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CONTROL OF CONTAGIOUS ABORTION

by

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The disease known as Bovine Contagious Abortion, Brucellosis or Bang's Disease, has a world-wide distribution in cattle and, on account of the heavy loss from abortions, the frequent subsequent sterility of the animals and the diminution in the milk yield, it is economically one of the most important diseases affecting cattle. It is impossible to estimate the extent of the losses which may be charged against this prevalent widespread insidious disease but it has been stated that if all dairy herds were free of infection, the milk production would be increased 20 per cent. or more.

Figures taken from the last annual report of the New Zealand Dairy Board show that approximately 5 per cent. of all dairy cows in New Zealand abort each year. Abortion is most prevalent in young cows, the incidence in two, three and four year old cows being 10 per cent., 7 per cent. and 4 per cent., respectively, while in older cows it is generally between 2 per cent. and 3 per cent. In the season following abortion, cows on an average produce approximately 120 lbs. less butterfat than in a normal lactation and over 14 per cent. fail to conceive. On the above basis, it has been calculated that the annual loss to New Zealand from abortion is approximately 12,000,000 lbs. of butterfat, valued at £800,000.

In addition, the disease has a public health aspect as undulant fever in man may follow the consumption of raw infected milk or the intimate contact with infected cows. While admittedly the mortality is low, the affection is a serious one and of long duration. Most of the cases appear in adults and two-thirds of the cases in males. In Britain it is reported that infection has been chiefly traced to the consumption of raw milk and only in a small proportion of cases to contact with infected herds.

Mode of Infection: The infected female is capable of disseminating *Brucella abortus* by two main routes; one is from the uterus at or for a few weeks after abortion or parturition; the other is by the discharge of bacteria in the milk. (The urine and ingesta of the intestines have also been shown to contain the organisms.) Of these, the dissemination from the uterus is the most important and constitutes the greatest danger, as bacteria are present in large numbers in the diseased foetus, foetal membranes and uterine discharges and readily contaminate the pasture, food, water and buildings where, if conditions of moisture, temperature and light are suitable, the bacteria may remain viable for lengthy periods.

It is now generally accepted that infection is usually acquired by ingestion of the organisms through the food, grass, water or through licking contaminated coats. The infected material may be carried by dogs, foxes, birds, rats, or other animals and on the boots and clothing and there is some evidence that horses with fistulous withers may spread the disease.

Infection has been produced by inoculating bacteria into the vagina and positive serological response has been induced in male animals by inoculating into the prepuce. It is, therefore, theoretically possible for infection to be acquired by the bull during coitus and for the bull mechanically to transmit the infection to the female during coitus. The readiness with which uninfected pregnant animals contract the disease, when they are introduced into a herd in which abortion disease is active, further

of its freedom from infection. Much progress has been made in America in the control and eradication of Contagious Abortion since the introduction of the official "test-and-slaughter" plan in 1934. Although thousands of herds have been freed of infection, Cotton, who was formerly the Director of the United States Bureau of Animal Industry Experiment Station, remarking on this slaughter, says sadly: "It is hoped that more effective and much less expensive means of handling the disease will eventually be found, but until then it is our duty to make the best use of the knowledge and tools we have."

Eradication is more likely to be successful if an area plan is adopted rather than if used in individual herds as possibilities of re-infection are reduced.

Another method of control which has been adopted in herds of valuable or pedigree animals consists in the segregation of infected from non-infected animals and their maintenance as two separate herds until the infected animals are culled for low production or age. This method is practical only in exceptional herds as infection of the clean herd can occur in spite of intelligent and unremitting attention and vigilance. Thus, in New Zealand at the present time eradication would only be feasible in a minority of herds and we turn to vaccination in the hope of effectively controlling the disease.

2. Vaccination: Ever since Bang in 1906 first demonstrated that vaccinating non-pregnant heifers with live cultures reduced the number of abortions when these animals were subsequently exposed to infection, vaccinal immunisation has been the subject of experimentation. It was soon realised that dead cultures were ineffective in conferring immunity against the disease and live cultures were extensively employed in Great Britain and Europe for immunisation before it was appreciated that virulent strains of *Br. abortus* could infect non-pregnant animals, and that a proportion of these vaccinated animals would develop uterus and udder infections. Experiments were then designed to find methods of immunising cattle without infecting them advantage being taken of the fact that the susceptibility of female cattle varies at different periods of their life, calves being less susceptible than older animals and pregnancy greatly increasing susceptibility. Also, it has been demonstrated that laboratory strains varied greatly in virulence, offering the possibility of utilising strains of standardised reduced virulence.

