland. DANIEL, in 1813, illustrating a tour along the West Coast of England, Wales and Scotland includes in his pictures polled white-faced sheep from the Solway to the Outer Hebrides, with the exception of one picture of Harris, which shows some sheep coloured in both face and body in addition to white sheep. The Blackface seems to have spread rapidly north of the Forth once it was introduced. Since MARSHALL (1788) states that to produce twins from the Blackfaced type of Yorkshire sheep 'flushing' was necessary, it is probable that with all the native unimproved breeds the production of a single lamb was the normal and that twins were rare unless the ewes received flushing treatment. Probably it was difficult to secure the necessary conditions for this in those sheep pastures north of the Forth which were best suited to the breed. It seems reasonable therefore, to suppose that the breed could not have increased so rapidly as it did in Perthshire and the Highlands unless there was already in existence a native breed of hill sheep of somewhat similar general type with which it was bred. At the same time it should be remembered that the conditions were such as to encourage the retention of all female lambs for breeding and of wether lambs/

lambs until they were 3-5 years old before disposal. This would result in a much greater total head of sheep stock in a given number of years than could ever be the case under modern conditions. Moreover, it was the custom of the Northern farmers to visit the south of Scotland and purchase large numbers of wether lambs for grazing on the northern hills, and undoubtedly these added materially to the sheep population of the whole of the Highlands. Breeding with the native sheep stock would most probably have happened in the milder districts where the sheep population was more dense than in the bleaker districts where cattle were the more important livestock. This is confirmed by the description given by CULLEY (1807) of the Dun-faced breed which were described as too delicate for the mountains. It seems probable that hardiness was the chief factor in causing the Blackface to become so firmly established. This was in spite of the prejudice against their wool.

DISTRIBUTION OF THE BLACKFACE AND SIMILAR BREEDS.

The Scottish Blackface is the largest breed, numerically, in the British Isles. In 1915, it totalled 4 millions, (i.e., more than half the total sheep in Scotland, according to MACMILLAN (1915)): while at present WATSON (1932) stated they are seven times more numerous than the Cheviots, the other chief mountain breed in Scotland. During the War, when wool was controlled (1916-18), 12 million pounds of Blackface wool were produced annually in Scotland, compared to 10 million pounds of all other kinds of wool.

FIGS. 1 and 2 are photographs of a typical ram and ewe.

In Scotland, on the Mainland, Blackfaces are found as far north as latitude 57°50' (i.e. Loch Broom to Bonar Bridge). When first introduced into Scotland, they extended as far north as Caithness but now, except for an occasional isolated flock, they do not extend north of this latitude.

It is the principal mountain breed in the Counties of Inverness, Argylle, Perth, Angus and Dumbarton. It is also found in Ross-shire and the Western Islands. South of the river Forth, it is firmly established/

established throughout the southern Uplands. Most of the finest specimens are bred in Lanarkshire and in certain parts of the contiguous counties which lie east, south and west. The upper parts of the Tweed basin, the Lammermuirs, Dumfriesshire and parts of Ayrshire each produce a well-built, hardy type. Many flocks are found in Kirkcudbrightshire and Wigtownshire.

In northern England, it has a separate flock book and it is firmly established in north, west and south-west Ireland. It has been exported to South America, Canada, Italy, Japan and elsewhere, but not in such numbers as might be expected. Although first introduced into the United States in 1861 (LYDEKKER, 1912) it has never become popular there.

OTHER BREEDS.

At the present day, there exist in northern England several breeds very similar to the Scottish Blackface, chief among which are the following:-

THE SWALEDALE which is darker in its face and leg colouring at birth, the black hairs becoming more or less thickly interspersed with white round the muzzle, and sometimes above the feet. The wool is also finer and shorter. It is centred on the hills surrounding the upper part of the river Swale and extends westwards along the Pennines into Westmoreland;

THE/

THE ROUGH FELL which has typically a black face with grey muzzle. Its face colour is more often tinged with brown (according to WALLACE (1923)) than other blackfaced breeds and the wool is coarser. The breed is kept on the moors and hills in the northwest of Yorkshire and surrounding districts;

THE LONK which is the largest of the black faced group, less hardy and with a closer, finer heavier fleece. It is found chiefly in East Lancashire, Southwest Yorkshire and adjacent parts of Derbyshire;

and THE DERBYSHIRE GRITSTONE which is mainly found in the Peak district and is believed by WALLACE to belong to this group. It resembles the Blackface chiefly in possessing a black and white patterned face, and in being a mountain breed; it is however hornless and its body conformation is quite different, while the wool is the shortest closest and finest variety of black faced mountain wools.

DISTRIBUTION/

DISTRIBUTION OF WOOL TYPES.

The ideal conformation of the Blackface does not require description but it should be emphasised that it is essentially a mutton breed, which has to live, at least in its younger days, on comparatively high, bleak hills. Accordingly, its wool, although of great importance for the protection of the sheep, is of secondary importance to the breeder.

The fleece consists of wool, long hair fibres and kemp. The wool is fine and not of great length. The long hair fibres are much coarser and longer than the wool, varying in growth from a few inches to over a foot yearly. The kemp is even coarser, more brittle and of irregular length: its distribution on the body is uneven. In a number of animals it may be absent, while in others there may be very little. Alternately some sheep possess enormous quantities distributed all over the body. DARLING (1932) shows that kemp grows during summer and early autumn and is shed in late autumn.

The birth-coat fibres consist of three main groups: wool; heterotype "A", which has a whip-lash-shaped tip and develops into hair; and heterotype "B" which has a sickle-shaped tip and falls out after some weeks to be followed by kemp (LOCHNER 1931 unpub.) There is a popular belief, especially among breeders of Welsh Mountain/

Mountain sheep, that the presence of kemp is a sign of hardiness and that the birth-coat fibres which precede kemp are of great importance to the newly-born lamb. There is, however, no scientific foundation for this belief.

Little has been published on the geographical distribution of the various classes of Blackface wool, and it is difficult to state definitely the districts in which the various classes of wool are grown, because of variations not only in flocks but in individual sheep. The characters of the hairy fibres determine the grades into which the wool is classed for manufacturing purposes.

The shortest, finest Blackface wool is used for tweeds - especially "Harris" tweeds - for an inferior type of hosiery and for making coarse blankets. Wools suitable for this trade come from the Outer Hebrides, parts of Skye and the west coast of Ross-shire. It is of interest to note that the finest Cheviot wools come from west Ross-shire and northwards. Some ewe-fleeces from all districts of Scotland and northern England also fall into this class, while the wool from Swaledale sheep which is rather finer, is used blended for the same purposes.

Another type of wool is produced by some Blackface /

Blackface sheep - chiefly yearlings - of the Galloway district of south-west Scotland. This wool is fairly short, has a very silky bottom and no "starey" top, i.e. the hairy fibres are not too long (See FIG 3.). It is used for yarns which are of rather a better class than the carpet yarns for export to the continent. These may be obtained from all the Blackface districts in Scotland, especially those not producing "tweed" or "mattress" yarns.

The carpet yarns are the finer intermediate types, and as, at present, they are the least valuable, they are classed by brokers, whenever possible, as "wool for other purposes".

The mattress wool trade originated about 20 years ago when this type of wool was exported for use by the Italian army. It has now almost entirely displaced the formerly used Spanish wool in mattresses throughout the whole of Italy and the adjacent lands.

Mattress wool is the coarsest of all the Blackface wools and is mainly obtained from Lanarkshire and the western districts of Peebleshire. (See FIG. 4.). Slightly finer, but still classed as mattress wool, are the fleeces from Stirlingshire, and the southern highland districts of Perthshire, with a northern limit about Glen Lyon; the wools from Loch Rannoch to the north/

north, especially around the Great Glen tend to be of a finer quality. This belt of medium-coarse wools extends eastwards to some farms of Forfarshire and westwards to Argyllshire: but as the coast is approached, the fleeces tend to become finer. The wools of North Northumberland are also of this type, but they become finer further south.

In Ireland, the finest "Blackface" wools are found in the west of Connemara. But as this district has contained much Cheviot blood it is probable that few of the sheep are pure Blackfaces. A slightly coarser wool is produced in north-west Ireland. But the type of farming probably influences this - the holdings are generally small and little has been spent on the rams, with the result that the ewes are kempy. Moreover the ewes are kept until they are very old. The wool from the rest of Ulster is of an intermediate type. Somewhat inferior to the shorter Blackface wool of Scotland, but of fine quality is the Kerry grown wool of south-west Ireland.

VARIATIONS IN WOOL TYPES.

It is by no means clear why this distribution of Blackface wool types should occur, and apart from the genetical aspect which is discussed later, it is probable that a combination of climatic influences affect not only the sheep directly, but their pasturage as/

as well. Some of these factors may combine to produce a given wool type, in other cases they may tend to cancel each other.

CLIMATE AND NUTRITION.

Among the most important of the climatic influences which have been considered are rainfall, temperature and sunshine. A study of the Meteorological Office Book of Normal shows that none of these can be considered to account for this distribution. The most suggestive relationship appears to be between the monthly averages of the night isotherms for the later months of the year. It is a well known fact that the climate of the west is more humid and mild than that of the East, and this may have considerable effects on the herbage. According to MACDONALD (1884) a "humid atmosphere has the effect of lengthening the covering of sheep as well as of other animals". WALLACE (1912) however, states that "when Blackface sheep of Lanarkshire type, bred in Dumfrieshire are taken to Renfrewshire, a rainier district, their progeny soon acquire on their backs the thick, close-set "foggy" wool which protects the skin from rain water. In Perthshire these sheep develop finer and shorter wool all over the body, ... In Inverness-shire the coats of similar sheep do not grow so heavy or so strong and coarse in fibre"./

fibre" and "when sheep are migrated to the wetter west they assume longer and more open fleeces", and conversely "Along the dry East coast ..... sheep are closer in their coats" ... WALLACE on the same occasion suggests that the heavy clay soils and bogs superimposed on the coal measures are responsible for the long, heavy coat of coarse fibres which is typical of the Lanarkshire Blackface; and that on Limestone, the quality of the wool improves, but the quantity diminishes. MACDONALD (1884) states that the depth and quality of soil influences the character of the fleece. These statements, however, must be accepted as tentative only, since no details of experimental proof are advanced by the authors. Theories which (as in this case) depend solely upon the results of observation are valuable only as an indication of methods by which definite proof can be obtained. Up to date it has not been possible to confirm these observations, but in the absence of any results which confute them, they may perhaps be accepted without prejudice. Obviously, even if they are accepted, there is still much to be explained before an accurate idea of the causes underlying differences in fleece can be obtained.

Other factors which can influence the fleece through the pasturage are minerals. ORR (1929) shows that the mineral content of the West Highland pastures are/

are comparatively deficient in calcium, phosphorus, potassium and chlorine, and that these deficiencies are even more pronounced in the Island of Lewis, where nitrogen is also very deficient. ORR notes that the different varieties of grasses and legumes vary in their mineral contents and that those grasses which are eaten most readily by free grazing animals have the highest mineral content. He further states that excessive rainfall increases the phosphorus and potassium and decreases the calcium in plants, and may thus affect grazing values. By feeding minerals in cubes, also containing protein rich substances and cod liver oil, fleece weights were increased by 0.1 to 0.5 of a pound; or from 2.4% to nearly 12%. ORR also notes that certain unhealthy areas are very deficient in minerals: and WALLACE (1884) associates a disease, characterised by anaemia, "Vanquish", with land overlying granite rock.

In more recent work ORR and FRASER (1932) found that in the preliminary investigations into the feeding of hill sheep, fed ewes clipped more wool than the unfed controls. At Garrochan, the sheep fed with carbohydrates and minerals clipped heaviest, slightly less heavy were the fleeces from the ewes which received carbohydrates only, and those which received minerals only; the controls gave very markedly lighter fleeces. The/

The yeld ewes carried heavier fleeces than the milk ewes, as was to be expected.

