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"CLOVER DISEASE" OF SHEEP IN WESTERN AUSTRALIA

By H. W. BENNETTS, D.V.Sc., Principal, Animal Health and Nutrition Laboratories

FROM about 1940 onwards, an infertility in ewes, together with other breeding troubles and abnormalities of the sex organs of sheep, became a very serious problem in certain regions of Western Australia where the pastures were composed predominantly of subterranean clover.

The introduction of this plant has been responsible for enormous increases in the general productivity of large areas of country in Western Australia, mostly in districts where the climatic and other conditions have proved especially favourable to domination of the sward by subterranean clover, particularly during the earlier years of pasture improvement.

This "clover disease," as it came to be called, was at first thought to be restricted to Western Australia. Later, however, it was recognised in some other parts of the continent, again in association with subterranean clover-dominant pastures.

The cause of the disease was determined and various aspects of the problem have been studied by a large number of workers both here and elsewhere. The results of these investigations have been published in a series of technical papers, many of which are cited by Shier and Rossiter (1949) in an article entitled "Clover Disease. Practical Findings and Recommendations for Control." That article, revised and again issued in leaflet form in 1955, enumerates the factors responsible for the disease, indicates the essential effects on the animals, and details practical recommendations for control which are based on current knowledge of the disease.

The purpose of the present article is to give a more detailed account of the cause, effects, and occurrence of the disease and to bring up to date the information published in this Journal by Bennetts, Underwood and Shier (1946).

CAUSE

The various manifestations in the ewe and the wether which collectively are

described as "clover disease" are all due to one cause, the consumption of excessive quantities of subterranean clover at certain stages of growth. This occurs when sheep are maintained on green pastures which are dominated by this clover (*Trifolium subterraneum*).

It has been demonstrated that the clover contains a potent substance which has an action on the sheep identical with that of one type of sex hormone known as an oestrogen. The sex hormones are chemical substances produced normally by certain glands in the animal body, and together they control and maintain the various reproductive processes and organs. If the sex organs are, for long periods, exposed to the action of excessive amounts of one type of hormone, the normal hormone balance is upset and gross abnormalities may result. This is what happens when sheep over long periods ingest a diet which contains a high proportion of green subterranean clover.

Extensive experimentation over a period of years has shown that the clover contains a potent substance and produces in sheep and in laboratory animals effects which are identical with those induced by known oestrogens; the effects on ewes of prolonged diets of potent clover and of prolonged treatment with a known oestrogen (stilboestrol) have also been compared and found to be essentially the same.

It has been demonstrated that subterranean clover may be "dangerous" from germination up to wilting time, after which there is a rapid fall in potency (this is not due to drying but to stage of growth). Dry

clover and clover hay cut at the normal time can therefore, be eaten by sheep with impunity.

It seems evident that any known strain of subterranean clover could cause trouble; Curnow and Rossiter (1955) reported that over 120 strains examined were found to contain appreciable concentrations of the oestrogen (genestein). A number of different pasture plants including other clovers have been examined with almost consistently negative results.

