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# Infertility in Rams

W. MAURICE WEBSTER, Massey Agricultural College,  
Palmerston North.

## INTRODUCTION

The problem of infertility in rams is not a new one. That individual rams may be infertile or show only a low level of fertility has always been recognised by stud masters who practise individual matings either on a hand-service basis or in the paddock. On the other hand the rank and file of sheep-farmers have only begun to become aware of the fact. This is easily understandable since the husbandry methods adopted, whereby 2% to 2.5% of rams are turned out with large mobs of ewes, coupled with the polygamous habits of the species have together effectively masked unsatisfactory results of individual rams. Naturally too, the stud masters whose business it is to supply the rams required by commercial flocks have done nothing to publicise the infertility problem. Nevertheless stud breeders themselves have long been keenly alive to the problem and have brought individual cases to my notice and sought advice over the past 20 years. Indeed, some 15 years ago, the New Zealand Romney Marsh Sheep Breeders Association provided very substantial funds towards an investigation of the problem.

To-day, as primary producers are becoming fully conscious of their vital role in world economy, they are making ever increasing demands for expert advice and assistance towards improved production methods. Sheep men in particular are seeking ways and means of increasing the efficiency of their flocks and have awakened to the fact that a check on ram fertility is one important means of increasing their lambing percentages. Such a check-up calls for expert veterinary advice and the provision of such a service is a new avenue through which we as a profession can make a worthwhile contribution towards solving the problem of the world shortage of high quality protein food. The problem is undoubtedly a major one. My own work together with Crawford's very extensive surveys in the Gisborne district indicate that between 10% and 15% of all flock rams are infertile. Gunn and co-workers (1942) report a figure in excess of 10% over a series of 9000 rams examined in Australia. The official Annual Sheep Returns for New Zealand (1948) show that there are approximately 556,000 breeding rams in the Dominion of which it may be assumed therefore, 55,000 are useless passengers who do not pay their way. Admittedly there are still important gaps in our knowledge but sufficient critical factual data have accumulated over the years to enable us to offer valuable advice to sheep-farmers.

In this paper I propose to review briefly the various factors which have been shown to influence the fertility of rams and to deal rather more fully with those particular aspects which seem of major importance under New Zealand conditions.

## General Physiological Considerations.

Sex physiology in the male has been investigated much more extensively in the bovine than in other species and the modern trend is to base fertility appraisal mainly upon biochemical tests together with a morphological examination of the semen and to pay relatively little attention to the careful clinical examination of the sex organs—an angle to which earlier workers attached great importance. This policy is probably justified in the bull since experience has shown that unfavourable clinical findings coincide with unsatisfactory semen and seems to work well in practice. Sheep are a related species and the ram closely resembles the bull in general anatomical structure of the reproductive organs, in sexual behaviour and in the physical, bio-chemical and morphological properties of its semen. There is however one important difference

which must never be lost sight of, viz:—that the bull is an all-the-year-round breeder with little seasonal variation in sexual activity or in the quantity and quality of semen output, whereas the ram is a strictly seasonal breeder exhibiting marked libido and high fertility during the mating season but showing little sex interest and a marked reduction in spermatogenic activity for the remainder of the year. This is reflected in reduced libido and the production of scanty ejaculates with poor morphological and bio-chemical characteristics during the off-season. During this same period fertile rams undergo a strictly physiological involution of spermatogenic tissue in the testicles which show an overall reduction in size accompanied by a marked flabbiness and loss of tone on palpation. With the onset of the next breeding season as the testicles resume spermatogenic activity they again increase in size and re-acquire the turgid springy tone associated with the production of good quality semen.

In the bull on the other hand, whilst poor testicular development and lack of tone are similarly reflected in the inferior quality of the ejaculate, such clinical findings almost invariably indicate one of two things—either an irreversible pathological degeneration or a state of congenital hypoplasia, neither of which is likely to show subsequent improvement. It must not be inferred from the above that rams never show evidence of pathological degeneration or hypoplasia since such is not the case. Conversely, bulls may on occasions suffer from physiological testicular involution associated with temporary debility.

As a general rule identical methods of semen appraisal are applicable to both bull and ram but whereas a poor result in the bull usually justifies an unfavourable prognosis, a similar result in a ram justifies no expression of opinion unless the season of the year and the results of a careful clinical examination of the testicles are taken into consideration at the same time.

### **Breed and Heredity.**

The question is often asked as to whether rams of one breed are more prone to infertility than others. Whilst I have met with infertility in all breeds I would answer without hesitation that it is my experience that the New Zealand Romney is more prone to this defect than any other breed in the Dominion. Whilst it has proved relatively easy to obtain factual data in support of the foregoing statement it is by no means so straight-forward a task to determine the underlying root causes. The possible role of heredity immediately comes to mind but evidence has not proved readily forthcoming. It is of course a well accepted fact that shy-breeding strains have made their appearance in many different pure breeds of livestock—particularly in cattle, horses and pigs, and it seems reasonable to assume that a similar situation is likely to obtain in sheep. To demonstrate the existence of such a lethal factor in New Zealand sheep has proved very difficult. Stud breeders are notoriously secretive and in addition, their records are usually inadequate to trace such lines, should they exist. However, thanks to information supplied by one or two breeder friends with better than average records, one is justified in stating that such blood lines have occurred in this Dominion. Since lethal genes are automatically self limiting the chances are that shy breeding strains do not make a very large or important contribution to the whole infertility pattern.

I am not a geneticist and may be treading on controversial ground in my next consideration—viz: that vexed term “constitution”—so widely used by breeders and yet always defying precise definition. I offer my own definition as follows:—“Constitution implies the summation of all those inherited characteristics within an individual which by their interactions render that individual more efficient in

coping with the particular environment in which its ancestors evolved." In this sense it is their peculiar constitution which enables the Scottish or Welsh mountain breeds to thrive in an environment in which the Southdown would quickly perish, and the Merino to flourish where the Romney fails to adapt itself. The word "constitution" as commonly applied to stock in a general sense is, I maintain, a meaningless term but if used in relation to a particular environment maybe very significant. I believe that constitution in the foregoing sense is a very important factor in ram fertility. To stress the limited definition I will briefly quote an experiment we have had under way for some years at Massey College. This experiment is a comparative trial of two breeds of sheep—Romneys and Cheviots—on poor exposed hill country, run under similar conditions. On this basis the Cheviots have proved decidedly superior to the Romneys on the hills. Last year the combined flock of several hundred lambs was brought down from the hills for fattening off on the lowland flats on a rich certified rye-white clover pasture. Within 48 hours five Cheviot lambs died from acute tympany and when the flock as a whole was examined it was noted that over two-thirds of the Cheviot lambs were showing varying degrees of bloating whereas not a single Romney lamb was affected. The Cheviots as a whole, checked noticeably with the change of pasture and it was about a fortnight before they accommodated themselves to the rich succulent feed but the Romney lambs thrive and went ahead from the first. Thus each breed showed itself constitutionally superior in that particular environment in which its ancestors evolved.