An interesting example of the possible influence of feeding was observed in Dumbartonshire. A small farm carried a stock of home-bred and bought-in ewes, the latter having been purchased as lambs from a Lanarkshire stock with very coarse fleeces. One part of the hill was mainly heather. The other part was grass with scrub. There were no obvious differences otherwise between the two portions of the hill, altitude, aspect and climate being identical. Each of these hefts were stocked with home-bred and bought-in sheep in almost equal proportions. The sheep feeding on heather retained their natural fleece characters - the native sheep retaining the usual intermediate wool and the Lanarkshire sheep their coarse wool. On the other hand, all the sheep - both native and Lanarkshire - on the grass and scrub were fine-fleeced, the majority of the bought-in ewes being even finer than the local sheep on the heathery ground. It is interesting to note that in 1884, it was stated by MACDONALD (1884) that sheep on grassy hills were finer fleeced than the sheep on heather. While this example is suggestive, obviously more data are necessary before any definite conclusion as to the influence of diet can be drawn, especially since many practical observers believe that the exact reverse holds/

holds good. The contrary results may perhaps be accounted for by the great differences in the plants which constitute a grassy hill. SMITH (1923) states that the Bents (Agrostis vulgaris and Ag. alba), the Red sheep's Fescues (Festuca rubra), and Sweet Vernal (Anthoxanthum odoratum) are the commonest hill grasses, and that Red Fescue increases with phosphoric manuring. This increase of certain grasses may account for some of the variations in wool types, because should grasses which are nutritious in autumn, be crowded out by less nutritious grasses, it might be expected that the sheep would thrive less when most of the fleece growth was occurring, and thus, on areas with a deficiency of certain minerals, the sheep would tend to grow finer wool. KINCH (1884) in analyses of the commoner hill plants and grasses shows the great variation in their composition, and therefore feeding value, for instance, Heather (Erica vulgaris) has more than double (2.87%) the ether-soluble substances of any of the other plants or grasses and is 16 times richer than the lowest Draw Moss (Eriophorum vaginatum) which only contained 0.18%: the other substances of feeding value and minerals varied less, but still considerably, for instance, heather had only half the ash 1.12% of Mat grass (Nardus stricta) 2.37%

SMITH/

SMITH (1900) states that "if the botanical map be compared with the geological map, it will be seen that the greatest areas of heather coincide with the poor quartzitic hills of Rannoch and Atholl, whilst the greatest areas of pasture, on the other hand, coincide with rich schists, containing calcium, magnesium, and potassium, of the Breadalbane range". He notes that heather seems to be associated with a peaty soil poor in mineral content, and considers that the influence of man is only a secondary cause in the presence or absence of heather. It has already been noted that Glen Lyon forms one of the least indefinite of the dividing lines between two Blackface wool types. But the writer's farm - on the Breadalbane range - is chiefly heather, excepting the enclosed ground and the higher tops, although the geological map shows a limestone formation as running through it, and the wool is of mattress type. It is therefore evident that although heathery hills might be expected to produce fine Blackface wool if minerals determined wool type, owing to the poverty of the soil usually associated with heather, and the low ash content of that plant, this is not always the case. It has already been noted that the Outer Hebrides produce the finest Blackfaced wool and in the description of the geological formation given in a bulletin for ABERYSTWYTH IMPERIAL BUREAU of HERBAGE PLANTS (1931) it is stated that "The greater part of the/

the Island of Lewis is covered with peat, which varies in thickness from a few inches to 30 feet or more ... The peat in Lewis is very acid and wet, and extremely poor in plant food substances. The vegetation on the wet moorland consists chiefly of sedges, Molinia caerulea, Epiophorum, etc. Its grazing value is extremely low". CUNNINGHAM (1932) shows that deficiency of iron creates a comparatively hairless condition in rats; and states that it is indicated that the supplying of iron may promote growth of wool on sheep in iron deficient areas.

No correlation could be found between fleece type and geological formation when large districts, such as Lanarkshire, were considered, as geological formations are so local.

AGE AND SEX.

AGE

Yearlings have the longest fleece - partly because of the longer period of growth before clipping, but it is also coarser than in older animals. With age, the ewes and rams become finer in the fleece owing to the decrease in hair. It might perhaps here be noted in passing that in areas where there is a heavy mortality, i.e., more particularly in the areas of heaviest rainfall in the West of Scotland, it is the practice to keep ewes for one, or in some cases two years longer in the breeding flocks than in other parts where the death rate/

rate is normal and rainfall less. Since with each succeeding year fleeces become finer and lighter, it is obvious that the proportion of fleeces which are older and therefore finer will be greater than would otherwise be the case. It is unlikely however, that this is more than a minor contributory cause to the tendency to produce finer Blackface wool in the westerly wetter districts.

SEX.

Rams as a rule have coarser wool than ewes: but this may be due, partly at least, to the fact that they are often artificially fed and housed in winter. Wethers (castrated males) are intermediate in character and weight of fleece.

It is not however, possible to maintain that sex has any influence upon the clip coming from any particular farm, whether in a coarse or fine wool producing district, except that in those areas where there is a large number of ram breeders, the clip from them will contain a relatively larger number of coarser fleeces from both males and females (since the larger coarser-fleeced ewes tend to be used for ram breeding more than finer fleeced ones).

HEREDITY.

The earliest improvement in the Blackface was centred/

centred round Lanarkshire. A coarse-woolled sheep was selected as the desirable type, as these looked larger and sold better. As communication improved, rams were purchased from this district and imported to Stirlingshire and Perthshire and this type became established, through the local sale of sires, bred in these counties.

In Argyllshire, and the west, owing to the large death rate from disease in bought-in rams, the practice never attained the proportions it did in the counties mentioned above. They tended to use more locally-bred animals, so that the influence of the Lanarkshire type was never great. Moreover, many of the Argyllshire stocks may have been founded on the original soft-woolled dun or white faced breeds by the introduction of rams from other districts. If this is so, the more primitive unimproved characteristics of the original native sheep will enter into the constitution of the existing flocks in the western districts in greater concentration than in other counties. It is interesting to observe that considerable variation in type is found from farm to farm in these districts. There is local belief that soft-woolled sheep make better milkers, and so farmers would tend to select soft-woolled animals for breeding since the Blackface is essentially a mutton-producing breed; in addition, until/

until recent times the finer wools were selling at higher prices.

A similar state of affairs exist in the fine woolled districts in the Islands and western Ross-shire.

In Galloway, the Wensleydale (locally known as the Yorkshire) was even quite recently largely used for crossing with the Blackface ewe and probably has had a permanent influence on some hill stocks. This is confirmed not only by the more curly fleece characters, but by the flatter conformation of the face in the Galloway stocks.

PARASITES.

Parasites are other possible factors in the causation of fine or coarse wool. Infestation with liver fluke, for example, resulting in unthriftiness, and even emaciation, may cause a break in the fibre and shedding of wool. It is well known that other diseases characterised by starvation can cause a similar break in the fleece. Gastro-intestinal and lung worms are found in sheep all over Scotland but as a rule on the higher and drier ground, infections are negligible. In the warm, west country, however, they form a very serious hindrance to stock-farming and are possibly mainly responsible for disease and debility there. It is conceivable that a degree of parasitism less severe in its effects than that produced by liver fluke, which causes

a/

a distinct 'break' in the wool, might produce a 'thinning' rather than a break. If this debilitated condition were continuous, the fineness would be also continuous and the wool would be finer in character than in a healthy sheep. It is certainly suggestive that the finer types of Blackface wool come from the west. In in-wintered rams, where shelter and food - often with a high protein ration - is provided, a much coarser and heavier fleece usually results.

Forty years ago EVANS (1890) declared that the main source of mortality in sheep in western Argyllshire was caused by worm parasites - particularly those infesting the lungs and alimentary tract, and recently animals examined by Dr.T.W.M. CAMERON from the same district and the south-west show that a very high incidence of infection exists: on the other hand, Lanark and Perth hill sheep were only lightly infected. Any source of debility acting continuously would, of course, produce a similar effect, but internal parasites appear to be one of the most constant factors which act continually in these areas. Similarly ecto-parasites - such as ticks, keds and lice - may have a direct effect on the wool. They also are commoner in the west than elsewhere in Scotland.

C R O S S E S.

Blackface sheep are crossed with other breeds for one of two reasons - either to try and improve the breed or to produce crossbred lambs for early slaughter. The crosses are almost invariably made by mating the Blackface ewe with a ram of another breed. With a view to effecting improvement principal crosses have been made by means of rams of the following breeds - Lonk, Gritstone, Merino, Southdown, and Kerry Hill. None has proved to be entirely satisfactory up to date on Blackface stocks.

LONK.

It seems probable that Lonk rams have been used in Blackface flocks more extensively than is generally recognised. It was expected by some owners who made this cross that a sheep with a larger body size which yet possessed no lessened degree of hardiness would result. It was intended to incorporate a proportion only of Lonk blood into the stock, and to renew this at suitable intervals by successive introductions of rams and the use of their F_1 and F_2 sons/

sons into the ewe stock. The Lonk is relatively longer in the leg and usually considerably more white in face and leg colour, and it is probable, since so far as the writer is aware no measurements or weighings were ever made, that this greater length of leg together with its lighter colour gave only an apparently greater body size. Since it is probable that pasturage is much more important in the production of size, this cross is of doubtful value. Some years ago, however, yearling ewes of the F_1 generation were in demand in Yorkshire for mating with one of the white faced breeds.

On low ground in Fifeshire, and, later, in Ross-shire, Blackface ewes were crossed with Lonk rams. Most of the F_1 ewe-lambs might have been mistaken for pure Blackfaces. The older females were rather different however, the crown being 'harder' and the fleece more 'frizzy' with a smaller size of staple and much more kemp. Size was no greater than would have been expected from pure Blackfaces, on similar ground. It was extremely difficult to distinguish from pure Blackfaces, the progeny of the F_1 ewes and Blackface rams. Black-spotting on the

body/

body was as frequent as in the pure bred parent stock while the more open character of the fleece would probably be a serious disadvantage to the sheep in bad weather on the open hill.

GRITSTONE.

In Northumberland, the Tweed Valley and southern Argyllshire, attempts have been made to improve the Blackface wool by crossing with Gritstone rams. Unfortunately for the value of the experiments, some of the parent stocks were below the average both in wool quality and body conformation. Moreover, only small numbers were used. The results showed that, while occasionally an F_1 animal (about one in five) produced a fleece very suitable for the carpet trade, the other fleeces varied greatly - ranging from that of an inferior Blackface to that of a Gritstone, but as a rule the wool was rather longer than that of the Gritstone but shorter than Blackface wool. When the F_1 generation was mated with pure Gritstones, a similar state of affairs resulted, except that the Gritstone type predominated. Both breeds often carry a number of black spots on the body and these were as common in the crosses as in the parents.

Fleece weights were lighter than those

which pure Blackfaces should have carried on similar ground. Most of the crosses also showed the disadvantages in conformation of both parents - the weakness of tail head of the Blackfaces, and the narrowness and shallowness of chest of the Gritstones.

A few Blackface-Gritstone crosses from better parent stock raised on the low ground at Edinburgh, were quite well woolled and shaped but the percentage of off-types was too high to make the establishment of a hill stock appear possible. However the appearance of the F_1 females suggested that, mated to a Border-Leicester or Suffolk ram, they would produce good killing lambs. The F_1 females from the Gritstone ram-Blackface ewe cross are usually polled, whereas the males usually have small horns. The reverse cross is usually horned and the wool characters seem to follow the male parental type. The crosses have the longer tail of the Gritstone.

A small number of pure Gritstones and Gritstone-Blackface crosses kept on very crowded pasture, became heavily parasitised - much more so than Blackfaces and Cheviots on similar ground. Although the numbers observed were too small to justify any definite conclusions, the results might suggest a lack of resistance/

resistance to helminthiasis, similar to that observed in the case of horses by PILLERS (1927). He noted that Welsh ponies, normally relatively free from sclerostomes, became much more susceptible when crossed with Lowland sires.

MERINO.

Crosses between South African Merino rams and Blackface ewes have been produced in Fifeshire on low ground, (where the question of relative hardness could not be tested). The crosses and back-crosses with Blackfaces however compared favourably with low ground Blackface stocks. This was to be expected since the herding instinct of the Merinos and their dislike of alpine plants would not be such a disadvantage in lowland fields as it would be on hilly ground. Their feet also appear to have been free from the trouble usually found in other Merinos and Merino-crosses in Britain. The most interesting feature of this experiment however, was the greatly increased density of what otherwise would appear to be soft Blackface wool, even when the back-crossing had been carried to the fourth generation. It appeared that the ewes might carry two to three pounds more wool than would have been expected under similar conditions from pure Blackfaces. The earlier crosses/

crosses were all very plain in body and head, but by the fourth generation, this had been largely obliterated by the Blackface blood.

SOUTHDOWN.

This cross had very varied results in fleece, although body conformation was more constant. The legs were short with wide, well-muscled thighs but the fore-end was weaker. Face colouring varied from the whole-coloured "mousy" face of the Southdown to a darker brown whole coloured face or a face patterned with these colours. The fleece varied from that of an inferior Southdown to that of a soft Blackface with every intermediate type. This might cover the body evenly or both extremes might be found on the same animal with a clear cut line of demarcation separating the two kinds of fleece. The young sheep were less hardy under unfavourable conditions than pure Blackfaces. They have been used in parks for producing good, early-maturing mutton. The F_1 generation wool varied from long and coarse to fine and short: it was dense and might be almost kemp-free. EWART (1919) found the F_2 generation were most irregular in body conformation and fleece characteristics. They were more prolific than pure Blackfaces. None had as

long/

long a fleece however. LOW (1842) ninety years ago, praising this cross, stated they had black legs and face, and close good fleeces, but were smaller than the Leicester crosses.

KERRY HILL.

This cross has been tried in West Perthshire and Ross-shire with the object of uniting the Blackface hardiness and the Kerry Hill wool qualities. The number in the F_1 generation was too small, however to avoid injudicious inbreeding, while the unwanted castrated lambs realised much less than their true value in the open market as their qualities were entirely unknown. The wool while softer than that of the parent Blackface was only of carpet quality. Two of the four rams used in one experiment were black-spotted and this fault was passed to the crosses. The cross bred ewes were considered to make better mothers than the Blackfaces. Unfortunately, except for show animals, the Kerry Hill breed is not 'fixed' and includes many types, some with a Clun Forest appearance. A uniform F_1 generation was accordingly not to be expected under these circumstances.