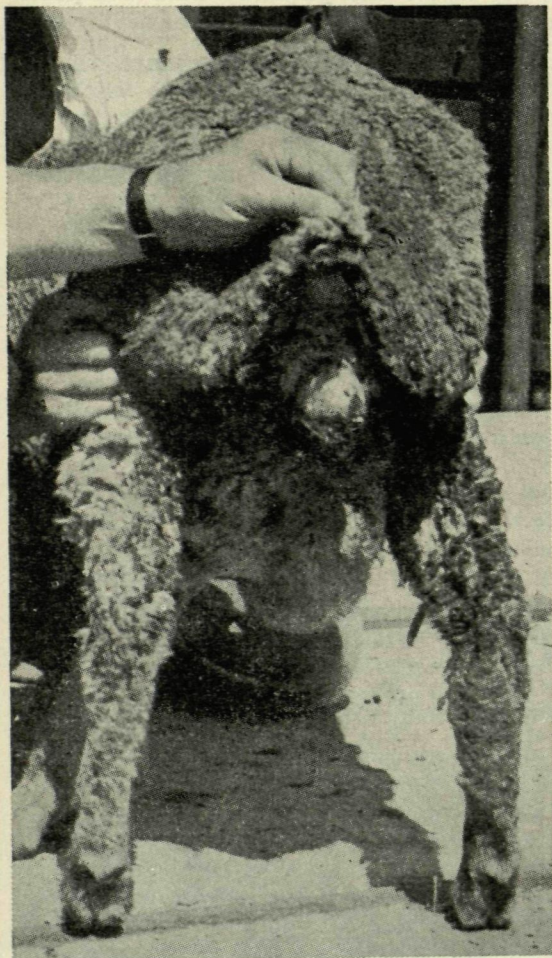


Fig. 1.—Prolapse of the uterus in a ewe suffering from clover disease.

(By courtesy of H. T. Carroll)

It should be borne in mind that in the case of the ewes the effects of subterranean clover grazing are progressive and cumulative. Even one season's grazing of green clover may induce signs of the disease in

some individuals but the numbers affected and the severity of the effects increase progressively with the years.

Chemical examination of extracts of potent clover finally resulted in the isolation of a substance, genistein, which is believed to be the active principle or "oestrogen."

EFFECTS

1. Ewes.

Ewes may be affected with "dead lamb disease" or dystocia; they may be infertile or fail to get in lamb, and they may show prolapse of the womb; maiden or dry ewes not uncommonly show marked udder or teat development and milk secretion. In some instances, ewes may show an abnormality known popularly as "high tail."

Dead Lamb Disease—In some instances lambs are carried to full term but are born dead or are weak and die soon after birth. Not uncommonly this is the first evidence of the appearance of "clover disease" on the property and may be the only manifestation noted during the first season.

More commonly, however, a number of ewes are affected with a type of dystocia, or difficult birth, which generally results in death of the lamb and death or wastage of the mother (up to 30 per cent. loss of breeding ewes). The signs of this dystocia, a result of uterine inertia, are characteristic of clover trouble. The condition differs from the familiar type of difficult birth, not uncommonly affecting a small percentage of ewes, which is usually due to abnormal size or position of the lamb. In "clover disease" the maternal dystocia is characterised by the apparent absence of labour and failure of the ewe to show concern or discomfort prior to the advent of complications resulting from the death of the unborn lamb.

Towards the end of the in-lamb period the appearances of the body and a degree of udder development indicate that the ewe is pregnant or due to lamb. At term, however, there is only a feeble and brief period of labour, frequently when the ewe is in the standing position. This results only in rupture of the "water bag" and escape of the foetal fluids. Following this

almost momentary attempt at lambing no further effort is apparent, and the ewe unconcernedly rejoins the flock.

Quite commonly there is no external evidence of the foetus at this stage and very careful and prolonged observations are necessary to find these early cases in the paddock; delivery is then accomplished relatively easily although the lamb, in most instances, is already dead.

In general however, the ewe is not noticed to be in trouble until some days later when the feet or portion of the head of a dead lamb may be seen protruding from the passage. Other signs are a humped attitude, occasional straining, the presence of an udder greatly distended with milk and, not uncommonly, attempts to foster young lambs. At this stage the foetus is generally decomposed, the womb is dry and has contracted so that delivery is accomplished only with difficulty. Prolapse of the uterus is a not uncommon sequel and in any event the ewe is a poor prospect for future breeding.

Ewes affected with dystocia may not be noticed until some weeks or months after they should have lambed when the flock is brought in and handled. The signs then noted are a putrid discharge from the passage, poor condition, abnormal posture and occasional straining. In some cases there is no obvious abnormality but the presence of a mummified foetus may be detected by palpation through the body walls.

We have seen then that affected ewes may give birth to dead full-term lambs or may fail to deliver their lambs. It is considered that both manifestations merely represent different degrees of maternal dystocia resulting from inertia of the womb and leading to death of the full term foetus because of delayed lambing or failure to lamb. Uterine inertia, or loss of muscular power of the womb, is doubtless related to the effects of the clover oestrogen.