Great Britain and New Zealand are very similar in many respects. Both have a temperate kindly climate but with wide variations in soil types, rainfall and altitude within a small area. Great Britain has evolved numerous local breeds of sheep—each constitutionally adapted to and therefore superior within its own environment. In New Zealand we have, at least in the North Island, tended to the other extreme and tried to adapt one breed—the Romney—to all extremes of altitude, climate and soil until to-day this breed reigns supreme "monarch of all he surveys from the mountains right down to the sea." Personally I have doubts as to whether all the multiplicity of breeds in Great Britain is wholly necessary or desirable, but they can be broadly grouped into several distinctive types such as the hill and mountain breeds adapted to a wet bleak climate and poor hill grazing; lowland types adapted to better pastures and a drier climate, and marshland sheep adapted to rich grazing under exposed conditions. The living organism is said to be almost infinitely adaptable and versatile and the Romney breed has certainly proved to be so, but there is a limit to everything and I believe we have asked too much of even the Romney (ewes as well as rams) in expecting them to entirely adapt themselves to much of the more rigorous hill country of the North Island. Therein possibly lies the real answer to much of the infertility problem of the poorer back country. This situation cannot be altered in a day and whilst we may preach the doctrine of a greater diversity of breeds constitutionally better adapted to a poorer hill country environment we must at the same time adopt a realist attitude and consider what can be done to ameliorate the situation as it exists.

One might explore other genetic possibilities but there is at least one direction in which I now feel sure that, over the years, Romney breeders have all unwittingly laid a rod in pickle for themselves. I refer to their policy of "Covering up the points", i.e. concentration on getting as heavy a wool growth as possible on face, legs right down to the hoof, and scrotum. As a result the modern Romney ram, instead of fine hair, has a scrotal covering of heavy fleece wool. I know of no other breed, save the Merino, with a similarly heavy wool growth over the scrotum—and note that it is a recent development of the present century. If one glances at the illustrations of Romney Marsh sheep in any of the older

books on breeds of livestock one sees the rams depicted with bare legs and a bare scrotum. Dry's work on selective breeding of pure Romneys for reversion to ancestral type is interesting in that one of the first modern refinements to disappear is the wool from legs and scrotum.

Crew (1922) first observed the thermo-regulatory function of the scrotum and the researches of Phillips and McKenzie (1934) clearly showed that normal spermatogenesis requires a temperature slightly lower than that of the body proper and that scrotal insulation, thus raising testicular temperature to body level, brought about a rapid degeneration of the germinal epithelial elements in the seminiferous tubules which was reflected in reduced and abnormal spermatogenesis. This effect on fertility is rapidly produced but regeneration is a relatively slow process. If insulation is maintained for any length of time the degenerative changes become irreversible.

Gunn and co-workers (1942) made a notable contribution to our knowledge. They showed, by confining rams in a heat and humidity controlled room, that exposure to hot summer conditions such as obtain in sub-tropical regions may in itself produce the same ill effects as scrotal insulation. They related their experimental findings to the field conditions which obtain in the hotter parts of Australia and established a co-relation between seasonal weather conditions and fertility. American and other workers have reported similar results and it is now well established that high summer temperatures exercise an unfavourable influence on spermatogenesis. The latter only becomes normal (i.e. fertile semen is produced) at lower temperature levels which enable the thermo-regulatory mechanism to function efficiently.

It appears quite conceivable therefore that in their pursuit of the policy of covering the points Romney breeders in New Zealand have evolved a natural scrotal insulation sufficient to interfere with normal spermatogenesis at such times as the animal is carrying any appreciable growth of wool. In order to explore the thesis of natural scrotal insulation I planned an experiment on a group of 30 Romney rams. All were shorn early in September and when the experiment began immediately prior to the breeding season in the following March they were carrying fairly heavy fleeces representing seven months growth. The rams were already divided into four groups containing six, six eight and ten individuals respectively which were the subject of contrasting systems of management and nutrition. Half the rams in each group were taken at random and given an exaggerated crutching. The scrotum in particular was very closely shorn by hand and all wool was removed from belly and thighs as well by machines. Using three different criteria—viz:—conception rate to artificial insemination; pH changes in the semen under standard storage conditions, and sperm morphology, there proved to be highly significant statistical differences in favour of scrotal ventilation. There were also notable differences discernible on palpation of the testicles. The crutched group with three exceptions had large testicles showing excellent tone whilst the fifteen woolly rams with one exception had smaller testicles, flabby and lacking in tone.

Since the effects of crutching form only a part of the experimental pattern, a more exact measure of its true influence is afforded by an analysis of variance thus making allowance for the interaction due to the other variables introduced by difference in management and nutrition. On this basis too the pH differences in favour of crutching were shown to be highly significant.

It may be accepted therefore that a heavily woolled scrotum provides sufficient natural insulation of the testicles to interfere with normal spermatogenesis in Romney rams and that improved ventilation stimulates the germinal epithelium resulting in a higher fertility level. Field trials have confirmed these experimental findings and there seems

little doubt that the universal adoption of midsummer shearing in warmer districts or an exaggerated crutching on the lines already indicated in the colder and more changeable areas will result in an all-over improvement in the fertility level of rams. This in turn means a more concentrated lambing and a higher lambing percentage.