CROSSES/

CROSSES FOR COMMERCIAL LAMB PRODUCTION.

BORDER LEICESTER.

Blackface sheep are regularly crossed with other breeds for purely commercial purposes and some of these crosses are of considerable importance. The commonest is that between a Border Leicester ram and draft Blackface ewes. The cross according to CULLEY (1807) has been known since the beginning of the 19th Century at Moffat and in Ayrshire and Galloway between Blackfaces and the Dishley breed. The Border Leicester X Blackface cross is known in Scotland as the "Greyface", while in Yorkshire they are sometimes referred to as "Mashams" although this name should, more correctly, be reserved for the Wensleydale and Blackface cross (see under). "Greyfaces" mature more quickly and are more easily fed than "Mashams", according to MACDONALD (1884) quoting GREENSHIELDS.

"Blue-headed" Border-Leicester rams and dark faced Blackface ewes are generally preferred for this cross since butchers believe that the lambs from such ewes are better "killers" than those from lighter faced ewes. Greyface ewes mated to a ram of/

of a Down breed produce early maturing lambs. Moreover these ewes are good milkers and often produce twins. Their fleece is lustrous, slightly stapled, long and with some crimp.

WENSLEYDALE.

Another well-known cross is that with a Wensleydale ram. This cross was very common in the south-west of Scotland, where it was known as the 'Yorkshire', and it still is common in Yorkshire, where it is the true 'Masham'. It grows more slowly but to a greater weight than a "greyface".

In Wigtownshire and Kirkcudbrightshire, this cross appears to have influenced the local 'pure' Blackface breed which are flatter in the face and have more open curly wool with a more pronounced staple. It is believed that the soft open wool of the Blackface of this district is due to climate, but it may also be partly due to the introduction in earlier times of other blood: this may be Cheviot blood, since before the introduction of Wensleydale rams, the Blackfaces of Galloway and Ayrshire were described by CULLEY (1807) as "variations"! which he thought was due to Cheviot blood.

The/

The lesser known crosses with Blackface ewes include Cheviot, Suffolk, Lincoln, Shetland and Welsh rams.

The CHEVIOT cross is usually accidental and is most commonly found accidentally in the Borders where Cheviot and Blackface hirsels adjoin. These crosses are known as 'Mules' locally (although elsewhere this name refers to other crosses). Occasionally this cross is made deliberately when changing a Blackface stock into a Cheviot, or vice versa; the change from Cheviot to Blackface being practically the only occasion when Blackface rams are used with another breed. The F_1 generation is unpleasing, with indefinite colours and a coarse crown - the horns of the Cheviot when present being less well set on the head than those of a typical Blackface. (Considerable attention has been paid by breeders to the Blackface horn to avoid trouble during lambing). The fleece of the cross is intermediate between the two breeds. As long ago as 1837 by YOUATT, and five years later by LOW (1842) this cross was considered unsuccessful except for changing the breed on a hill.

SUFFOLK rams are occasionally used with old Blackface ewes to produce an easily fattened lamb of/

of good size suitable for killing in late summer. Ewe lambs of the F_1 generation however are seldom wintered for use as breeding stock.

LINCOLN rams produce a bigger coarser lamb than other crosses; it was favoured fifty years ago according to MACDONALD (1884), as it was said the wool and mutton was superior to that of the Leicester or Cheviot crosses. The males have small ill-shaped horns with colours similar to a Greyface. The fleece is longer than that of the parent Blackface, more lustrous, crimped and stapled. The lambs require more feeding and are slower to mature than "Greyfaces".

SHETLAND crosses are rare. The lambs have short tails like the sire, and the lamb wool is dense and long, varying in type from straight to tightly curled. The face colours can vary from that of a Greyface to black, depending on the variations of the parents. The F_1 generation has strong horns, according to ELWES (1912) and the rams may have four horns. ELWES (1912)&(1913) suggests the colour "Sheila" may be the result of Blackface blood. According to the same author (1912) Blackfaced rams were used to 'improve' the native ewes of St. Kilda one/

one of the few cases when Blackfaced rams have been used to improve another breed.

EWART (1919) states the second cross of the "Siberian"-Blackface had typical Blackface wool except that it was more lustrous.

The WELSH MOUNTAIN cross is unusual but interesting.

With the WHITE WELSH, the face colours have the patterning of the Blackface but the black areas are replaced with dark brown, reddish brown, or grey areas interspersed with white hairs: the colouring of the legs is similar. So also are the body spots, although they tend to be redder, the red Heterotype fibres of the Welsh standing out above the other fibres. A spot at the back of the neck, as in the Blackface, is common. The curl of the birthcoat varies from being wide and open to fairly tight.

The progeny of the BLACK WELSH cross are black. The birth-coat and conformation are otherwise of the same type.

ELWES (1913) describing the cross with the COTSWOLD, notes it is a sheep which is readily fattened on grass at about 16-18 months, but is too large for modern requirements.

FACE COLOUR and ITS RELATIONSHIP WITH ECONOMICALLY IMPORTANT CHARACTERS.

INTRODUCTION

In common with various other breeds, e.g. Lonk, Gritstone, Kerryhill, the Scottish Blackface has a parti-coloured face. Unlike the Swaledale, and Rough Fell however, the face of the Blackface may vary from a black without any white to one which has only a little black colour, usually restricted to the muzzle, the margins of the forehead and the area of skin surrounding each eye. Between these two extremes there is in the Blackface almost every variation. In fairly recent times however, there has been a tendency to breed a brocket-faced sheep in preference to other patterns. The brocket is so-called from its vague resemblance to the face markings of a badger, but the similarity between a badger's face is not now very great. A brocket face is said to be one in which there is some white; typically the black and white areas should be clear cut. Common patterns are a star or blaze on the forehead, ticks on the side of the nose - between the eyes and nostrils - the latter often meet over the bridge of the nose like an inverted "V", and may also join the white markings of the forehead. It might here be mentioned that the present tendency is/

is to encourage the breeding of dark brockets rather than light brockets. Apart from this no particular pattern can be considered typical of the Scottish Mountain Blackface breed. "Muff" may be considered a face character. (See FIGS. 5 and 6). It consists of soft wool round the cheeks and on the forehead. The forelock is often some inches in length and the wool is coarser than on the cheeks. Local names for it are "Dossan" and "Snowlock". Since a great deal of attention is paid to face-colour by some breeders and since there appears to be only a very vague idea of fixing any type the breeder choosing in general rams with lighter faces to mate to dark faced ewes, and vice versa, it seemed desirable to attempt a preliminary study of the behaviour of face colour under ordinary farming conditions.

Many popular beliefs exist regarding the significance of face colour in the Scottish Blackface. Thus it is generally believed that a dark face is associated with hardiness and black spots on the body and a light face with good milking capacity. Muffy wool on and around the face and legs is thought to be a sign of a good milker and a well covered belly. A face tinged with dun is believed to denote an unthrifty sheep.

Undoubtedly face colour as well as fleece character/

character in the Blackface varies with the district and it is difficult to determine how much the popular beliefs are founded on fact and how much they are the natural consequences of the beliefs themselves. For, if a district, e.g., the high hills of Perthshire, requires a sheep, hardy both in constitution and fleece, and if the breeders believe that these are associated with a dark face, then there is a tendency to use dark faced rams with a hard fleece, and these characters become established. In the milder districts, on the other hand, where wool for carpet manufacture was in demand, sheep with the opposite outward characters have been bred, e.g., a lightface, - to produce milking qualities, and a soft wool - for selling purposes.

A series of observations has been made at the writer's farm in Perthshire over a period of ten years in order to test the validity of some of these beliefs.

The writer's farm - "Morenish"- contains 175 acres of enclosed ground, rising from 350' at the side of Loch Tay, with an unfenced hill rising to 3,400'. Tupping and lambing take place under control on the enclosed ground which is divided up into a series of fields.

Each ram has drawn to him his own batch of ewes, and these were kept strictly isolated in their own field during the mating period. For the first 17 days/

days at least, often longer, notes were made of the ewes served be each stock ram. In some cases another ram was introduced as a "chaser" subsequently, but lambs born from ewes which might have been served by more than one ram, or those in which there was doubt of the parentage through other causes, were not used for genetic records. On the other hand, such lambs of doubtful origin were included where only observational and behaviouristic data were required. At the commencement of these observations, the existing sheep were all numbered by means of ear-tags. Subsequently each lamb was numbered within a few days of birth and notes were made on face-colour and black spotting on the body. Notes were kept of the progress of each lamb, and full breeding records of such lambs as were retained for stock purposes were made.

The records were checked so far as possible on all occasions when the sheep were being handled for ordinary purposes, such as at clippings, dippings, weaning, selling, casting of ewes, drawing of stock ewe lambs, tupping and lambing. At these times, it was possible to replace most of the comparatively few lost ear-tags before confusion could arise; it was possible to follow with accuracy the history of each breeding ewe and ram, and after the first few years, it was possible to follow back an individual's ancestry with entire accuracy for two or more generations/

generations. Naturally, it was not possible to maintain and improve the stock without the purchase of breeding rams. These were recorded in exactly the same way as the rest of the stock immediately on arrival, and efforts were made in every case to ascertain as many details concerning their previous history as possible. The records of a total of some 3,500 animals - ewes, lambs and rams, which were first started in 1922 and are still being continued were in this way available for examination.

It is desirable to explain the system of recording in some detail since in the great majority of Blackface flocks the system of recording is mainly based upon memory, which cannot at all times be accurate.

FACE-COLOUR.

The face-colour of each sheep was assessed according to the following scale:

A0 - represented a completely black face.

A5 - represented a completely white face, which actually was not encountered.

A½ to A4 represented intermediate stages. A½ was used for a very little white on the face, one per cent to seven per cent, (See FIGS. 7 and 8).

A1 - signified eight per cent to fifteen per cent of white, (See FIGS. 9 and 10).

A2/

A2 - represented sixteen per cent to thirty-five per cent, (See FIGS. 11 and 12).

A3 - indicated thirty-six per cent to fifty-five per cent white, (See FIGS. 13 and 14).

A4 - was the value given to fifty-six per cent of white and over (See FIGS. 15, 16, 17 and 18).

Since autumn 1929, photographs of the rams, ewes and lambs were taken with a Leitz 'Leica' camera. This takes a photograph measuring 36mms. X 24 mms. The photographs were all taken at a distance of 3' from each animal's head. It was found necessary to have the sheep held by an assistant and by using a simple type of range-finder (a "Fodis" - made by Leitz) set for 3'0" it was found possible to photograph large numbers of sheep with ease and accuracy. Actually the range-finder has an accuracy of ±1" at 2 yards distance. A negative was in this way obtained which rendered comparisons between different animals, or between different areas of the same animals, possible.

Following this plan photographs of the lambs born in 1930 were taken soon after birth, and those retained for stock purposes were again photographed during the summer of 1931 - 15 months later. The amount of white on the face has been assessed in the laboratory by the following method.

The negative image was cast on to squared paper by means of a small projector (See FIG. 19). This/

This gave a magnification of about 20 times which was kept constant for all animals examined. On the squared paper an outline drawing of typical heads had been prepared. The number of squares enclosed in the outline was known; the number of squares covered by the white markings on the sheep's face was counted and reduced to a percentage. Mealiness around the nostrils in adult ewes and rams was considered as black since mealiness is never seen in Blackface lambs. It is not claimed that the result obtained in this way gives an actual value for the amount of white on the whole face, since when the curved surfaces of a sheep's face are photographed on a flat film, the area of white shown in the photograph is obviously less for the sides of the face, cheeks, etc., than it is in the living sheep. The amount of white in the photograph of the forehead, on the other hand, bears a close relationship to the amount of white present in the living animal since the forehead is normally very flat in Blackface lambs. Yet it is believed that since the method of photographing was constant the percentage figures obtained may be used as a relative index between sheep and sheep, which may be used for comparative purposes. In 1931, the lambs were photographed in spring and autumn.

CHANGE/

CHANGE OF FACE COLOUR

As a very general rule, the face-colour of the lambs is lighter than that of the average class of the parents. It is known that face colour in Blackface lambs darkens for some months after birth and accordingly the face-colour in the newly born lamb must not be regarded as other than a general indication of the adult face colour. This was confirmed by comparing photographs of the lambs soon after birth and photographs of the same animals taken when four to six months old. In one year, a third set of photographs was taken at fifteen months old and it appeared that little darkening takes place after the first few months.

Histograms of the change in face-colour shown by the photographs of 137 lambs (See FIG. 20) and 54 yearlings (See FIG. 21) indicate that the change is irregular, but that with very few exceptions the percentage of whiteness on the face falls - and in some cases entirely disappears. It will be noted that one of the AO yearling ewes developed a white spot on the forehead, but that none of the other darker sheep became whiter, although a very few of the whiter lambs and yearlings did become whiter. It will be noticed that in the histogram of the face change of fifty-three sheep between birth and the following summer:- two became very much whiter, four slightly whiter, six remained/

remained the same colour, and five became only about two per cent whiter; most of the rest became considerably whiter; in the histogram the progeny of ten sires are shown, and the variations in face change do not seem to be influenced by the sire.