These manifestations are seen most frequently when clover disease first appears on a property, and when (as in 1943 and 1955) there is an early break in the season which results in ewes being on green clover pasture for the greater part of their pregnancy. Subsequently, within a year or two,

the main problem is not dystocia but infertility.

Infertility—The infertility has no characteristic features. In a ewe flock maintained on clover dominant pasture there is a progressive increase in the number of ewes which fail to get in lamb so that within some four or five years the lambing percentage may fall to below 10 per cent.

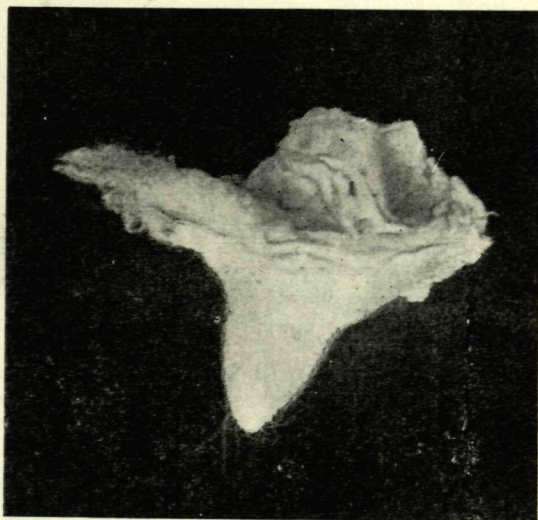


Fig. 2.—An abnormally-developed teat from a wether affected with clover disease. It contained $\frac{1}{2}$ oz. of milk.

Extensive experimental observations have shown that there is no failure of heat. The ewes come in to service, more or less regularly, but fail to get in lamb. It seems most probable that the ewes do not conceive because of the abnormal condition of the womb (uterus). In that connection, the naked eye and microscopic examination of the breeding organs of large numbers of ewes from affected properties revealed the common occurrence of a cystic condition of the uterus (cystic endometrium).

This abnormality, a characteristic effect of the prolonged action of an oestrogen, was found to be generally present in a large number of infertile ewes examined from many affected properties. The cystic condition becomes progressively more severe with the time on potent clover. In a few individuals, even one season's grazing on clover-dominant pastures may lead to a degree of abnormality. The effects are almost always permanent—an infertile

ewe remains infertile despite being transferred to non-clover grazing—the cystic condition of the uterus once established remains.

The cysts referred to can be seen on the inner surface of the uterus, they may be few and microscopic or they may be very numerous and easily seen by the naked eye, being then from about 1/25th to 3/5th of an inch in diameter.

Prolapse—The condition referred to as prolapse occurs generally during the spring months. It may affect up to about 10 per cent. of the flock, both bred and unbred ewes being susceptible. The process involves a turning inside-out of the womb and it is this inverted uterus which is prolapsed. The condition may proceed to a more or less complete inversion of that organ.

The earliest stage revealed by careful observation of the flock is that of a ewe lying down, bleating and straining as though attempting to lamb. This is followed by the early appearance of the prolapsed uterus and a cessation of any marked straining. Affected animals, however, are rarely noticed until the prolapse is obvious externally and we personally have seen very few cases at an earlier stage. The condition develops progressively until, within a week or two, the body of the uterus is completely, and the horns partially, inverted. The prolapse then projects from the body as a swollen tube up to ten inches long by three inches in diameter, terminating in partially inverted horns. The exposed lining of the organ is highly inflamed and red but later becomes grey, eroded and dead. The initial swelling and enlargement of the organ then subsides.

Affected animals are usually slaughtered when found. If not they may survive for months or die from infection, toxæmia, or from the effects of rupture of the prolapse. Attempts at replacement of the prolapsed organ and its fixation by various methods adopted by sheep-owners are rarely successful. This is to be expected in view of the great stretching and weakening of the supporting ligaments.