### pH as a Fertility Index.

Before going further it is necessary to briefly outline the interpretation of pH readings in the appraisal of fertility. An understanding of this is essential in order to appreciate the significance of much that follows later in this paper. My interest in this aspect of fertility appraisal is of long standing and it is almost 20 years since I first drew attention to the relationship between the pH of semen and fertility (Webster 1932). Much work has been done since then and the mechanism is fully understood. Briefly it is as follows:—Fresh semen always contains appreciable amounts of reducing substances—fructose and glucose—derived from the accessory gland secretions. The latter are alkaline in reaction whereas epididymal sperm is acid. An acid environment inhibits sperm motility which would result in a useless dissipation of energy if it occurred within the epididymis. On the other hand an alkaline environment stimulates intense activity in viable sperm. Thus the admixture of alkaline accessory secretions during ejaculation provides the stimulus to intense activity and simultaneously readily reducible sugars as a source of energy. In passing it may be noted that the oestral secretions of the female reproductive tract are also alkaline and thus continue to provide an activity environment. Semen from a fertile male contains a high count of active spermatozoa and the combined effect of their metabolic activity is seen in a rapid fall of the pH during storage as the sugars are being converted to lactic acid—the conversion being essentially an anaerobic one. Walton's work at Cambridge has shown that a certain small amount of sperm respiration does occur with absorption of oxygen and production of carbon dioxide but this is relatively unimportant compared with the acid conversion of sugar. The amount of sugars normally found in fresh semen varies within wide limits as between species. It is highest in the ram where it may approach 1% and the bull comes next. In those species producing a large volume of semen with a relatively low sperm concentration it is much lower.

The average initial sugar content in 35 fertile ram semen samples we found to be 827 mgm. per 100 c.c. (range 447 to 1096 mgm.). In 37 infertile specimens the mean was 522 mgm. per 100 c.c. The initial lactate content in sixteen fertile samples averaged 126 mgm. per 100 c.c. (range 72 to 181 mgm.). Thirty minutes anaerobic incubation of fertile semen at a temperature of 90 degrees F. gave an average sugar loss of 156 mgm. (range 118 to 205 mgm.) and corresponding lactate gain of 128 mgm. per 100 c.c. (range 117 to 131 mgm.). With six specimens from sterile rams the average sugar loss on similar incubation was 23.7 mgm. per 100 c.c. (range 8 to 48 mgm.) and lactate gain 14.4 mgm. (range 7 to 23 mgm.).

Thus in fertile semen there is a large and rapid loss of sugars and over three-quarters of that loss is accounted for by an increase in lactic acid. In terms of pH change the same fertile samples had an average initial pH (measured within 2 to 3 minutes of ejaculation) of 7.1 (range 7.05 to 7.39) and a mean value after 30 minutes incubation at 90 degrees F. of pH 6.51. This represents a mean difference of 0.68 of a pH unit, or for convenience of express, an "acid swing" of 68 points. Conversely, semen from sterile rams under similar conditions gives a very small acid swing which seldom exceeds 10 to 20 points. After some hundreds of tests we decided on an arbitrary rule that an acid swing of 50 points or more after 30 minutes anaerobic incubation at 90 degrees F. indicated good fertility, 30 to 50 points fair and less than 30 poor to sterile.

Since the acid swing in any given sample represents the summation of the metabolic activities of the individual living sperms it is obvious that the higher the sperm count the greater the swing. Thus 30 samples from fertile rams with counts ranging between  $2\frac{1}{2}$  and 3 million per cubic millimetre gave an average swing of 50 points and 18 samples with counts between 4 and  $4\frac{1}{2}$  million had an average swing of 63 points. Since the average count in fertile rams usually lies between  $2\frac{1}{2}$  and  $3\frac{1}{2}$  million and rarely falls below 2 million the error is relatively unimportant and not likely to lead to false conclusions.

It is on the basis of the foregoing data that we have developed a ram fertility testing outfit for use in the field by breeders and others. A sample of semen is collected in an artificial vagina and immediately transferred to a small test-tube, covered with a layer of liquid paraffin and placed in a thermos flask of warm water (90 degrees F.) for 30 minutes. A drop of the incubated semen is then placed on a white tile and mixed with a drop of B.D.H. Universal Indicator which has a colour range from blue-green at pH 8.0 to grass-green at pH 7.25 through shades of yellow (pH 7.0-6.0), thence through orange to brick red (pH 5.0.). The initial pH of infertile semen almost invariably gives a blue-green colour with little or no change on incubation (c.f. Table II). Semen from high fertility or low fertility rams both give an initial pure green colour which in the case of the former changes to orange-yellow after 30 minutes incubation whilst the latter gives a greenish-yellow test. In the field test outfit the resultant colour is matched against a standard colour chart from which the diagnosis—"Fertile," "Doubtful low fertility" or "Sterile" is read off directly.

### Effect of Flushing.

Flushing is a term used by sheep men to indicate the response of their sheep to the combined stimuli of shorter days, cooler temperature and improved pasturage following autumn rains. In the ewe the effects are signalled by the onset of regular oestrus cycles after the anoestrus interim during spring and summer. In the ram the flush is real as well as figurative. Outwardly it is marked by a general hyperaemia of the skin—particularly of the serotum and inner thigh which turn a livid purplish red. This is the outward and visible sign of renewed activity within the testicles which, as spermatogenesis is resumed, increase in size and become tense and turgid to feel. Once rams have flushed, libido becomes much more marked and if they have not access to the ewes they will be observed frequently mounting one another in efforts to copulate.

Few sheep farmers are prepared to question the benefit of flushing ewes on better feed in order to secure an earlier and more concentrated mating (and consequently lambing) together with a higher proportion of twins. Most authorities on sheep husbandry also subscribe to this view although recent American work has denied its value—personally however I believe their experimental technique is at fault.

On the other hand there is little unanimity of opinion regarding the possible benefit derived from flushing rams on better feed prior to the opening of the breeding season. In replies to a questionnaire addressed to sheep breeders most men on flat better class country queried any beneficial effect but a considerable number of hill country farmers expressed themselves in favour of the practice. I believe both points of view may be correct in the particular circumstances. On the richer lowland pastures nutritional conditions are more or less optimum and the shortening days and cooler temperatures as the sun declines from its midsummer zenith provide the necessary stimulus, whereas on poorer hill grazings an improved plane of nutrition may act as the trigger to touch off the reaction.

I have made several observations in connection with flushing which seem particularly important in relation to the fertility problem. Firstly, that rams when once physiologically flushed are highly susceptible to any environmental change, usually but not always of an unfavourable nature.

Their reaction is in the nature of a spermatogenic regression resulting in temporary or, in extreme instances, permanent infertility. Things such as a change of climate or of feed, a slight attack of foot-rot, late dipping, even a sudden cold snap of weather, will suffice to put rams immediately "off the boil." Ewes on the other hand, once they have started their seasonal oestrus cycles seem very little affected by environmental change and only a major illness such as a photosensitisation outbreak suffices to break the cyclic rhythm.