In the histogram of the change in face colour between birth and late summer of the year of birth data of 136 lambs are shown. Four became considerably whiter, two slightly whiter, ten remained the same colour, (six of them were black at birth) and three became only about two per cent whiter. The lambs were sired by twelve rams. Of the four which became considerably whiter three are by an A4 ram, which himself did not become darkerafter birth while most of his other lambs became considerably darker, including one (C47) whose face area darkened by thirty three per cent, and eight of his progeny, (C3, C21, C30, C34, C70, C78, C142 and C173) became less dark than the average for their birth face colour.

Three graphs (FIG. 22) are shown which indicate the average face-colour change which takes place in a lamb between birth and late summer. One shows the forehead colours - this is usually the whiter area. Another the lower face, and the third the average for the whole face in the same lambs. In the A0 class there were 6 lambs, in the A½ eleven, in A1 fifteen, in A2 thirty-five, in A3 forty and in A4 thirty lambs. Classes A2 and A3 were halved into two further groups and/

TABLE I. FACE COLOUR CHANGES IN LAMBS.

	YOUNG LAMB'S FOREHEAD	OLD LAMB'S FOREHEAD	YOUNG LAMB'S LOWER FACE	OLD LAMB'S LOWER FACE	YOUNG LAMB'S WHOLE FACE	OLD LAMB'S WHOLE FACE
Ao (0% white)	o	o	o	o	o	o
A½ (1-7% ")	4%	Under 1%	2%	Under 1%	3%	Under 1%
A1 (8-15% ")	16%	4%	7%	2%	11%	3%
A2 (16-25% ")	24%	12%	15%	7%	20%	10%
A2 (26-35% ")	42%	23%	23%	10%	32%	17%
A3 (36-45% ")	51%	30%	29%	14%	41%	23%
A3 (46-55% ")	60%	41%	41%	24%	51%	33%
A4 (56-65% ")	75%	57%	46%	32%	61%	44%
A4 (66-75% ")	89%	71%	51%	38%	72%	54%
A4 (76% & over)	95%	70%	68%	46%	83%	59%

This Table shows the average face colour change that takes place between birth and late summer.

and A4 was divided into three groups of 10 per cent of whiteness in face-colour.

In the graph which indicates the change in forehead colour it will be seen that in the whiter groups the percentages of white fall by about 20 points, and that in the graph of the change of face colour in the lower part of the face the darkening averaged slightly less. TABLE I shows the same data.

FACE/

FACE COLOUR INHERITANCE.

With the exception of WOOD (1909) who, starting in 1903 crossed Suffolks and Dorset Horns and raised an F_2 generation, little work has been done in Great Britain on the genetics of the face colour in sheep. WOOD'S results were analysed by ROBERTS (1928) who groups the breeds of sheep as regards face colour into those with whole colour on the face, for example, the Suffolk; those with very white faces, for example, the Dorset Horn, and those with broken colour on the face, which includes the Scotch Blackface and Kerry Hill. The F_1 lambs of the Dorset Horn and Suffolk cross "had speckled faces of a more or less uniform kind, with some tendency to the formation of a pattern round the nose and eyes", a pattern which is similar to many Blackfaced lambs. ROBERTS suggests that, in the F_2 generation, if AABB is a black face, aabb a white face, AABb, AaBB and AaBb will have speckled faces, and AAbb, Aabb, aaBB and aaBb will have patterned faces. Kerry Hill-Merino and Border Leicester-Blackfaces crosses and pure Kerry Hills have confirmed this.

Nearly a hundred years ago white patterning (called in those days "mottled") was stated by YOUATT (1837) to occur on the face of Blackface sheep, and ever/

TABLE II. FACE COLOUR INHERITANCE.

RAM'S FACE COLOUR	LAMB'S FACE COLOUR	EWE'S FACE COLOUR A0	A½	A1	A2	A3	A4
A2	A0	2	2	1	1	-	-
	A½	2	3	3	4	1	-
	A1	1	1	3	8	5	1
	A2	-	1	2	11	8	7
	A3	-	-	6	6	15	11
	A4	-	1	-	3	6	4
A3	A0	1	-	-	1	-	-
	A½	1	-	1	-	-	1
	A1	2	2	3	3	1	-
	A2	1	7	2	5	6	2
	A3	1	1	5	5	11	6
	A4	1	-	2	-	3	2
A4	A0	-	-	-	-	-	-
	A½	-	-	3	2	-	-
	A1	-	2	-	4	1	-
	A2	-	1	4	10	4	2
	A3	1	-	6	12	16	6
	A4	1	-	1	8	5	7

This Table shows the number and face colour of the lambs obtained by mating A2, A3 and A4 rams to ewes of six face colour groups shown above.

ever since then has it been thought desirable not to have an excess of white in the face colouring: that this has been possible, without producing a high percentage of black faced sheep indicates that face colour of Blackfaces depends on more factors than the somewhat similar coloured cross between the Suffolk and Dorset Horn would suggest; for assuming that 2 factor pairs, with intermediate inheritance, are responsible for the main distribution of colour and white on the face, whole black face and whole white face being the homozygous type, the latter would frequently occur if 2 pairs of factors alone were the cause of face colour.

On TABLE II it will be seen that eight out of 291 lambs had whole black faces. Given the above hypothesis and a system of random mating - also assuming that the incidence of the two factors is the same, a proportion of 2.75% black faced lambs should correspond to a proportion of 12.35% white faced lambs. Of course the mating system is not random as there is some selection against very white faces; but even allowing for that it is very difficult to account for the fact that white faced lambs are so rare - in fact they are almost unknown.

Although in pure Blackface breeding white faced/

TABLE III. FACE COLOUR INHERITANCE.

"MID-PARENT" VALUES.	LAMB VALUE				
	1	2	3	4	5
2	9	2	1	0	1
2.5	6	7	10	8	1
3	6	13	14	12	6
3.5	5	8	17	26	7
4	2	6	23	34	15
4.5	1	1	6	22	7
5	0	0	2	6	7

This Table shows the same data as Table II. but the parents are grouped into "Mid-parent" values. i.e. the average value of dam and sire.

faced lambs are almost unknown, in a cross to such a breed as the Cheviot or Border Leicester an appreciable proportion of white faced lambs occur in the F_1 generation.

It is difficult to account for the findings in the Blackface breed on the basis of only two factor pairs. It is probable that there are additional factors for face colour and if it were assumed that the additional factor or factors were recessive, and that the great majority of the sheep of the breed were homozygous, it would be possible to reconcile the extreme rarity of white faced lambs in the pure breed with their not infrequent occurrences in crosses to white faced sheep.

Owing to the irregular change in face colour between birth and a few months old, and since the majority of the sheep under consideration had been assessed for face colour at birth it seemed necessary to restrict the observations, not only to the lambs, but also to dams and sires whose face colour at birth was known, and since most of the rams, which have been used, have been bought, this has restricted the number of lambs for consideration to 291; and to rams whose face colour ranged from A2 to A4.

TABLE II shows the results of mating these rams to ewes of face colour ranging from A0 to A4.

TABLE III shows the result of correlating the "mid-parent"/

"mid-parent" value (half sum of value of individual parents) with the observed value of the lambs. A positive correlation of $\cdot 352 \pm \cdot 01$ was obtained. For this purpose classes A0 and A½ have been grouped together, because each class was very small and the differences in face colour were much less than between the other classes. The original evaluation of A0 to A4 was changed into values of 1 to 5.

From these results it will be seen that the general expectation of mating Blackfaced rams with Blackfaced ewes is that the majority of the lambs will posses a face colour midway between the face colours of their parents. It is reasonable to assume that this indicates (as was to have been expected) that face colour inheritance in the Blackface depends upon multiple factors. Opportunity did not arise to make deliberate face colour matings of rams with large numbers of ewes of the same face colour.

TABLE IV. Correlation of Face Colour and Black Spotting.
Amount of Black Spotting on the Lambs.

Face colours of Lambs.	E0		E½		E1		E2		E3		E4		E5		Total.
A0	2	2%	25	21%	32	27%	31	27%	18	15%	6	5%	3	3%	117.
A½	18	8%	110	48%	64	28%	20	9%	14	6%	2	1%	0	-	228
A1	52	13%	176	46%	98	25%	39	10%	20	5%	2	1%	0	-	387
A2	158	23%	302	47%	112	18%	66	10%	13	2%	1	-	0	-	652
A3	202	36%	224	40%	87	16%	33	6%	6	1%	4	1%	0	-	556
A4	114	53%	73	34%	20	9%	3	1%	5	2%	1	1%	0	-	216
TOTAL	546		910		413		192		76		16		3		2156

This table shows the face colour groups of 2156 lambs and the amount of black spotting that occurred on these lambs. The number of lambs which fell into each class is shown; and in addition the percentage figures are given.

See also Graph FIG. 24.

TABLE V. INHERITANCE OF BLACK SPOTTING.

NO. of SIRES VALUED	AMOUNT of BLACK-SPOTTING IN SIRE	NO. of EWES VALUED	AVERAGE AMOUNT of BLACK SPOTTING IN DAMS	"MID-PARENT" AVERAGE	NO. of LAMBS VALUED	AVERAGE of PROGENY.
13	0	535	1.23	0.61	595	0.65
3	0.5	86	0.96	0.73	92	0.63
3	1.0	138	0.73	0.87	145	0.80
2	2.0	6	1.66	1.83	6	1.75

TABLE V. shows the influence on sire and dam on the amount of black spotting in their progeny.

FACE COLOUR and BLACK SPOTTING in FLEECE.

Black spotting on the body of the lambs (See FIG. 23) was indicated by a system similar to that adopted for face colour; e.g. E0 has no black spots, E½ a small black spot (often on the neck or at the root of the tail) and so on, up to E5 which is all black. The progeny of some 60 rams has been studied and TABLE IV. shows the relationship between this character and face colour.

A graph (FIG. 24) shows the same data. It will be seen that there is a distinct correlation between these two characters, blackness on the face being generally associated with black spotting on the body. The more black on the face, the greater the amount of black spotting on the body and vice versa, as was to be expected.

Since black spotted rams and ewes have as far as possible not been used, it was not possible to obtain a correlation coefficient, but TABLE V shows that the average value of the parents, approximates to the average value of their progeny.

Therefore the use of rams with less black spotting than the average of the ewe flock may be expected to reduce the amount of black spotting in the progeny, to a figure which is about midway between that of sire and dam, while rams with more black spotting than the average of the ewe flock may be expected to give progeny which have more black spotting than their dams.

FACE COLOUR and MILKING CAPACITY of EWES.

An attempt was made, in 1930, 1931 and 1932 to investigate the popular belief that face-colour and milking capacity were associated. It is very difficult to assess the milk yield of a ewe since artificial milking cannot be carried out so as to provide figures representing the daily amount secreted.

For this reason it was decided to use the dead weights of the male and wether lambs as an indication of the milking capacities of their dams. It must be admitted that other variables, which cannot be allowed for, enter into the results obtained, and may in some cases invalidate them, so that it is only possible to point out what are the indications. The method adopted was to wean the wether lambs at the same time, and have them slaughtered as soon after as was possible following ordinary commercial practice. Between weaning and slaughter they were kept under the same conditions - being grazed on rape and foggage. The male and castrated lambs were slaughtered and their dead weight noted. A complication which has been ignored in assessing these results, is the influence of genetic factors for growth. Abnormally small lambs, where the size was obviously due to loss of mother or disease/

TABLE VI. AVERAGE DEAD WEIGHTS of MALE and WETHER LAMBS.

	Darkest Faced Ewes												Whitest Faced Ewes.					
	A0			A½			A1			A2			A3			A4		
	No.	lbs.	ozs.	No.	lbs.	ozs.	No.	lbs.	ozs.	No.	lbs.	ozs.	No.	lbs.	ozs.	No.	lbs.	ozs.
Average for 1930	8	23:	10½	7	23:	-	18	24:	2½	22	21:	12½	14	23:	13½	11	22	10¾
Average for 1931	5	22:	4½	6	21:	12	15	24:	1¼	22	22:	4½	20	22:	15¾	10	20	11
Average for 1930 and 1931	13	23:	2	13	22:	6¾	33	24:	2	44	22:	0½	34	23:	5½	21	21:	11½

This table shows the number and average dead weights of the lambs slaughtered in 1930 and 1931. A graph FIG. XXV, shows the same data. Fuller details are given in appendix TABLE I.

TABLE VII. The average weight of all the slaughtered lambs was 22.8 lbs., with a standard deviation of 3.15 lbs., and a standard error of ± 0.2514.