Spontaneous "recovery" is known to occur but it is doubtful if the "recovery" is permanent; recurrences have been seen

some months later in such cases and it is suspected that they are not uncommon. It is difficult to understand how a well-developed prolapse could really recover.

"High Tail"—A percentage of ewes which have been maintained on subclover pastures may show this condition which is now widely recognised by sheep owners and purchasers. The apparent elevation at the base of the tail is actually due to a displacement (rotation) of the pelvis, which becomes lowered behind as a result of relaxation of the pelvic ligaments that normally hold it in position. This effect results from the action of the clover oestrogen.

In advanced cases of "high tail," manipulation of the region in front of the base of the tail may elicit a grating of bone which may be both felt and heard. This grating (or crepitus), results from a displacement of the sacro-iliac articulation.

The presence of "high tail" does not seem to affect the health of the ewe but does indicate that it has received an excessive intake of subclover, and in consequence, is most probably infertile.

2. Wethers.

Wethers grazing pastures dominated by subterranean clover may show two obvious abnormalities, namely lactation and "false bladder." Both these conditions result from the stimulation of accessory sex organs by the clover oestrogen. The effects produced are of great scientific interest although, relatively, not of any serious economic importance.

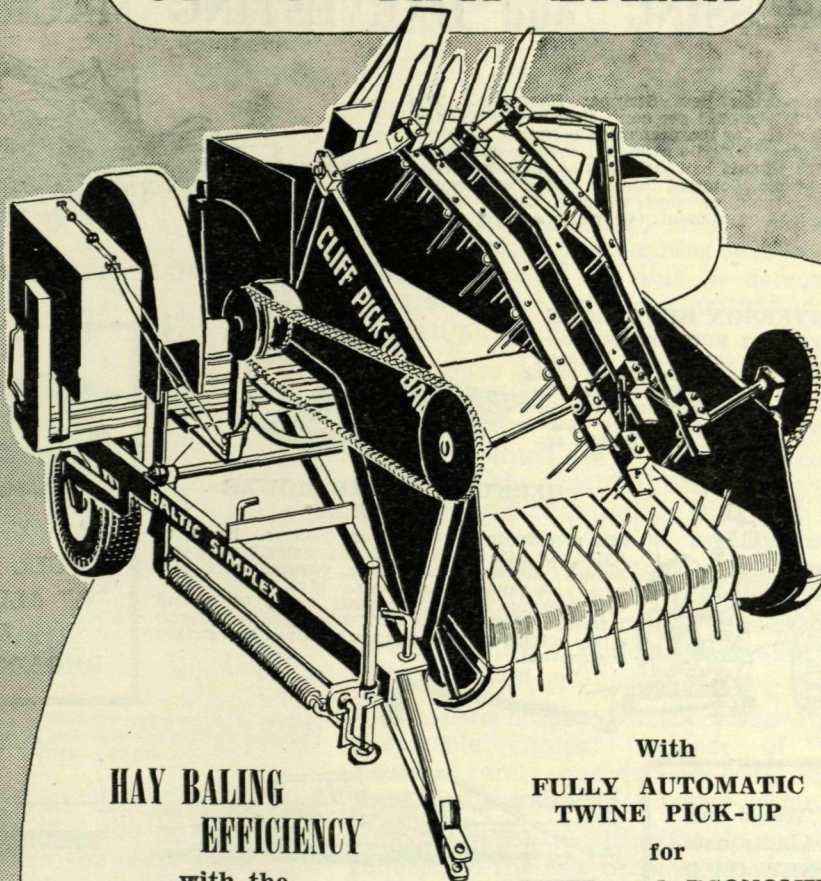
Lactation in Wethers—This was first brought to our notice by reports from a number of clover-dominant properties where in the spring months of 1942, and 1943, it was stated, "shearers were squirting milk on the board." On one property, in 1942, it was estimated that about 300 wethers, of 3,800 carried, showed some evidence of lactation.

We had no opportunity of investigating this unusual phenomenon until October 1945, when a number of affected wethers were examined on several properties. Subsequently the condition was commonly noted in the field and was seen also in experimental wethers maintained on clover grazing or treated with a synthetic oestrogen (stillboestrol).