I have known any one of the environmental changes listed above to change the acid swing from 50-60 points to 10-15 points and the morphology from 1-2% total abnormality to counts ranging from 33% to 66% abnormal sperms within 24 hours—and note—these drastic changes occur not in rare isolated instances of highly susceptible individuals but comparatively frequently in whole groups of rams. I shall cite specific examples later, at this stage I merely want to emphasise as strongly as possible that great care is necessary in the management of physiologically flushed rams otherwise their fertility is readily upset, whereas considerable liberties can be taken with ewes.

In the second place it is important to realise that ewes and rams, even in the same environment, do not necessarily react simultaneously to the stimuli which produce the seasonal sexual flush. Here in New Zealand with our kindly climate and regular seasons we are apt to think of sheep breeding purely in terms of the calendar and expediency born of managerial experience. In other words we turn the rams with the ewes on a given date—say 10th March—and anticipate our lamb crop five months later. Under local conditions this arbitrary rule generally works, but not always. In other countries where climatic extremes may be wider and seasons much more unpredictable it is well recognised that the sexual season in sheep is conditioned not so much by the calendar as by feed conditions in preceding weeks or months. Gunn and co-workers (1942) found in Australia that the breeding season was not only variable, but could be forecast with some degree of accuracy. Its onset being conditioned by generous rains terminating a drought period. Similar departures from the New Zealand calendar rhythm do occur sometimes but we are apt to overlook the fact. Our regular date for joining the rams at Massey is March 12th and as a rule our mating data conform to expectations, i.e. nearly 100% of the ewes have taken the ram within the first three weeks. One year however this did not happen. Inspection showed that in early March the rams were fully flushed and sexually vigorous. However by the end of the month only quarter of my experimental flock of 600 ewes had taken the ram and only 32 conceived. It was only towards the end of the second cycle, i.e. about the 10th April that the ewes began to come on season in numbers. When they did so it was at the rate of 70 to 80 per day for a short period instead of the normal expectation of about 35 per day (1/17 of 600). This was not an isolated instance as a similar situation obtained in a number of local studs. There is a moral to be drawn from this experience—viz., it is not always the rams' fault when reports come to hand that they have been out for a month but are not working. In cases such as I have quoted the cause was quite clearly lack of opportunity rather than desire.

The next example illustrates the reverse situation. A prominent stud breeder who made a practice of raddling his rams on the brisket reported that his rams had been joined with the ewes for nearly a month and that every ewe was returning to service (the raddle colour was changed on the eighteenth day). He asked for a ram testing outfit. Two days later he rang again to report that he had tested eight rams and every one gave a "blue" colour. I visited the stud on the following day and examined the rams myself. On clinical examination I found a general absence of skin flush and lack of testicular tone was obvious. None of the rams seemed particularly keen but ejaculations were collected from 14 rams, a further 4 refused service and 5 were not tried for lack of

time. The semen samples obtained were examined microscopically on the spot in addition to pH testing. Of the 14 samples only one gave a good acid swing. This specimen had good volume and a high count of vigorous sperm with good morphology. The second ram gave good volume but a very moderate acid swing. Microscopically his semen had a high count and good morphology but only about 50% per cent of the sperm actively motile. The remaining 12 rams gave ejaculations aptly described as "a few drops of dirty water." There was no appreciable acid swing and microscopic examination in every case showed a low count of dead or feebly motile sperm mixed with cellular debris. Inspection of the ewe flock showed practically every ewe marked with the first colour and about half of them with the second. Two things were therefore obvious; one that the ewes were coming normally into season; two that the rams had all been working. The stud in question lies on the sandy coastal belt and the autumn had been particularly dry. There was no shortage of feed or water but the pasture was burnt brown without a green blade to be seen. I advised that all the rams be withdrawn except the two specially mentioned above and placed on the only green feed available on the farm—an area of young lucerne aftermath following a late hay-cut. They were allowed a run-off on to an adjoining grass paddock. I arranged for a second test a fortnight later. On this occasion 21 rams were tested of which 15 gave excellent results, 3 were in the doubtful category and 3 still infertile. The remaining 2 rams refused service. The 15 rams giving good semen showed a remarkable improvement in testicular tone and some visible flush. Of the two rams left with the ewes after the first visit one was classed among the 3 infertile whilst the second was one of the two which refused service. The 15 good rams were immediately returned to the ewe paddocks whilst the unsatisfactory ones were left on the lucerne for a further spell. From this date onwards the ewes began to settle without further trouble. The owner is an experienced breeder who does his stock well but never forces them on concentrates. Although he himself had not noticed the fact I think it probable that seasonal conditions in the earlier part of the year had been such as to precipitate a premature flush in the rams. This would account for their nearly normal libido, whilst the subsequent hot dry spell had temporarily disturbed normal spermatogenesis. Whatever the primary cause the result of a fortnight's flushing on green lucerne were certainly spectacular.

A second similar instance occurred in another stud. In this case the breeder made a regular practice of feeding a small concentrate ration to his rams from the New Year onwards. In the season in question the early summer was dry and the pastures browned-off early. Over the holiday period heavy rains fell and as a result the New Year produced an excellent growth of lush pasture. The combined effect of this fresh grazing plus the concentrates produced a full flush of the rams by mid-January. The breeder, alarmed at this premature conditioning of his rams withdrew the concentrate ration and simultaneously midsummer heat and another dry spell quickly burnt up the pastures once more. This provided a nutritional check to put all the rams "off the boil" by the time breeding operations commenced in March. As in the previous instance 18 rams out of 20 proved infertile on test and were withdrawn from the ewes and placed on young clover and the concentrate ration resumed. Within a fortnight all was well on this stud also.

I have quoted these two cases in some detail because I believe they almost certainly provide the key to the major cause of ram infertility. My experience over the years has been chiefly amongst stud rams where individual breeding records are known. It is no exaggeration to say that among the many instances to come under notice, for every infertile ram born and bred on the premises at least 10 prove to be importations from another stud. More particularly does infertility occur among rams imported from another district with a different climate. Whilst for instance, Wairarapa breeders may inter-change rams among themselves

with more or less impunity, one meets with numbers of Wairarapa bred rams which prove unsatisfactory when brought over to the West Coast district. Similarly West Coast breeders inter-change safely among themselves but are very prone to get complaints about rams sold to Hawke's Bay and Poverty Bay on the East Coast.