The total number of lambs in each group and their average figures are:-

FACE COLOUR of DAMS	NUMBER of LAMBS	MEAN WEIGHT	STANDARD ERROR	STANDARD DEVIATION	STANDARD ERROR
A0	13	23.13 lbs.	± 1.05	3.78	± 0.74
A½	13	22.42 "	± 0.68	2.47	± 0.49
A1	33	24.12 "	± 0.56	3.22	± 0.40
A2	44	22.03 "	± 0.42	2.76	± 0.29
A3	34	23.34 "	± 0.56	3.28	± 0.40
A4	21	21.73 "	± 0.59	2.71	± 0.42
	158	22.8	± 0.2514	3.15	

disease, have been omitted from the table, as also have fostered lambs, except, where the foster-mother belonged to the same face-colour category as the dam. The influence of the sire has also been disregarded since the different categories of ewes were approximately evenly distributed among the rams. The age of the dam has been disregarded, since the face-colour at different ages in this flock varies very little. Appendix TABLE I. gives the dead weights of each lamb. TABLE VI. gives an analysis of the weights, and a graph (FIG. 25) shows the same data.

An examination of the TABLES VI and VII will show that GROUPS A1 and A4 differ by a greater amount from the mean weight of all the lambs, than do the other four groups. In GROUP A1, which has 33 lambs, the calculated chance against the average difference being due to random sampling errors is 50 : 1. A similar calculation for GROUP A4 gave a chance of 10 : 1. Consequently, it may reasonably be assumed that the lambs born from ewes with face colours falling into GROUP A1 are likely to yield better average carcase weights than lambs from ewes in other groups; while lambs born from those ewes falling into GROUP A4 will not approach the average.

Comparisons of the numbers of lambs sired, or whose dams were sired by any one ram, showed that since they/

they were evenly distributed in the various groups, the influence of the sire or grandsire could be disregarded: therefore, it is probable that in the early life of a lamb the nutrition it obtains from its dam is of greater importance in relation to body weight increase than are genetic growth factors inherited from the sire.

The sizes of the ewe lambs of 1931 and all the lambs of 1932 were estimated by eye, at weaning, and the lambs were subsequently grouped into classes. Economic conditions prevented recording the dead weights of the male and wether lambs of 1932. The results were shown on a graph (FIG. 26) as a rate of larger to smaller lambs. This graph may be considered as confirmation of the graph of dead-weights. The lambs born from ewes with the extreme type of face colour, i.e. whitest and darkest, showed a larger proportion of small individuals than the average. Lambs which had not been reared by their own dams - unless the foster mother was same face colour group - were again excluded from the calculations.

HARDINESS.

Hardiness is extremely difficult to asses. In lambs it may be indicated by rapidity in gaining their feet after birth and vigour of suckling. Post-natal activity is influenced by weather conditions to a considerable extent, for example, more newly-born lambs have to be given assistance by the shepherd on a warm moist foggy day, or on an excessively hot day, than during brisk or cold weather. Probably, lambs are least trouble when there are a few degrees of frost and the weather is clear and sunny. Piercing and cold east winds are tolerated well by hardy lambs if some shelter is available, but unless they gain their feet rapidly after birth they are very liable to perish on such a day. Wet weather with chilling east winds are particularly bad for both ewes and lambs; especially are lambs which do not suck well liable to die on such days.

These facts make it exceedingly difficult to draw up a satisfactory measure of hardiness which will apply to Blackface lambs, for the weather during lambing is usually extremely variable, and the results of observations made on small numbers may give an entirely erroneous idea of the actual position.

In some cases it would seem that hardiness is a character which may be inherited from the sire, although this is seldom recognised in practice.

Since/

TABLE VIII. The following observations were made from the lambings of 1924 to 1931, involving 2,380 possible matings. A graph (fig.27) embodies the figures of TABLE VIII

Out of	130	matings by	2	Rams of	$A\frac{1}{2}$	face colour	60	lambs	were	reared:-	=	46%
"	" 640	"	" 6	"	" A1	"	" 416	"	"	"	=	65%
"	" 950	"	" 9	"	" A2	"	" 532	"	"	"	=	56%
"	" 530	"	" 5	"	" A3	"	" 360	"	"	"	=	68%
"	" 130	"	" 4	"	" A4	"	" 74	"	"	"	=	57%

Since it was not possible to draw up a scale for hardiness on the same basis as the other characters, it was arbitrarily decided to consider as hardy lambs those which lived for at least a month; lambs which did not live for this period were considered not to be hardy.

Rams were classified according to their face colour when adult. The total number of ewes to which they were mated and the number of lambs alive after a month were noted. The result was expressed as a percentage of month old lambs to matings. It was assumed that the number of late lambs, the sires of which were unknown, and of barren ewes, were constant for each.

These observations were made from the lambings of 1924 to 1931, involving 2,380 possible matings. A graph (FIG. 27) embodies the figures of TABLE VIII.

Again it will be observed that there appears to be a correlation between the face-colour of the ram and the hardiness of the lamb, in that rams which were classed as belonging to GROUP A1 and A3 gave higher percentages of lambs at one month old to total matings, than did rams whose face colours were classed in other groups. On the other hand rams of GROUP A½ face colour gave a percentage figure much below all others. The average percentage of all lambs sired by these rams surviving to the age of 1 month was 60·6%. The lambs from GROUP A1 rams exceeded this figure by 4·4%, and

those from GROUP A3 by 7·4%, while GROUP A½ rams only gave a 46% of month old lambs, which is some 14·6% below the average for the whole. No A0 rams have been used.

FERTILITY.

The fertility of a flock may depend on both the rams and the ewes, Many writers have shown that twinning depends on the number of ova which ripen and, which after fertilisation, develop. This in turn is influenced by the condition of the ewes before and during mating. WHITE and ROBERTS (1927) have shown in Welsh Mountain sheep that in conditions where barrenness is most common, twinning is least common. In the present work where the influence of the sire on his progeny is being considered, and where only the daughters and granddaughters of a ram have been available for breeding, fertility has been measured by the simple standard of whether a ewe was barren or pregnant at lambing time.

The accompanying appendix table (IIa and b) is intended to show the fertility of all the flock ewes the sires of which are definitely known. It gives the results of mating the female progeny of 44 rams; these are 550 in number. The total number of lambings which would have occurred if each ewe had been pregnant each time served is 1618. It should be noted that these are lambings not lambs. For the purposes of this analysis ewes in which early abortion or foetal atrophy occurred must be included among non-pregnancies since both of these conditions generally pass unnoticed in a hill flock even with careful management. Ewes which were known to have aborted late in pregnancy were considered among the pregnant group: the number of these varied/

FERTILITY OF EWES. TABLE IX.

From	32	matings	the	daughters	of	No.	7	Ram	gave 32 pregnancies	= 100%
"	38	"	"	"	"	M899	"	"	36 "	= 95%
"	79	"	"	"	"	552	"	"	71 "	= 90%
"	154	"	"	"	"	563	"	"	138 "	= 90%
"	62	"	"	"	"	558	"	"	55 "	= 89%
"	208	"	"	"	"	561	"	"	186 "	= 89%
"	24	"	"	"	"	557	"	"	21 "	= 88%
"	320	"	"	"	"	551	"	"	276 "	= 86%
"	116	"	"	"	"	553	"	"	100 "	= 86%
"	27	"	"	"	"	8	"	"	23 "	= 85%
"	85	"	"	"	"	554	"	"	72 "	= 85%
"	33	"	"	"	"	M890	"	"	27 "	= 78%
"	81	"	"	"	"	568	"	"	62 "	= 77%
"	38	"	"	"	"	9	"	"	29 "	= 76%
"	42	"	"	"	"	566	"	"	30 "	= 71%

Table IX shows the fertility of the ewes sired by the 15 rams whose daughters could have lambed 24 or more times .
Appendix table II.a gives the full details.

TABLE X. FERTILITY OF EWES.

RAM'S WHOSE DAUGHTERS GAVE	RAM'S NUMBER	POSSIBLE NUMBER of PREGNANCIES		ACTUAL NUMBER of PREGNANCIES	
100-96%	7	32	32	32	32
95-91%	M899	38	38	36	36
90-86%	552	79		71	
	563	154		138	
	558	62		55	
	561	208		186	
	557	24		21	
	551	320		276	
	553	116	963	100	847
85-81%	8	27		23	
	554	85	112	72	95
80-76%	M890	33		27	
	568	81		62	
	9	38	152	29	118
75-70%	566	42	42	30	30
			1339		1158

86·5% Fertility of the 15 rams.

This Table shows the same data as table IX. the rams being grouped into classes of 5% intervals.

TABLE XI. A Table to show the Breeding Capabilities of the Grand-Daughters of four Selected Morenish Stock Rams.

NUMBER of GRAND SIRE	GRAND SIRE'S PERCENTAGE of BARREN EWES	GRAND-DAUGHTERS at 2 YEARS OLD		GRAND-DAUGHTERS at 3 YEARS OLD		GRAND-DAUGHTERS at 4 YEARS and OLDER EWES		TOTAL AT ALL AGES	
		PREGNANT	BARREN	PREGNANT	BARREN	PREGNANT	BARREN	PREGNANT	BARREN
7	0	4	0	2	1	6	0	12	1
9x	24%	2	3	2	2	2	1	6	6
566	29%	5	0	1	0			6	0
568	23%	3	2	2	1			5	3

ed between 1 and 2 per cent in different years. Since barrenness is generally higher among primiparous ewes than in other sheep the figures for both two and three year old ewes have been shown separately from those for older ewes. Since seasonal differences are of importance the years of birth of the daughters are given. It will be noted that the variations due to the seasonal differences though considerable do not fall unduly heavily upon any one group. Percentages have been calculated only for such rams as have left stock-ewes, which could have lambed in the aggregate at least 24 times, (See TABLES IX and X). But it does not include all the daughters of these rams, since the smallest and those conforming least to breed type were sold as "shott" ewe lambs; in a good year about 25 per cent of the ewe lambs were sold, but more often it was necessary to ratain for stock a much larger proportion. Similarly some of the ewes were sold at 5 years old and some at six years old. Those ewes which had bred male lambs suitable for being kept as rams, and those which had bred good ewe lambs tending to be kept longest: but it was not the practice to cast any ewes because they were twice barren, in fact from this point of view a random selection of the females was kept whether they had been barren or not.

Another table (TABLE XI) gives the records of the granddaughters of the sires, with daughters having a record significantly distant from the average. Unfortunately however, the figures are too small to be significant/

TABLE XII. A table to show the Influence of season and age on the Fertility of the ewes.

Year of Birth of ewes	1923	1924	1925	1926	1927	1928	1929	1930	Total of the eight to six seasons.
Year of first lambing	1925	1926	1927	1928	1929	1930	1931	1932	
As 2-year olds	24P 3B 12%	61P 12B 16%	55P 19B 26%	70P 7B 9%	63P 13B 17%	56P 22B 28%	59P 23B 28%	51P 12B 19%	439P 111B 20%
As 3-year olds		19P 2B 10%	47P 17B 27%	56P 6B 10%	69P 4B 5%	56P 9B 14%	58P 11B 16%	56P 13B 19%	361P 62B 15%
As 4-year olds			41P 8B 15%	126P 8B 6%	136P 12B 8%	130P 11B 8%	100P 10B 9%	56P 7B 11%	589P 56B 9%
Ewes of all ages born in	1923	1924	1925	1926	1927	1928	1929	1930	
	84P 13B 13%	234P 37B 14%	247P 37B 13%	269P 22B 8%	219P 32B 13%	170P 40B 19%	115P 36B 24% (2-3yr. olds only)	51P 12B 19% (2yr. olds only)	1389P 229B 14%

Totals and Percentages for each year (ewes of all ages)	1925	1926	1927	1928	1929	1930	1931	1932	
	24P 3B 12% (2yrs.old only)	80P 14B 15% (2-3yrs. old only)	143P 44B 24%	252P 21B 8%	268P 23B 10%	242P 42B 15%	217P 44B 17%	163P 32B 16%	1389P 229B 14%

P. signifies Pregnant. B. Barren

significant. The small number of these figures may be partly accounted for by the fact that if the daughter is "yeld" she can have no progeny. Ram 566, for example, had one daughter yeld for her four possible breeding seasons.

In Appendix TABLE IIb. are shown the daughters of the rams which left few stock ewes. Three sons of 551 were used as ram lambs before being sold as "Shearlings", and another son of 551 was brought back as an old ram. 551's daughters had a barrenness figure of 14%, his sons have sired 14 stock ewes, which have been pregnant 25 times and barren 6, - 19%.

Five of 561's sons were used as ram lambs, they left 17 stock ewes who were pregnant 53 times and barren 7. 561's daughters had a barrenness figure of 11%, his granddaughters 12%.

One of 568's sons left two stock daughters, they were pregnant twice and barren twice.

TABLE XII shows the seasonal variations for two-year-old, three-year-old and over three-year-old ewes.

The significance of the figures for female progeny of the 15 rams, the combined breeding seasons of which totalled 24 or more, has been tested by the formula on page 89 of R. A. FISHER'S "Statistical Methods" (1932) 4th Edition: Corrections for the age of the daughters at their possible breeding seasons were made by halving the figures for barrenness in two-year-olds and by deducting 25 per cent from the figures for barrenness/

renness in three-year-olds. The chance is 20:1 against the varying proportions of barren daughters amongst the progeny of the different rams being due to random sampling.

Similarly, the figures for two-year-old daughters only, sired by rams who left 8 or more daughters, showed that the odds were about 15 to 1 against the fluctuations being obtained by chance.