Cotton and Buck, of the United States Bureau of Animal Industry, demonstrated that a strain of reduced virulence isolated in 1923 and designated "Strain 19", when inoculated into heifer calves was capable of inducing a serviceable immunity when these animals were artificially exposed to infection during their first pregnancy. Interest in calfhood vaccination with Strain 19 was stimulated in America by these initial controlled experiments and a number of reports of the use of the vaccine in the field are available. On the completion of a four-year extensive field trial the Bureau of Animal Industry officially recommended calfhood vaccination with Strain 19 as an adjunct to the test-and-slaughter policy for the control of contagious abortion.

While vaccination of heifers over eight months of age and older non-pregnant cows is not included in the official American control scheme, there is abundant field evidence supporting the efficacy and safety of its application. Californian research workers recommended, as a result of experiments indicating beneficial results from the use of Strain 19 on adult cattle, the vaccination of non-pregnant cows in badly infected herds where "test-and-slaughter" policy is not being pursued. This method enables much quicker results to be obtained and in one herd in which 44 per cent. of cows were infected, the disease was eradicated in six years without removing any diseased cows until they were economically useless. The advantage of calfhood vaccination with smooth strains is that the resultant agglutinin reaction is less persistent than that

indicates the relative unimportance of the possibility of infection being transmitted by coitus. The infected mammary gland has not been incriminated as a direct source for the spread of the infection from animal to animal. Abortion has been induced by the inoculation of *Br. abortus* into the teat canal, but there is insufficient evidence to support a supposition that *Br. abortus* may be transmitted from udder to udder on the hands of the milker or by milking machines, and, indeed, pregnant non-lactating heifers are as susceptible to the infection as pregnant lactating cows, which would not be expected were infection spread through milking. Infected milk may be spilt and contaminate the pastures and food and calves fed on infected milk can discharge viable *Br. abortus* in the faeces but whether infection can be produced by the relatively small numbers of bacteria spread in this way is very doubtful. Nevertheless, the infected udder must be regarded as a potential reservoir for the extensive dissemination of the bacteria as bacteria harboured in the udder may spread to and infect the pregnant uterus and finally be discharged in great numbers. Viable calves born with diseased foetal membranes may discharge *Br. abortus* in the meconium and so constitute a possible source for the spread of infection.

Susceptibility: Female calves are highly resistant to permanent infection both by the ingestion of *Br. abortus* and by subcutaneous inoculation with cultures of the bacteria and it has been shown that calves which reacted positively to the serological test, when removed from their dams and kept free from further infection, gave no evidence of *Br. abortus* infection when they were bred. The insusceptibility is continued up to the time when conception takes place though probably in a lessened degree. With the onset of pregnancy a susceptible stage is reached which is maximal two or three months after pregnancy has been established. The commencement and continuance of lactation predisposes the udder to *Br. abortus* infection, but infection may occur in this organ when the animal is not pregnant. After sexual maturity has been obtained the actual age of the animal would appear to play an unimportant part, uterine infection occurring probably as readily in the cow carrying its second or later calf as in the pregnant heifer.

History of Outbreaks: When *Br. abortus* infection is first introduced into a herd it spreads through it at a varying rate. Its most severe form is usually observed in herds which have been free from apparent infection for some considerable time, or where a new herd is being built up by indiscriminate purchase of in-calf cows or in-calf heifers. Whether abortions will follow an infection acquired by an adult depends very greatly on whether the animal is pregnant or non-pregnant at the time infection is acquired. As regards the subsequent history of the aborting animals, as a rule they do not abort again, sometimes they abort a second time, and, only occasionally, a third time. In self-contained herds where the disease has been present for some years the abortions are mainly encountered in the pregnant heifers and in a smaller number of older cows.

Treatment and Control: A great range of medicinal agents have been investigated over a period of many years for the treatment of infected animals, all of which have now been discarded as completely ineffective after comprehensive critical experiments. However, the hope is still present in spite of repeated failure, that some drug or combination of drugs may be found that will cure cattle actively or chronically affected with Brucellosis.

The only two effective methods of control of the disease are those of:

1. Eradication.
2. Vaccination.

1. While eradication is the ideal method of control its successful application is limited by economic consideration and many practical difficulties. The aim of eradication is not only the elimination of infection from a herd but the subsequent maintenance

stimulated in animals vaccinated later in life and that at the end of their first pregnancy the interpretation of the agglutination test is not confused. Also, calfhood vaccination reduces the risk of permanent infection. The persistent reaction in vaccinated adult animals would present a problem in America where the test-and-slaughter scheme with compensation for the control of contagious abortion has been operative for some years, but this difficulty is surmounted by confining officially approved vaccination to calves under eight months of age. There is, however, no evidence that the immunity produced by calfhood vaccination is any greater than that produced by the inoculation of mature heifers and cows. No advantage can possibly follow the vaccination of infected cows as vaccination cannot influence the course of the disease in these animals. These animals are still spreaders of the infections and their subsequent freedom from abortions could not be contributed to the vaccine. Also, it must be observed that when non-reacting adult cattle in infected herds are first vaccinated, it is impossible to avoid the inoculation of some animals incubating infection and the course run by the disease in these will not be influenced by vaccination. Therefore, no matter how complete the immunity produced by vaccination, some infected aborting animals will be found among the vaccinated group during the period of their first gestation following vaccination.