The ram market is keenly competitive. Most of the studs are situated in the best favoured districts in the country. Young stock are done as well as possible, the yearling rams are shorn early in August in order that they will carry an impressive fleece by the time the main sales are made in the following January. In preparation for the spring shows and January sales they are done particularly well and most breeders feed a concentrate ration during the summer. The net result is that most two-tooth rams come to the sale ring over fat and in soft condition, carrying a heavy fleece and they are prematurely flushed to breeding condition of deliberate intent since a well-developed pair of testicles is an obvious selling point. This system probably works reasonably well as far as the top rams are concerned. These realise high prices to other breeders and arrive in the new quarters to conditions similar to those of their original home in every respect, save perhaps climate. A dry bracing east coast environment may be exchanged for the relaxing and more humid west coast, or vice versa. There is abundant evidence that such a climatic change is often sufficient to upset the physiological rhythm of the sexual season. Such being the case what is the position with the rest of the breeders' lines of rams which are sold for flock purposes to the ordinary sheep farmer at a lower price range? They have been equally pampered in their home paddocks but in their new quarters they may face a change of climate but they certainly will meet a completely new environment, no concentrates, a poorer and drier type of pasture and as a rule the necessity of working for their meals by climbing the hills. In practice provided the change is not to extreme most rams will lose their flush and become infertile for a period but recover later in the season as the weather becomes cooler and the feed freshens with the autumn rains. In some instances fertility is not renewed until the following year. Thus it is not uncommon for stud breeders to purchase a two-tooth ram which proves infertile in its first season but a reliable breeder in subsequent years. When the change is a drastic one—say from the lush green pastures of the Feilding district to the drought stricken hills of Hawke's Bay in a dry season—I have seen whole lines of two-tooth rams rendered permanently sterile within a month or six weeks of arrival at their new domicile before they ever had a chance to serve a ewe. Susceptibility varies from individual to individual and under average conditions only the more susceptible rams in a bought-in line will react sufficiently to become permanently sterile whilst the remainder may or may not become temporarily affected and then recover as they become acclimatised to their new surroundings. Under flock conditions the seriousness of the situation is masked by the inability to obtain individual breeding records of ordinary flock rams, but there is little room for doubt that every year thousands of two-tooth rams—perfectly normal and potentially fertile when purchased—have their procreative function permanently destroyed before ever they are put with the ewes.

#### **Acclimatisation and Plane of Nutrition.**

As the sub-title indicates this section is in many respects a continuation of the line of thought followed in the preceding section. When discussing scrotal insulation I made mention of an experiment on the effects of management and plane of nutrition. This work brought to light some highly significant facts which are also of major importance in an understanding of the infertility problem. The 30 two-tooth Romney rams used in this experiment were drawn from two sources. Sixteen were born and bred on the Massey College farm. They had run all their lives on excellent rye-clover pastures, fertilised annually and with a carrying capacity of 6-7 ewes per acre. The remaining 14 rams came from the S.

Wairarapa district where they had been reared in a colder and more bracing climate and on natural pastures—i.e. a mixture of the finer grasses on undulating country. These rams were divided into two main groups, a high plane of nutrition group comprising 6 Massey rams and 6 Wairarapa rams and a low plane group containing 8 Wairarapa and 10 Massey rams. The experiment began on January 5th when the rams were carefully examined. In all of them the testicles appeared normal for the time of year. None of them had been forced on concentrates beforehand and none showed visible signs of seasonal flushing.

The High Plane group were placed in a 2-acre paddock in which irrigation had been arranged in order to ensure that the herbage was at all times fresh and green during the ensuing 3 months when conditions are normally somewhat dry. These rams were also fed a daily concentrate ration consisting of  $\frac{1}{2}$  lb. of an equal mixture of linseed nuts and peas per head. As might be expected the rams thrived exceedingly well, grew magnificent wool, put on weight and by the beginning of the breeding seasons in mid-March could be aptly described as in "natural show condition." By the third week in February they were all fully flushed and their testicles handled very well.

The Low Plane group were taken to a hill country property some 10 miles distant and turned out in a rough steep hillside paddock running to an altitude of 500 feet and facing the prevailing nor'-west winds. This paddock carried a very poor quality herbage consisting mainly of *Danthonia* and *Browntop* with a considerable admixture of weeds and moss. The summer was dry and the herbage very brown with little in the way of a green picking. For the first week or so I received almost daily complaints from the shepherd to the effect that the rams would have to be moved on to better feed or they would die since they were just hanging around the gate and making little attempt to feed. Investigations showed that it was the Massey rams which were hanging round the gate whilst the tougher Wairarapa rams were fossicking over the hill. The shepherd's pessimism proved unfounded and the Massey rams became reconciled to their fate and hunger drove them to eat what to them was probably a very unpalatable type of food after the rich pastures on which they had been bred and reared.

When the Low Plane group were brought in from the hill at the beginning of the mating season they looked rather a rough lot, particularly in contrast with the High Plane group. On the other hand they were little, if any, worse than many similar groups of flock rams to be seen on the poorer back country sheep runs. All the rams had lost some condition and the wool was rather dry and harsh but they were physically fit and vigorous as indeed they had to be in order to keep their bellies filled. The majority showed only slight visible flushing which could be described as a bright pink but one third showed no evidence of visible colouring. With a few exceptions the tone of the testicles on palpation was in marked contrast to that of the High Plane rams. Approximately half showed evidence of some degree of testicular atrophy—even though they showed slight colouration.

During the breeding season the H.P. rams remained in their irrigated paddock and continued on their concentrate ration. Although convenience dictated bringing the L.P. rams in from the hill they were run in a small gully paddock in which the available feed was very moderate in both quantity and quality.

The experimental flock of 600 mature ewes used for artificial insemination tests was run as a single unit. Vasectomised rams, raddled on the brisket, ran with the flock and marked ewes were drafted out daily for insemination. Conception records were checked against subsequent lambing results.

The routine followed during the breeding season was to collect semen samples from the rams by means of an artificial vagina, H.P. and L.P. groups being sampled on alternate days. Two or three ejaculations were collected from each ram on testing days. All samples were examined

for pH, acid swing and morphology. Sperm counts were made and small groups of four or five ewes artificially inseminated in order to provide a practical check on laboratory appraisal. By using micro cells on the potentiometer and observing strict economy of material it proved possible to carry out the various tests on portion of a single ejaculate and to use the remainder for insemination. This routine was followed throughout the consequently the A.I. results provide a direct check on the laboratory appraisal of individual samples.