It would seem therefore from these results that the number of fertile matings depends at least in part directly on the sires of the ewes. The daughters of four of the fifteen rams gave a markedly low figure for fertility and those of two rams a very high fertility figure. TABLE XII shows that the seasonal variation was insufficient to account for these results. This fertility-potentiality of the sire could not be associated with the face-colour. The sex ratio of reared lambs has been low, 100 females to 88 males - a fact which NICHOLS (1927a) noted to be usual among Blackface sheep, and which he suggests indicates lethal factors.

ORR and FRASER (1932) gives 33 per cent as the average number of barren, included aborted, ewes in 1929 - 30 on a farm in South Argyllshire, with artificial feeding on some of the hefts in the following year it was reduced, although it had increased on the unfed heft which had been the best in the previous year. NICHOLS (1924) gives the figures for barrenness for some four thousand Blackfaces as 5·9 per cent, with 1·1 per cent of abortions. On a farm which also carried Cheviots, NICHOLS (1927b) states that 5 per cent/

cent of the Blackfaces were barren from 1911 to 1924, excluding abortions and ewes which could not rear lambs, which were numerous.

MARSHALL (1905 and 1908) for East of Scotland hill flocks of Blackfaces and Cheviots in 1905 gives the percentage of barren ewes as under 1 to 7 per cent, and of aborted ewes as 1 to 5 per cent. The following year the figures for barrenness were 2 to 8 per cent, with 4 per cent the commonest figure: abortions were not numerous. In 1907 barrenness was rather less; with the exception of one Blackfaced flock where 16 per cent was barren; abortions were rather more numerous.

WHITE and ROBERTS (1927) dealing with the Welsh Mountain sheep for the season 1923 - 1924 gives the percentage of barren, including aborted ewes as 5·1% for mountain, 2·8% for intermediate, and 2·4% for low ground flocks.

HEAPE writing in 1899 but dealing principally with Lincoln and Down breeds, states that young ewes are more likely to abort under adverse weather conditions than old ewes, that sub-soil formation influences abortion and barrenness, that heavy rainfall is associated with a high incidence of abortion and barrenness, and that "stained"ground causes abortion. He also notes that the fertility of certain breeds is sufficiently marked to constitute a racial characteristic, and remarks that some breeds are more fertile when mated with another breed.

It should be noted that these figures quoted above represent barrenness from causes not necessarily dependent upon the influence of either sires or of dams, but rather on the influences exerted by both parents. No attempt was made, so far as the writer is aware, to assess male and female influences - genetic or otherwise - separately.

These figures suggest that barrenness in Scotland is not excessively prevalent in the East but increases in a Westerly direction, with Perthshire in an intermediate position.

CONCLUSIONS/

C O N C L U S I O N S.

GENERAL

Available evidence seems to show that the Scottish Blackface breed is not an indigenous breed of sheep in Scotland. It has been introduced from the south and has spread northwards. The breed has never become successfully established in Caithness and Sutherland: otherwise it has become the most numerous and important breed in the remaining mountainous parts of the country. It is probable that its characters have been influenced by crossing with the native "dun" - or with the "white-faced" sheep and the infusion of this and possibly other blood may explain in part the differing characters in various districts.

FLEECE CHARACTERS

The character of the fleece varies in different districts in Scotland: so much so that definite areas are associated with the production of various grades of Blackface wool required for tweeds, carpets mattresses and so on. The reasons for the difference between the fleeces of these districts are not obvious it is suggested however that there may be some areas where a larger amount of unimproved blood enters into the compositon of the sheep stocks than elsewhere and that parasitic infestation and variation in the mineral/

mineral and other content of the pasture may collectively or individually play a large part in this differentiation.

Climatic conditions per se do not appear to exert that considerable influence on fleece which is usually attributed to them.

CROSSING

The results of crossing with modern breeds of sheep has been considered and it seems evident that some of the characters are sex-linked, (for example the fleece characters of the Blackface x Gritstone.) Of the other crosses that with the Merino appears to be of the greatest interest, since increased density of fleece could still be demonstrated in the fourth generation of back-crossing to the Blackface. In practically all crosses rams of other breeds have been crossed with Blackface ewes. Crossing with Border Leicesters and Wensleydale are important commercial crosses, producing sheep, specially useful for the butcher.

FACE COLOUR.

The relationship between face-colour and various other factors has been considered, mainly from data accumulated on the writer's own farm in Perthshire/

Perthshire during the past ten years. These results indicate that breeders can, by selection of their stock, with due regard to face colour, improve commercially important points.

Sufficient data has been collected to show that by selection of the parents for face colours, a considerable proportion of the progeny will have those colours which this work has shown to be desirable, i.e. the extremes of face colour both black and white in ewes have been shown to be associated with lambs of inferior size and dead weights. That the face colour of the sire is important because it is shown that different colours are correlated with different degrees of hardiness in his lambs. It has been demonstrated that blackspotting in the fleece can be materially improved by using sires free from this fault and that black spotting and face colour are correlated.

FERTILITY.

It is shown that under a constant environment both high and low fertility is transmitted from the sire to his daughters and is characteristically exhibited by them subsequently. It has not however been possible to test whether females may transmit fertility factors to their sons, and only very limited figures are given to show the influence of rams on their/

their grand-daughters and on their sons, since only a few home-bred rams were used. Evidence is advanced which suggests potential economic importance of the influence of rams on the fertility of a Blackfaced breeding stock; for although the average for barrenness in this flock was 14%, one ram left daughters who were never barren, another ram's daughters only had a figure of 5% for barrenness, but four rams left daughters whose barrenness figures were 22%, 23%, 24% and 29%.

FLOCK RECORDING.

It is very evident that much valuable information on matters intimately concerned with breeding and inheritance under practical conditions is lost through the absence of a general system of marking and flock recording. The experience of marking and recording on which this work is based shows that the advantages gained compensate for the expenditure of such time and money as is involved.

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ILLUSTRATIONS.

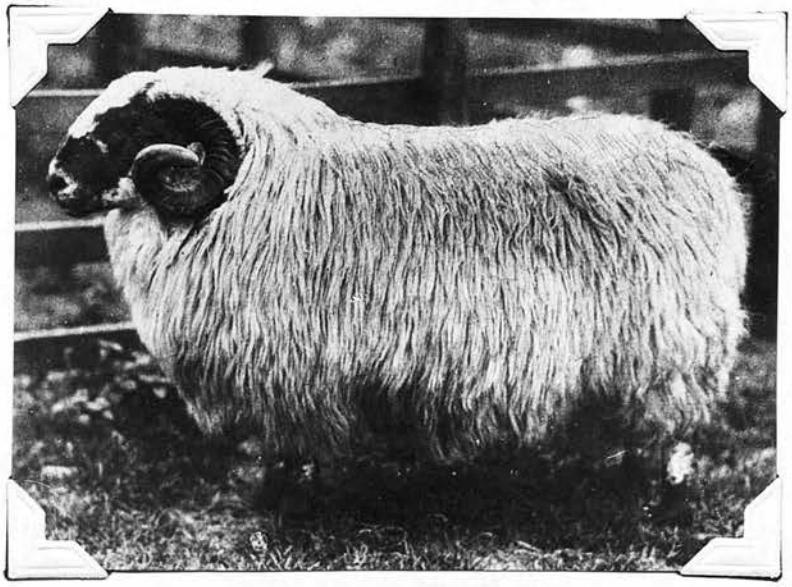

FIG. I. A typical Scottish Mountain Blackface Ram.

FIG. II. A typical ewe of the same breed.

FIG. III. Blackface wool from Wigtownshire, 0·6 original size.

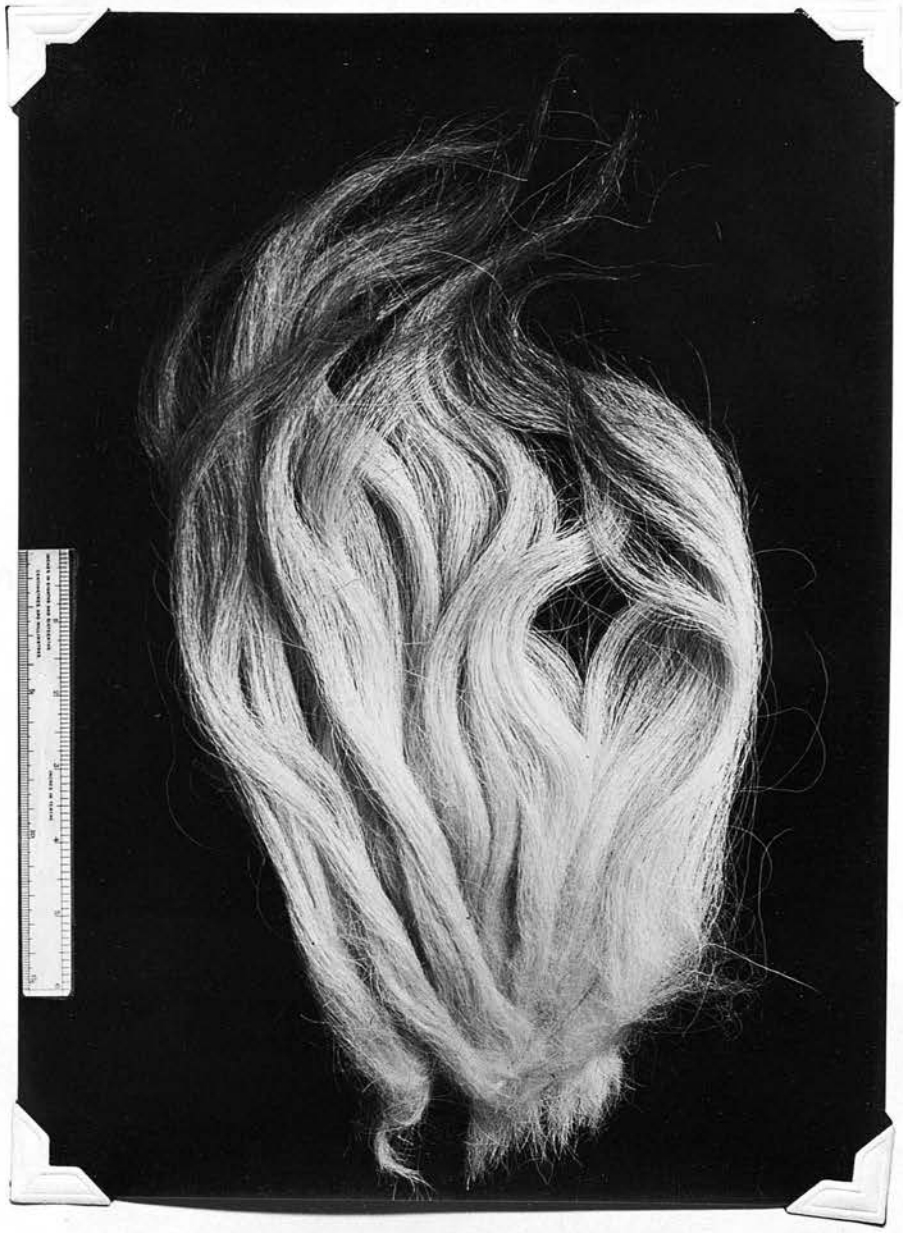

FIG. IV. Mattress type Blackface wool from Lanarkshire. 0·38 original size.

FIG. V. A Blackfaced ewe showing an excessive amount of 'muff' on the forehead and a 'mealy' nose.

FIG. VI. Another Blackfaced ewe with a typical amount of 'muff' and with a 'mealy' nose.

FIG. VII. A lamb of face colour Group A½
Note ear tag on near ear.

FIG. VIII. The above lamb fourteen months later.

FIG. IX. A lamb of face colour Group A1.

FIG. X. The above lamb fourteen months later.

FIG. XI. A lamb of face colour, Group A2.

FIG. XII. The above lamb fourteen months later.

FIG. XIII. A lamb of face colour Group A3.

FIG. XIV. The above lamb fourteen months later.

FIG. XV. A lamb of Face Colour Group A4.

FIG. XVI. The above lamb fourteen months later.

FIG. XVII. Another lamb of face colour Group A4.

FIG. XVIII. The above lamb fourteen months later.