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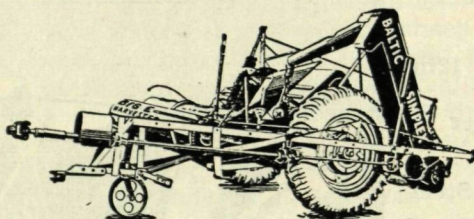
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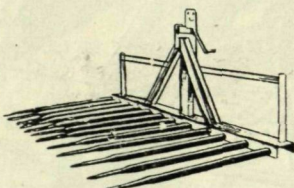
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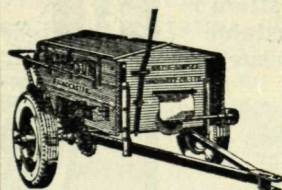
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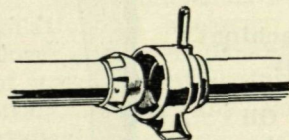
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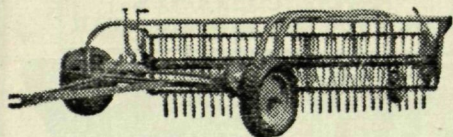
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The condition is characterised by a more or less marked development of the teats, with secretion into a closed space bounded by the teat wall and above by a lid, or capsule, which covers the base of the teat; there is no udder development, but milk is secreted by tissue lining the teat wall. It may resemble ewe's milk in appearance and has a similar chemical composition.

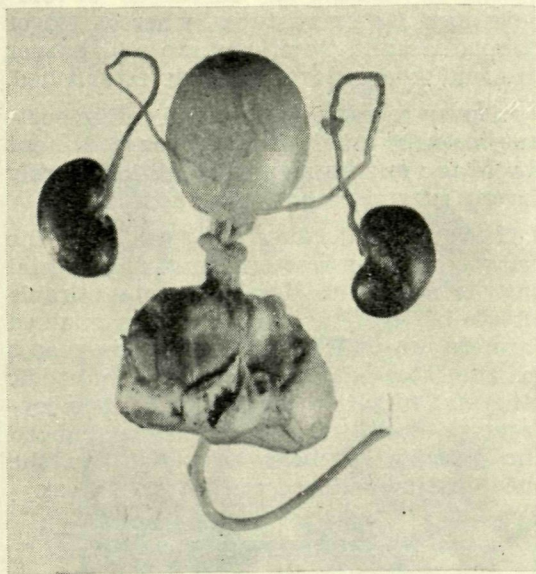


Fig. 3.—“False bladder.” Urinary organs of a wether affected with clover disease, showing the greatly enlarged bulbo-urethral glands.

The degree of teat development may correspond to that of a ewe in full lactation, e.g. in one case the teats were $2\frac{1}{2}$ in. long by 2 in. in diameter at the base.

False Bladder — This extraordinary phenomenon consists essentially of an almost incredible development of what appears to be a new organ in the form of a large sac communicating with the urethra (the tube leading from the bladder to the penis) and which thus becomes filled with urine.

This sac, up to 6 in. in diameter, lies on top of the urethra and may almost fill the cavity of the pelvis. When the sac is well developed it is obvious externally as a large fluctuating swelling which may bulge out of the whole region of the crutch below the anus. In some cases this sac may rupture through the skin and, particularly when the normal passage is

blocked as a result of “clover stones”* or inflammation etc., the urine may be voided from this opening in the lower portion of the crutch.

The condition becomes apparent during the spring months. The signs are loss of condition, swelling in the crutch and evidence of straining and pain. In advanced cases wethers do not survive for many weeks; they lose condition rapidly and die as a result of infection or urinary obstruction. Less severely affected animals may recover; others are affected to such a slight degree that they show no signs of ill health, and abnormalities caused by the clover oestrogen can only be detected by a careful post-mortem examination by a trained observer.