From the foregoing outline it will be clear that the experiment was carefully designed to bring out any effects attributable to either plane of nutrition or change of environment.

The group of six Massey rams on the H.P. duplicated the common practice of stud masters in doing their rams well and feeding a small concentrate ration to put on that little extra bloom which helps their sales.

By contrast the 10 Massey rams sent to the poor hill grazing offered the opposite extreme of a drastic change to harder conditions thus reproducing what often happens in practice when two-tooth rams are bought and suddenly transferred from the relative luxury of their nursery stud to the sunbaked hills of the East Coast in a dry season.

The group of eight Wairarapa rams put on the hill grazing with the 10 Massey sheep had been reared in a less kindly environment than obtains in most ram rearing studs, of which the Massey farm is more typically representative. It was hoped that the move to the poor hill area would involve, for the Wairarapa rams, nothing much more rigorous than the normal summer conditions they might have experienced at home in a dry season. As things turned out the autumn was particularly hot and dry and made conditions on the hill rather harder than was planned.

The fourth group of six Wairarapa rams joined the H.P. Massey rams on irrigated grazing plus concentrates and was planned to test the effects of over-doing rams which had not been used to pampering.

The results of the seasons work are summarised in the following table:—

TABLE I.

		Fertility appraisal	Number of rams	Ewes inseminated	Ewes conceived	Percentage conception
(fertile rams only)						
High Plane	6 Massey rams	High	0	234	74	31.6
		Low	6			
		Sterile	0			
High Plane	6 Wairarapa rams	High	1	150	50	33.3
		Low	3			
		Sterile	2			
Low Plane	10 Massey rams	High	2	86	35	40.7
		Low	1			
		Sterile	7			
Low Plane	8 Wairarapa rams	High	3	191	77	40.3
		Low	2			
		Sterile	3			

The table shows the number of rams which proved normally fertile, of low fertility or sterile in each of the four sub-groups and also the results of inseminations with the semen of the fertile rams only. If we consider the latter first an inspection of the data makes it quite apparent that there is no significant difference in the conception rate between Massey and Wairarapa rams in either the H.P. or L.P. groups. On the other hands there is a difference of nearly 10% in favour of the L.P. group when the two main groups are compared. This difference is significant ( $X^2 = 5.12$ ) and provides experimental evidence of the current view among breeders that keeping stock in show condition results in a lower average of fertility.

Turning to the fertility appraisal of the individual rams the most striking result was obtained with the 10 Massey rams in the L.P. group, 7 of which proved completely sterile. Apparently such pampered rams as a whole, have not the stamina to stand up to the rigorous condition imposed. Not the least significant feature to my mind is the fact that of the three individuals sufficiently hardy to survive the ordeal, two showed a high level of fertility, whereas not a single one of their six mates in the H.P. group gave more than mediocre results.

The Wairarapa rams in the L.P. group stood up to the rigorous regime better on the whole than the Massey rams although among them too, three rams found the change too severe. On the other hand three of the five which remained fertile gave excellent results. It is again significant to me that the Wairarapa rams in the H.P. group made a poor showing as regards fertility since only one of the six was good whilst three were unsatisfactory and two sterile. This confirms other observations which I have made and suggests that it is equally possible, in figurative terms, to kill rams by kindness as by exposure to hardship.

At the end of the season in May the L.P. rams were returned to the hill grazing whilst the H.P. group remained in the same paddock but their concentrate ration was discontinued until the following January when it was recommenced. In the second season's work an identical routine was followed. Results showed that the trends indicated above became even more marked. In the H.P. Wairarapa sub-group only one highly fertile ram remained, the other five proving sterile. Of the four survivors (two died during the winter) of the Massey rams one proved good, two of low fertility and one sterile. Among the L.P. rams one Wairarapa sheep died during the winter. Three of the remainder gave good results, two were poor and two remained sterile. Among the 10 Massey rams 9 proved completely sterile whilst 1 maintained his high fertility.

In the light of earlier experience I had anticipated some such result from the experiments in the L.P. group since they merely confirmed a number of field observations of what may happen to more or less pampered young rams when suddenly transferred to a more rigorous environment shortly before the breeding seasons. What was surprising was the almost equally disastrous result in the H.P. group when the more hardily reared Wairarapa rams were subjected to excessive pampering. Hereto, from field observations I had my suspicions that something of the sort might occur but certainly not to anything like the extent which proved to be the case.

### **Effects of Temperature.**

Numerous references have been made in earlier sections to the ill effects of high temperatures on spermatogenesis. Following earlier work on scrotal insulation McKenzie and Berliner (1937) noted that spermatogenesis was inferior during the warmer months of the year and drew attention to the fact that not only were there individual variations in susceptibility but also well marked differences between breeds. They suggested that some breeds are genetically better adapted than others to heat resistance. Lambert and McKenzie (1940) stressed the importance of avoiding excessive summer temperatures and state

that rams protected against temperature above 80 degrees F. produce more and better semen earlier in the season than rams exposed to the normal summer range of 80 degrees F. to 100 degrees F. Gunn and co-workers (1942) applying these findings to the field conditions obtaining in the hotter parts of Australia found that in Merino rams daily maxima of 90 degrees F. or more led to well marked degenerative changes in spermatogenesis. Moule (1950) has recently confirmed this a a result of his observations in Northern Queensland. It is also evident from Gunn's data that the lower the night minimum temperatures the less harmful is the result of the daily maxima on sperm production.

There are few references to the effects of low temperature but Chang (1943) showed that the external application of ice blocks for ten minutes to the scrotum in rabbits caused very poor motility in sperm ejaculated one to two hours after the ice treatment and that morphological degeneration increased from 0-10% prior to treatment to 25-95% abnormal sperm 8-24 hours later. Russian workers have stated that exposure to sub-zero temperatures causes a deterioration in semen production.