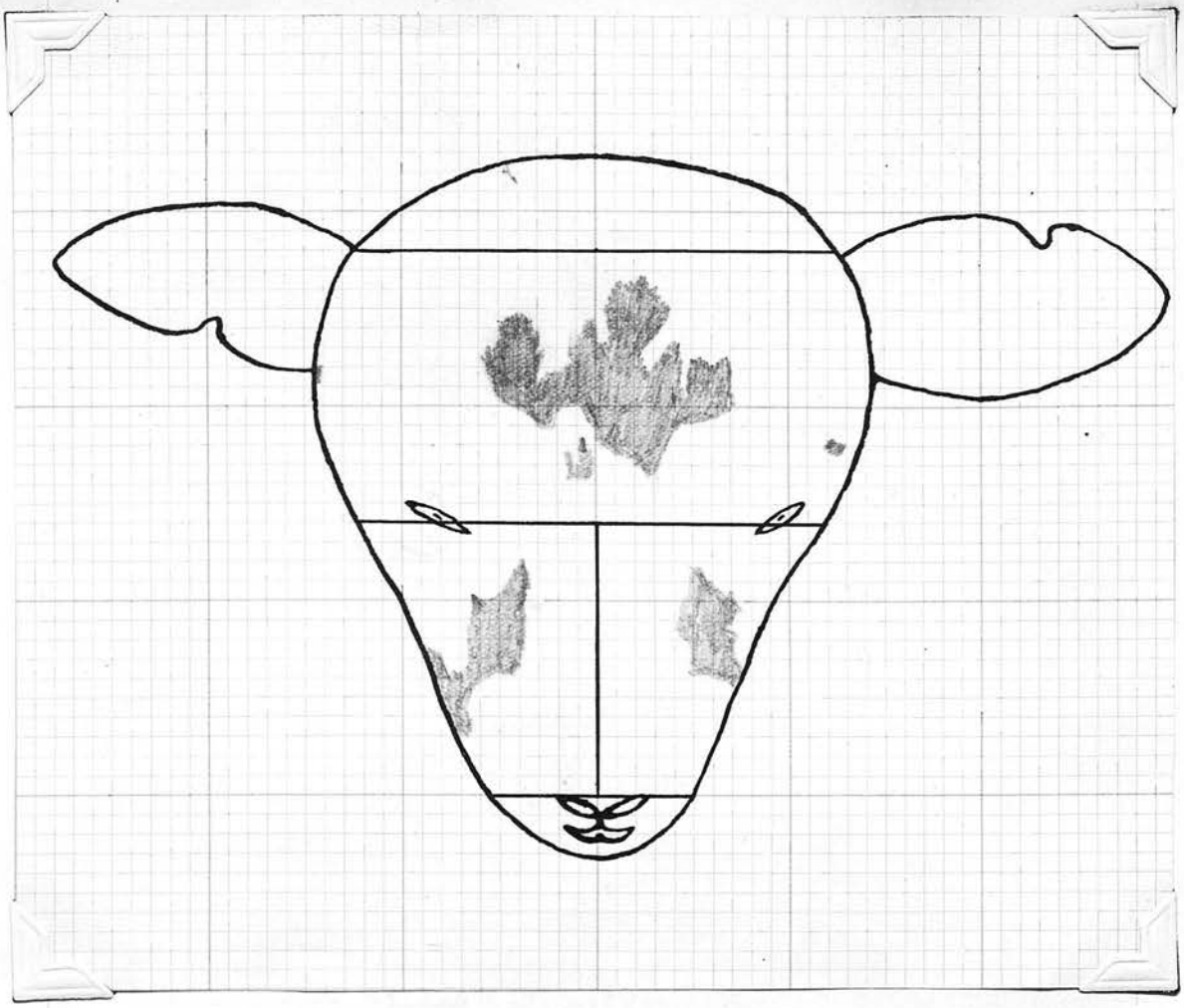

FIG. XIX. shows the negative of lamb K878 projected on to squared paper, the white areas being shaded.

The count for the forehead is $\frac{60}{380}$ equals 15·8%

" " " " lower face " $\frac{18}{125}$ and $\frac{12}{115}$ " 12·5%

" " " " whole of the face is $\frac{90}{620}$ " 14·52%

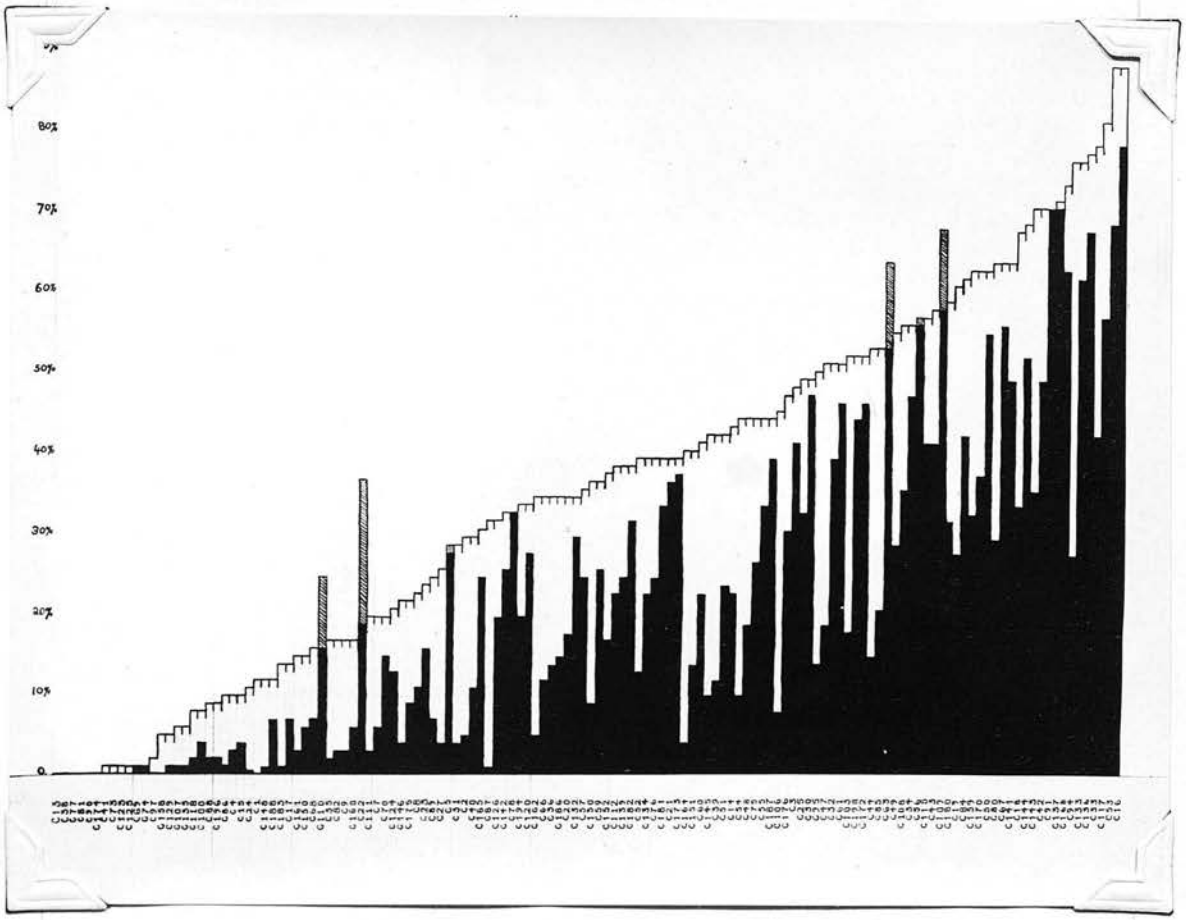

FIG. XX. A Histogram which shows the birth face colour of 136 lambs arranged in order from darkest to lightest, the percentage of white being indicated by the stepped line, the lambs' numbers are along the bottom. Their face colour at the end of their first summer is also shown as a percentage of white, indicated on the histogram by the solid black, and where it exceeded the birth percentage by the cross hatched column.

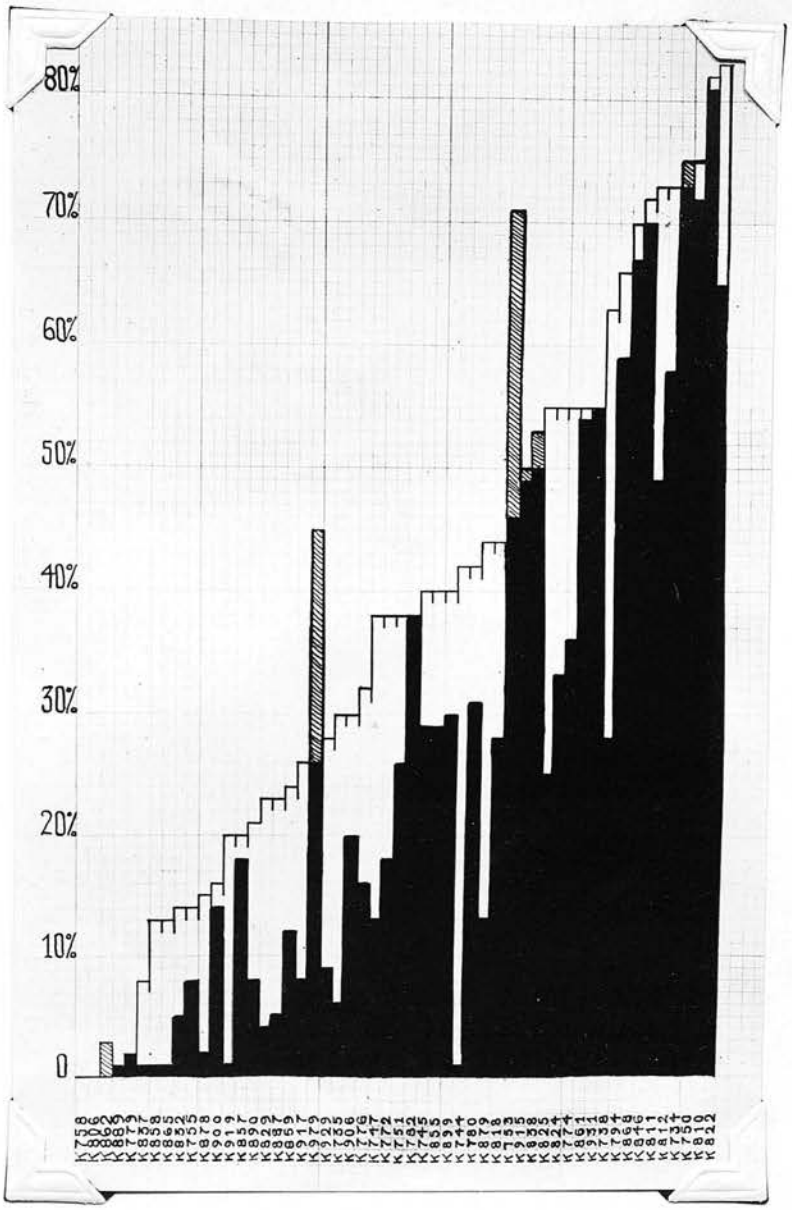

FIG. XXI. A histogram which shows the birth face colour of 53 lambs arranged in order from darkest to lightest, the percentage of white being indicated by the stepped line, the lambs' numbers are along the bottom. Their face colour at fourteen months old is also shown as a percentage of white, indicated on the histogram by the solid black, and where it exceeded the birth percentage by the cross-hatched column.

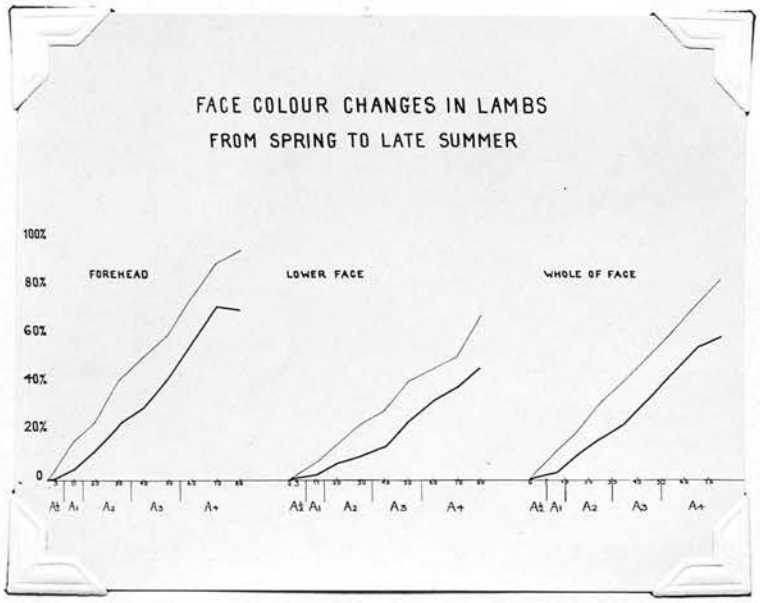

FIG. XXII. Illustrates the data given in TABLE I. The thinner lines are the birth percentage of white; the heavier lines the late summer percentages. The "whole of face" graph is from the same data as Histogram FIG. XX.

FIG. XXIII. A Blackfaced lamb some days old showing typical black spotting.

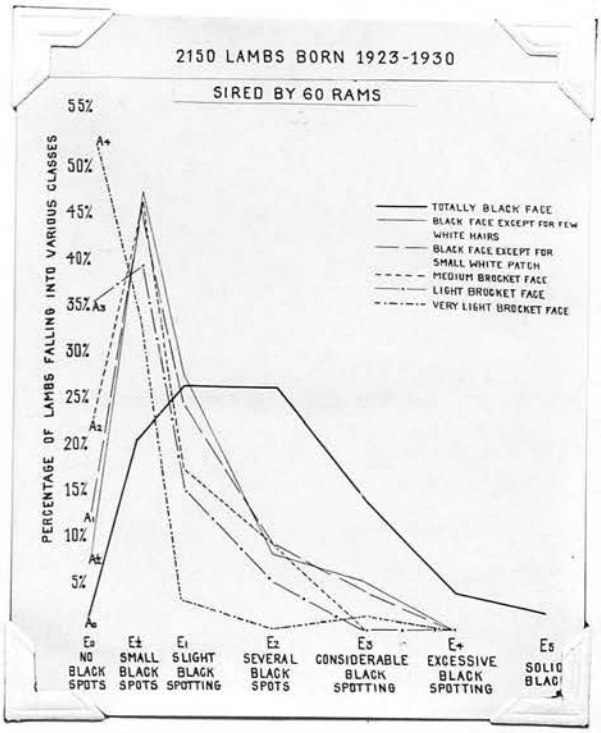

FIG. XXIV. Illustrates the data of TABLE IV. It will be seen that face colour and black spotting are correlated.