We have shown (Bennetts 1946 and 1947) that the “false bladder” develops from a pair of small glands (bulbo-urethral) which are situated on the upper surface of the urethra. Briefly as a result of continued stimulation from the clover oestrogen these glands are profoundly altered in character; they greatly enlarge and become cystic, and in extreme cases the whole structure of the glands breaks down forming a large cyst or sac which becomes filled with urine.

The percentage of wethers showing recognisable clinical evidence of “false bladder” rarely exceeds 2 per cent. and the mortality rate would be even lower.

In sharp contradistinction to the effects induced in the ewe the abnormalities seen in the wether are not permanent. The teat development, lactation and the changes in the bulbo-urethral (and prostate, etc.) glands are progressive while the animals are eating potent green clover. When the oestrogenic stimulus is removed, however, these abnormal developments are checked and the affected organs or tissues return to their normal condition (that is with the fall of potency of the clover after wilting and through the dry feed period).

* “Clover Stones.”—The common occurrence of calculi in the kidneys of sheep associated with grazing of subclover has been reported in this Journal by Bennetts (1950). These calculi, which may be quite large, are sulphur yellow in colour and are very soft and friable. Small stones or fragments may reach the lower urinary tract and in the male, cause obstruction and “water belly.”

3. Rams.

The fertility of the ram is not impaired as a result of grazing subclover dominant pastures, nor does the ram exhibit any of the abnormalities described in the wether. The ram seems to be entirely insusceptible to the effects of the clover oestrogen. There is experimental evidence to support the claim that this insusceptibility results from the protective effect of the male sex hormone (testosterone) which is secreted by the testicle of the entire male. (The actions of the "male" hormone are in many respects antagonistic to those of the "female" hormone, oestrogen).

OCCURRENCE AND CONTROL

"Clover disease" became a very serious problem in this State subsequent to 1940, following a period of intensive pasture improvement with the early Dwalganup strain of subterranean clover. As we have seen the disease results from an excessive intake of subterranean clover, and the effects on ewes are cumulative and permanent.

The serious situation which developed here was undoubtedly in the main due to the following factors:—

- (a) A local environment so favourable to the clover that it tended to dominate the pastures, particularly in the early stages of development,
- (b) The concurrence in three years, 1942, 1943 and 1944, of seasonal conditions which favoured this dominance and, notably in 1944, an unusually long green growing period. The cumulative effects of these seasons were felt for many years.

Subsequently an understanding of the nature and cause of the disease provided a basis for control. Recommendations for an appropriate system of farm and sheep management have been detailed by Shier and Rossiter (*loc. cit.*) and will not be repeated here. Briefly the object is to prevent ewes from regularly eating excessive amounts of green subterranean clover, of any strain—cattle and horses, however, may graze it with impunity. Control must depend on management—there is no other answer to "clover disease."

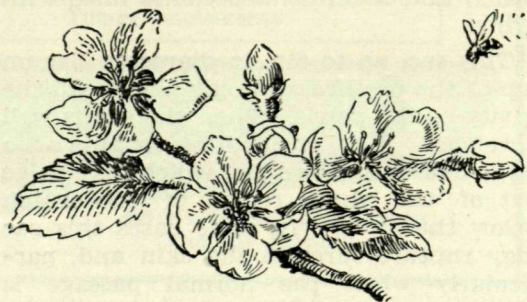
The measures recommended and adopted by farmers have undoubtedly met with much success, but it is probable, that the relative freedom from trouble during recent years may have been due, at least in part, to the effects of seasonal conditions. Ewe and lamb losses reported widely in 1955 have indicated that "good clover years" may still constitute a hazard in the areas of old-developed clover pastures, whereas clover dominance and its effects are still harder to avoid where clover is newly established.

"Clover disease" is relatively unimportant in most other parts of the continent where the environmental conditions rarely favour subterranean clover dominance.

It is evident, however, that in the "clover belt" of Western Australia special care is needed to defeat the undesirable effects of this plant which has enabled farmers to achieve spectacular increases in the stock-carrying capacity of their land and which, by its employment in ley-farming rotations has greatly enhanced the fertility of many properties in the sheep raising and cereal-growing areas.

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