Under certain conditions in New Zealand a sudden fall in atmospheric temperature accompanied by heavy rain may seriously affect the fertility of rams. An element of good fortune first drew attention to this fact. In the previous section the data relating to the H.P. and L.P. ram groups covered the period 20th March to 19th April. During the whole of this time the weather was very settled. Beyond one or two very light showers there was no rain. Days were mild and sunny and light warm nor'-west breezes prevailed but many days were calm. The average daily temperature maximum was 68 degrees F. (range 61 to 71.5) and the nights were mild. On the late afternoon of the 19th April a sudden change occurred in the weather. A bitterly cold southerly wind sprang up accompanied by heavy continuous rain and sleet. Within 36 hours 2.29 inches of rain had fallen and the maximum temperature on the 20th was 56 degrees F.

During the previous month the daily routine was as follows:—the ewe flock was yarded early each morning and all marked ewes drafted into a holding pen. The rams were brought from their paddocks and held in an adjacent pen. A suitable ewe was selected from the marked group and secured in a small breeding crate in a separate pen to which the rams were admitted singly for semen collection per artificial vagina. The rams soon became fully trained to the routine and there was great competition among them to be at the head of the queue. Semen collections began at 9 a.m. and continued for two hours, during that period between 20 and 30 samples were collected daily, the rate of collection being governed by the speed at which the technician, working on the spot, could put through the pH estimations on the potentiometer. Between 11 a.m. and noon the marked ewes were inseminated.

On arriving at the yards on the morning of the 20th April to commence operations we were met with the sight of 42 rams lying down in their yard. A ewe was secured as usual but the rams displayed no interest. Even when the gate leading to the breeding pen was opened wide not one troubled to get to its feet. Eventually we forced the keener rams to their feet one at a time and more or less pushed them into position behind the ewe. Even then they displayed no interest and took the first opportunity to lie down once more. We next tried the effect of competition and shepherded 3 or 4 of the keenest rams behind the ewe in a bunch. This did eventually arouse faint signs of masculine jealousy and after four hours patient work in the bitter driving rain we had succeeded in persuading 4 rams to give a half-hearted service each. It was then decided to box the 19 ewes which were on heat with the 42 rams in a yard. About half the rams continued to lie down even then. It was not until 4.30 p.m. that the 19 ewes were served. The services were shared among six rams only, including the 4 from which a sample had been collected during the morning. On microscopic

examination these four samples showed practically no motility whatever and the abnormal sperm count ranged from 25.66% whereas up to that time these rams had all given consistently good semen with excellent motility and never more than 2.3% total abnormality.

On the 21st the rams were showing some signs of recovery and samples were collected from approximately half of them and by the 22nd the majority would again serve and were displaying greater keenness. However all samples showed very poor motility with a high abnormality count in what had previously been fertile rams and there was very little acid swing. It was fully a week before we got back to normal routine and some rams began to produce good semen comparable with that yielded before the storm. In others whilst normal libido was displayed, the semen continued to deteriorate in quality and in addition to a high proportion of abnormal sperm, now contained masses of cellular debris. Such rams became permanently sterile and most of them later developed epididymitis. To make a long story short 10 of the 18 fertile rams had become sterile overnight and remained so for the rest of the season, three of them died during the winter and only 2 of the 7 survivors proved fertile in the following year. The remaining 8 previously fertile rams recovered their fertility within 10 days or so.

The effects of this storm are shown for convenience in tabular form below:—(Note, the column headed "before 20/4/39" is the same as that headed "fertility appraisal" in Table I).

See Table II.

For some reason which I cannot explain the vasectomised teaser rams appeared to show relatively little loss of libido; at least they continued to pick out the ewes in more or less expected numbers. The fact that the ewes continued to come in season in normal numbers over the critical period is evidence that the storm did not interfere with the female sexual cycle.

In the light of this surprising experience I ventured the prediction that there would be a break in lambing throughout the district commencing about the 14th or 15th September and also that there would be a low lambing percentage that year. Both predictions proved correct.

TABLE II.

		Fertility Appraisal	Number of rams		
			Before 20/4/39	After 2/4/39	1940
High Plane	6 Massey rams	Low	6	2	2
		High	0	0	1
		Sterile	0	4	1 (2 died)
	6 Wairarapa rams	High	1	0	1
		Low	3	1	0
		Sterile	2	5	5
Low Plane	10 Massey rams	High	2	2	1
		Low	1	0	0
		Sterile	7	8	9
	8 Wairarapa rams	High	3	2	3
		Low	2	1	1
		Sterile	3	5	3 (1 died)

To anyone who has studied the Annual Sheep Returns it is well known that occasionally the lambing percentage falls much lower than usual. Searching back through the returns as far as the turn of the century I found that on five occasions the Dominion lambing percentage had been much lower than average. In each instance the official explanation was a hard winter and snow in the high country during the lambing

period. However a similar search through the meteorological records revealed that in each instance the exceptionally low lambing was related to a sudden heavy southerly storm in the preceding March or April (i.e. during the mating season). Thus in the light of what as a research worker I regard as a most fortunate experience, I would cast doubts upon the correctness of the official explanation of abnormally low lambings in past years.

Bearing this experience in mind a very close watch was kept on meteorological conditions in the following year. By ordinary standards there was nothing abnormal and certainly no drastic changes. Nevertheless on two occasions during the mating season all my rams became infertile for a period of 48 hours. There was no morphological change in the semen, simply a loss of motility and consequent absence of acid swing.

Reference to the meteorological records shows that on the first occasion that the rams became temporarily infertile there was a combination of heavy rain and a cold southerly change sufficient to produce a temporary chilling effect. On the second occasion there was again rain but conditions were mild and humid with little wind. The answer in this instance is the condition of absolute humidity (no difference between wet and dry bulb readings) in the following 24 hours. 59 points of rain on May 4th was sufficient to thoroughly drench the fleeces of the rams and in the super-saturated atmospheric conditions which followed they could not dry out and remained wet and chilled.

Still further confirmation came on a subsequent occasion. A sheep farm up country decided to go in for A.I. using 7 selected rams on some 1300 ewes. He was given the necessary instructions and carried on very successfully for over a month. I had advised him to make a colourimetric pH check on his rams once or twice a week. This he had done and his conception rate was 65% over his first round of artificial matings. I was therefore surprised when he telephoned to say he had given up A.I. for the season and had turned reserve rams out with the ewes to finish off the mating because he had tested his seven special rams that morning and all gave a sterile test. I immediately asked what the weather had been like on the previous day. He replied that it had been a very rough day with heavy rain and hail and at one stage the ground was white for half an hour. The reason for his sterile tests was quite obvious in the light of my earlier experience. Here again it proved quite temporary. Although he had abandoned A.I. I persuaded him to test the rams again a few days later when all proved satisfactory.