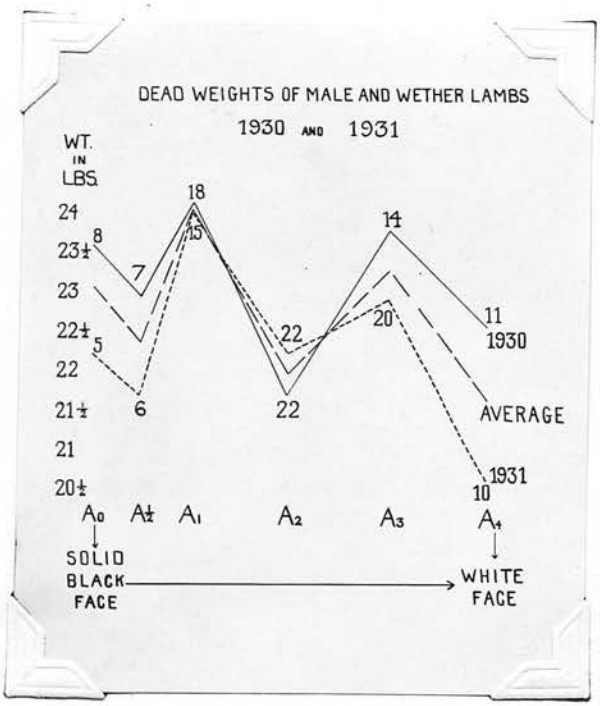

FIG. XXV. Illustrates the data of TABLE VI. The face colour groups of the lambs' dams are indicated along the bottom. The numbers indicate the number of lambs of each class.

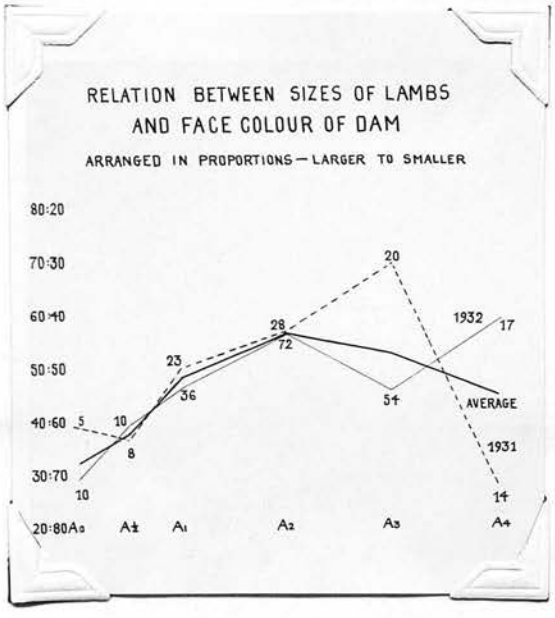

FIG. XXVI. This graph illustrates the tendency of ewes with extremes of face colour to produce smaller lambs than the average.

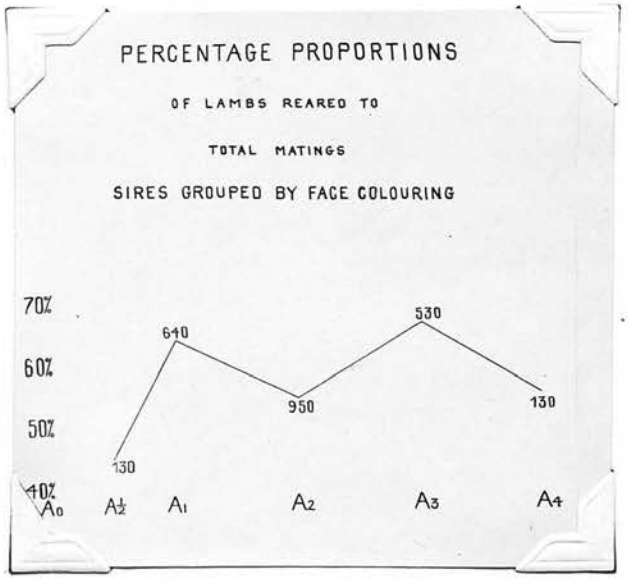

FIG. XXVII. Illustrates TABLE VIII. The numbers indicate the number of possible matings.

APPENDIX TABLES.

APPENDIX TABLE I.

1930. Dead-weights of Male and Wether Lambs, divided into groups according to Face-colour of dam.

Ao		$A\frac{1}{2}$		A1		A2		A3		A4	
lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.
29	15	27	4	28		28	8	31	5	25	12
27		25	4	27	14	26	2	29		25	
24	13	24		27	11	24	14	28	12	24	15
23		23	12	27	5	24	13	26	10	24	14
22	10	21	2	26	12	24	5	25	8	23	6
21	15	20	14	25	13	24	1	24	6	23	5
21	2	18	11	25	12	23	8	23	14	23	2
18	13			25	8	23		23	9	22	8
				24	10	22	10	22	7	20	6
				24	9	22	8	21	4	19	7
				24	5	22	1	20	14	16	11
				24	3	22		19	9		
				23	10	21	12	19			
				22	12	21	10	17	11		
				22	6	20	15				
				19	3	19	11				
				17	7	19					
				16	14	18	8				
						18	5				
						17	9				
						17	0				
						16	5				
Averages 23	$10\frac{1}{2}$	23		24	$2\frac{1}{2}$	21	$12\frac{1}{2}$	23	$13\frac{1}{2}$	22	$10\frac{3}{4}$

APPENDIX TABLE I (continued)

1931. Dead-weights of Male and wether Lambs, divided into groups according to face-colour of dam.

Ao		$A\frac{1}{2}$		A1		A2		A3		A4	
lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.
26	6	24	4	28	12	26	7	28	9	25	0
25	12	23	15	27	15	26		27	1	23	7
22	8	22	4	27	3	25	5	25	8	22	10
19	7	21	5	26	8	24	8	25	6	22	
17	6	19	14	26	5	24	2	24	13	20	7
		18	14	26	4	24	1	24	13	20	4
				26	1	24		24	9	18	12
				25	10	23	15	24	8	18	10
				22	14	23	4	24	2	18	2
				22	4	23	4	22	5	17	10
				21	9	22	14	22	3		
				20	12	22	4	22	2		
				20		21	9	22	1		
				19	10	21	9	21	9		
				19	8	21	5	21	9		
						20	13	21	3		
						19	15	20	10		
						19	13	20	5		
						19	11	18	14		
						19	2	17	9		
						18	8				
						17	13				
22	$4\frac{1}{2}$	21	12	24	$1\frac{1}{4}$	22	$4\frac{1}{2}$	22	$15\frac{3}{4}$	20	11

APPENDIX TABLE IIa.

A table to show the Fertility of the F_1 ♀♀ Sired by known Rams.

Sire	Year of Birth of Daughters	Number Barren more than once	Number of 2-year old ewes of which:-		Number of 3-year old ewes of which:-		Number of 4-year old ewes of which:-		Total at all ages		Percentage of Barren at:-			
			Pregnant	Barren	Pregnant	Barren	Pregnant	Barren	Pregnant	Barren	2yrs.	3yrs.	older	all ages
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(j)	(k)	(l)	(m)	(n)	(o)	(p)
7	1923	0	11	0	6	0	15	0	32	0				0
8	1923	1	5	2	5	1	13	1	23	4				15%
9	1923	2	8	1	8	1	13	7	29	9				24%
551	1924	1	14	5	14	3	29	2	57	10				
551	1925	2	12	6	15	0	37	5	64	11				
551	1926	1	16	1	14	2	24	4	54	7				
551	1927	0	12	2	12	0	20	1	44	3				
551	1928	1	14	3	15	1	14	0	43	4				
551	1929	3	8	4	6	5	-	-	14	9				
551	1924-29	8	76	21	76	11	124	12	276	44	21%	13%	9%	14%
552	1924	1	14	0	9	2	19	4	42	6				
552	1925	0	4	1	5	0	12	0	21	1				
552	1926	0	2	0	2	0	4	1	8	1				
552	1924-26	1	20	1	16	2	35	5	71	8	5%	11%	12%	10%
553	1924	0	17	1	10	4	30	1	57	6				
553	1925	2	11	5	12	2	20	3	43	10				
553	1924-25	2	28	6	22	6	50	4	100	16	18%	21%	7%	14%
554	1924	1	2	0	1	1	4	1	7	2				
554	1925	1	5	2	4	2	14	1	23	5				
554	1926	1	10	3	12	1	20	2	42	6				
554	1924-26	3	17	5	17	4	38	4	72	13	23%	19%	10%	15%
557	1924	1	5	1	4	2	12	0	21	3				
558	1924	1	5	4	6	3	21	0	32	7				
558	1925	0	6	0	5	0	12	0	23	0				
558	1924-25	1	11	4	11	3	33	0	55	7				11%

APPENDIX TABLE IIa (c0ntd.)

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(j)	(k)	(l)	(m)	(n)	(o)	(p)
561	1925	0	8	2	9	0	21	2	38	4				
561	1926	0	16	1	16	1	27	2	59	4				
561	1927	0	8	0	7	0	12	1	27	1				
561	1928	1	15	3	13	2	14	2	42	7				
561	1929	1	7	3	8	2	-	-	15	5				
561	1930	-	5	1	-	-	-	-	5	1				
561	1925-30	2	59	10	53	5	74	7	186	22	14%	9%	9%	11%
563	1925	2	9	1	3	2	17	1	31	4				
563	1926	0	6	1	6	0	15	0	27	1				
563	1927	1	12	2	12	0	16	2	40	4				
563	1928	0	8	0	5	3	5	1	18	4				
563	1929	0	9	3,	7	0	-	-	16	3				
563	1930	-	6	0					6	0				
563	1925-30	3	50	7	35	5	53	4	138	16	12%	12%	7%	10%
566	1927	1	6	1	4	2	9	3	19	6				
566	1928	1	2	5	5	1	4	0	11	6				
566	1927-28	2	8	6	9	3	13	3	30	12				29%
568	1927	2	10	4	7	5	21	1	38	10				
568	1928	1	5	3	5	2	5	2	15	7				
568	1929	0	6	1	3	1	-	-	9	2				
568	1927-29	3	21	8	15	8	26	3	62	19				23%
M899	1928	0	3	0	1	0	2	0	6	0				
M899	1929	0	12	0	10	1	-	-	22	1				
M899	1930	-	8	1	-	-	-	-	8	1				
M899	1928-30	0	23	1	11	1	2	0	36	2				5%
M890	1929	0	9	3	10	1	-	-	19	4				
M890	1930	-	8	2	-	-	-	-	8	2				
M890	1929-30	0	17	5	10	1	-	-	27	6				22%

APPENDIX TABLE IIb.

A table to show the Fertility of the F_1 ♀♀ Sired by known Rams.

Sire's No. or Name (a)	Year of Birth of Daughters (b)	Number barren more than once (c)	Number of 2-year old ewes of which:- pregnant (d)	barren (e)	Number of 3-year old ewes of which:- pregnant (f)	barren (g)	Number of 4-year old ewes of which:- pregnant (h)	barren (j)	Total at all ages pregnant (k)	barren (l)
M283,Son of 551	1927		1						1	
M285, " " 551	1927	1	3	2	4	1	4	1	11	4
K6 " " 551	1929		3		3				6	
M106, " " 551	1930		7	2					7	2
G	1925			1	1		3		4	1
G	1926		2		1		2		5	
G	1925-26		2	1	2		5		9	1
555	1924		3		1	2	6		10	2
556	1924		1	1	2		5		8	1
825,Son of 561	1926		2		2		4	1	8	1
835, " " "	1926		3	1	4		8		15	1
840, " " "	1926		3		3		7		13	
M282,Son of 561	1927		4	1	4		7	1	15	2
K10, " " "	1929		1	2	1	1			2	3
562	1925			1						1
565	1926		2		2		4		8	
564	1926		4		3		6	1	13	1
C	1926		4		4		9		17	
567	1927		4		3		4		11	
569	1927		3	1	3	1	7		13	2
M654,Son of 568	1928			2	1		1		2	2
M897	1928	1	2	3	4	1	4		10	4
M896	1928		4	2	6		4	1	14	3
M895	1928	1	2	1	2	1	2	1	6	3
M894	1928		1		1		1		3	
M893	1929	1	3	4	5	2			8	6
M891	1929		1	3	3				4	3
M891	1930		4						4	
M891	1929-30		5	3	3				8	3
M889	1930		1						1	
M888	1930		6	1					6	1
M887	1930		4	3					4	3
M886	1930		2	2					2	2