In view of the need for rapid results in the control of contagious abortion in Britain, vaccination of mature non-pregnant animals as well as calves with Strain 19 has recently been officially approved by the British Ministry of Agriculture.

Last season, in New Zealand, over 20,000 calves in infected commercial herds were vaccinated against contagious abortion with Strain 19. In a smaller number of badly infected herds immunisation with Strain 19 has been extended to embrace mature heifers and non-reacting non-pregnant cows. It was not considered practicable in these field trials to keep control animals but farmers participating in the scheme have been requested to collaborate and supply data that will assist in determining what has been achieved in the control of the disease by these methods of immunisation over a period of several years.

From data supplied by farmers the abortions from all causes in these herds last season are summarised below:-

	Total Number of Cows in Herds	Total Number of Abortions from all Causes.	Percent- age.
Two year olds . . .	14,719	3,782	25.7
Three year olds and over	54,868	4,996	9.1

These figures would suggest that the vaccinated animals would be exposed to heavy infection during their first pregnancy and if a substantial reduction in the number of abortions in the vaccinated heifers can be achieved during their first pregnancy, calfhood vaccination will prove a most valuable control measure.

Thus in the improvements of our methods of vaccinal immunisation and their application rest our brightest hopes of bringing contagious abortion under effective control but the critical analysis of the results of well conducted large scale field trials is necessary before we can assess their value.

DISCUSSION.

Dr Hopkirk: Asked whether Mr Buddle had considered the transmission of contagious abortion by means of flies infecting the eyes of cattle. He drew attention to the fact that it was impossible to eradicate contagious abortion from a single farm and keep it free from infection unless

there was district eradication adopted. He also stressed the necessity of limiting the numbers of calves in the three year experiment to about 30,000 rather than increasing to 40,000 so that proper field observations could be made and proper control of manufacture of vaccine with available laboratory staff be exercised. There would be a tendency for deterioration in both records and in production of vaccine were too much attempted.

Reply:

Female stock may be artificially infected with brucellosis by the application of relatively small numbers of bacteria to the conjunctiva; thus it is theoretically possible for flies to spread the disease mechanically in this way by depositing bacteria on the eye of non-infected animals, but it is very doubtful if infection occurs frequently through this channel. Also infection through the eye could be acquired in the absence of flies by material from an infected uterus being dispersed by the swishing tail of an animal which had recently aborted.

Mr Waters:

Extended his congratulations to those who had developed the investigation into the control of abortion to the stage that it had now reached, and asked how long it would take to get the necessary data to enable the principle of vaccine treatment to be extended in the event of it proving to be a success?

Reply:

Approximately 400 heifers vaccinated as calves in badly infected commercial dairy herds in New Zealand will complete their first pregnancy this season, and it is hoped that analysis of these results will give some indication of the value of calfhood vaccination under New Zealand conditions. Also the results of the first pregnancies following vaccination of several hundred heifers and cows in infected herds will be available this season. Critical analysis of the results of the first pregnancies of the animals involved in the large scale field trial commenced last February will not be possible until after next season.

Mr James:

How long could you expect immunity from calfhood vaccination to last?

Reply:

It has been suggested by research workers elsewhere that one could not expect a life long immunity against brucellosis to follow the single inoculation of calves with a strain of such low virulence as Strain 19, and the question of re-vaccinating after each pregnancy has been raised. Repeated exposure to natural infection following vaccination would doubtless reinforce the immunity artificially induced during calfhood, but it is hoped that further data on the persistence of immunity in later pregnancies will be gained from the field trial.

Mr Ward:

Asked what was the economic cost of carrying out vaccination of calves in 1943, and how many staff were required full time for this purpose?

Reply:

While two full-time research workers are engaged on contagious abortion vaccine investigations, vaccine production and its rigid standardisation in the field trial were not a major part of the work. On planning the field trial, consideration had to be given to the seasonal production in New Zealand, and as the vaccine had to be freshly prepared, the main vaccine production period did not extend beyond six weeks. More intensive work on immunity against brucellosis is being conducted in Government and other commercial herds, and laboratory investigations aimed at improving the vaccine are of the greatest consideration in the immunity investigations. The extent of the scheme as initiated last season was controlled not by the capacity of the laboratory to prepare vaccine, but by the present facilities for the