#### **Clinical Changes in the Testicles.**

In the introduction to this paper I referred to the fact that it is probable that over 10% of all flock rams are infertile. Gunn and co-workers have reported a similar incidence as a result of examining over 9000 rams in Australia. They found epididymitis 5.4%, testicular atrophy 3.4%, varicocele, hernia, undescended testicles, etc., 2%. In New Zealand very similar proportions obtain. Epididymitis is undoubtedly the commonest condition and fibrotic atrophy comes second. Probably between them these two conditions account for 85-90% of clinical infertility. The other miscellaneous abnormalities are relatively unimportant.

The causes of fibrotic atrophy I have already gone into freely in earlier sections. The explanation is clear and requires no further discussion.

The etiology of epididymitis is not quite so clear and I believe that it may be due to more than one cause. Primarily I think every case starts as a spermatocele. The epididymis consists of a single long intricately coiled tubule with a narrow lumen. In it the sperm from the seminiferous tubules of the testicle undergo a maturation process during their passage which normally occupies 5 to 7 days. Ram semen often contains 4-5 million sperm per cubic millimetre and the count in

epididymal semen is several times higher. It is a very dense semi-solid suspension which can at times be expressed from the cut epididymis in fine threads resembling tooth-paste from a tube. Spermatoceles may originate in two ways I believe. One type which might be regarded as physiological, at least in origin, is probably linked up with husbandry methods which result in premature flushing of rams whilst denying them the opportunity of relief by ejaculation. The ram has large testicles but a long fine epididymal tubule. When the germinal epithelium of the seminiferous tubules reaches full production enormous masses of sperm are being passed into the epididymis. Unless these are removed by regular ejaculation it is easy to conceive of the tubule being tightly packed and distended until the wall gives way at some point and gross dilation occurs as a spermatocele takes form.

The second type is pathological in origin and may begin as a result of external trauma such as accidental blows on the pendulous scrotum or as an extension of an inflammatory process originating in the scrotal dermis. This is probably the most widely accepted view, personally however I regard it as the least important in the overall picture. I would however qualify this general opinion by drawing attention to two exceptions. The first is the severe scrotal dermatitis which may result from putting flushed rams in an arsenical dip. The second is a form of weeping eczema of the scrotum which occasionally occurs as a small epidemic in a mob of rams. Under either of these circumstances an extension of the external inflammatory process may lead to epididymal adhesions and fibrosis. The more usual pathological origin is I believe from internal rather than external sources. In other words it commences with acute degenerative changes in the germinal sloughing of cellular debris. This process is inevitably accompanied by a fibrinous exudate and in the early stages the ejaculate from affected rams has a curdled appearance due to the presence of fibrin clots. Almost inevitably such a state of affairs must lead to a complete blockage of the fine epididymal tubule. If later on the germinal epithelium regenerates and resumes normal spermatogenesis there is no outlet and one or more large spermatoceles will develop. Alternatively if regeneration does not occur both testicle and epididymis undergo chronic sclerosis.

### **Conclusion.**

It must be accepted that the inefficiency index among flock rams is extremely high. Whilst some things such as climatic conditions are beyond human control there is nevertheless much that can be done by modifications of hitherto accepted husbandry methods to improve the position.

Sheep farmers must be taught to realise that rams are extremely susceptible to environmental change and that much greater care and attention should be given to their management than has been customary.

In particular the transfer of rams to a new environment is fraught with danger when once the rams are flushed. The ideal is to make ram purchases in the spring months and to get them home and acclimatised to their new surroundings before the sexual flush occurs.

Premature flushing should be avoided. A subsequent check may, if severe, lead to permanent sterility and will certainly cause a temporary loss of fertility.

Scrotal ventilation is most important. All flock rams should at least receive an exaggerated crutching to remove wool from scrotum and thighs immediately prior to the mating season. In warmer districts complete shearing in January is preferable.

Rams out of condition at the beginning of the normal breeding season as a result of dry conditions can be quickly flushed if put on to green feed.

The withdrawal of clinically sterile rams is an obvious step to take. It not only saves feeding useless mouths but by removing useless competition in the flock should result in a more concentrated and a higher lambing.

Finally in the case of valuable stud rams the use of waterproof canvas covers might be expected to give protection against possible interference with fertility attributable to sudden climatic change.

#### REFERENCES:

- Chang, M. C. (1943) *J. exp. Biol.*, 20: 16.  
Crew, F. A. E. (1922) *J. Anat. (Lond.)*, 56:98.  
Gunn, R. M. C., Sanders, R.N., and W. Granger (1942) *Bull. Coun. Sci. Industr. Res. Aust.*, No. 148.  
Lambert, W. V., and F. F. McKenzie (1940). *Circ. U.S. Dep. Agric.*, No. 567.  
McKenzie, F. F., and V. Berliner (1937) *Res. Bull. Mo. agric. Exp. Sta.*, No. 265.  
New Zealand Annual Sheep Returns (1948 Govt. Printer, Wellington, New Zealand.  
Phillips, R. W., and F. F. McKenzie (1934) *Res. Bull. Mo. Agric. Exp. Sta.*, No. 217.  
Webster, W. M. (1932) *Aust. Vet. J.*, 8: 199.
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## Discussion

Mr. LAMBOURNE: Australian workers have shown that recovery from temporary sterility often results in the production of semen slightly better than normal. Does this occur in rams after shearing? What methods of assessment were used? Was a single examination made or were there several?

Mr. WEBSTER: Shearing reproduces the effect of cooler weather and tends to give a normal seasonal flush. Repeated examinations at one or two day intervals were carried out over the whole breeding season.

Mr. DUNCAN: What are the effects of hot humid weather?

Mr. WEBSTER: The effects of hot weather are better known but they are the same as those produced by cold weather.

Dr. McMEKAN: One is impressed with the resilience of farm animals when exposed to extremes of environmental treatment. What changes produce permanent effects? Are hereditary effects relatively unimportant or is the range of variability within the Romney breed less than between breeds? Should cross-breeding be practised on hill country or might it be possible to select within the Romney breed? Few farmers have any idea whether low lambing percentages can be traced to one ram or strain.

Mr. WEBSTER: Lethal factors are of little importance, but if we consider constitution as I defined it, with a breed, it is important. For nine months of the year rams are as resilient as any other stock but while they are flushed they are very susceptible to changes in environment.