PART 4

Diseases and Parasites of Cattle

Brucellosis of Cattle

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THE DAMAGE done to herds by brucellosis of cattle, the rapidity with which it spreads, and the fact that the Brucella germ causes undulant fever in man make this disease especially important. A few years ago a Nation-wide campaign to eradicate it was begun; recently a new method of calfhood vaccination became a weapon in this campaign.

Brucellosis, an insidious disease commonly referred to as contagious abortion or Bang's disease, has caused heavy losses to the cattle industry every year, largely through reduced milk production, the loss of calves by premature birth, and sterility. Brucellosis may spread very rapidly in a susceptible herd, many of the animals contracting the disease within a few weeks after they are exposed to the causative agent.

The disease is caused by a germ known as Brucella abortus, which is introduced into healthy herds by the addition of infected cows or infected pregnant heifers. Brucella germs may be in the uterus or the udder of cows, in the generative organs of bulls, in certain lymph glands and joints, and in the intestines and other organs of newly born calves. Diseased cows eliminate the germs in the fetus, afterbirth, and uterine discharges for limited periods, and in the milk for prolonged periods. The malady appears to be commonly acquired through the mouth in feed and drink contaminated with the germs, or by licking infected animals, contaminated mangers, or other objects to which the germs may adhere. The skin and the membranes lining the eyelids may also provide an entrance for the abortion germ. Proof that bulls transmit the disease through the act of service is lacking.

It was not until 1896 that the organism responsible for bovine brucellosis was discovered by Professor Bang, noted Danish research worker. The existence of such a malady has been known for more

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than 100 years in the United States, however. For more than 40 years Department of Agriculture research workers have been continually engaged in investigations directed toward finding a cure or a means to control and eventually eradicate bovine brucellosis. Alice Evans, while an employee of the Department, did notable work in connection with brucellosis in discovering the similarity between the organism that causes abortion in cows and the corresponding organism in goats that causes undulant, or Malta, fever in human beings.

**BRUCELLA ABORTUS AND HUMAN HEALTH**

In recent years it has been shown that undulant fever in man may be caused by the same germs that cause brucellosis in cattle, swine, and goats. A large number of cases of undulant fever contracted from raw milk containing *Brucella abortus* have been reported. Handling infected pork products is also a means by which undulant fever is transmitted to man, as is the handling of discharges and aborted fetuses from infected animals. Though undulant fever would not be classed as a major health problem, it is nevertheless one to be reckoned with, and it can be reduced materially through the eradication of the disease in cattle. Dairymen and breeders of meat animals are aware of the possibility that human beings may contract undulant fever from raw milk, meat, and dairy products infected with brucellosis germs, and of the influence this may have on the market for their products. The simple precautions of pasteurizing milk and cooking meat, however, make these foods safe for human consumption.

**SYMPTOMS OF BRUCELLOSIS**

The symptoms of brucellosis in cattle are rather inconstant and indefinite. Abortion is probably the most widely known and most readily observed symptom, but it may easily be misinterpreted, since not all cows that abort are affected with the disease. Moreover, the prompt recognition of the disease in affected herds is made more difficult by the fact that many animals that have it never abort. Sterility is usually a serious trouble in herds infected with *Brucella abortus*, but it does not constitute definite evidence of such infection. The retention of the afterbirth, likewise, does not definitively indicate the presence of the disease, as this condition, too, may occur when brucellosis is absent. None of these symptoms prove the presence or absence of the malady, but they may well be regarded as justifying suspicion and calling for prompt action. This is particularly true of abortion; until a definite diagnosis with the blood-agglutination test can be made, it is advisable to infer that an aborting animal is affected with the disease and to take action accordingly.

**DIAGNOSIS**

In the blood stream of an animal infected with brucellosis there is an antibody, a substance known as agglutinin. When blood serum containing this substance is brought in contact with a suspension of
Brucella organisms (called an antigen), it causes the organisms to adhere to one another and form clumps. This action, known as agglutination, is the basis for the test used in diagnosing brucellosis in the living animal.

To obtain the serum for a test, a sterile needle is inserted through a disinfected spot of skin into the jugular vein of the animal, and a small amount of blood is drawn into a sterile test tube or small bottle. This is allowed to set for a few hours, until the serum separates from the blood clot. A carefully measured amount of the serum is then mixed with a carefully measured amount of antigen for the test. There are two methods of making the test, the tube method and the plate method, and either one is remarkably accurate when conducted by an experienced operator.

LOSSES FROM BRUCELLOSIS

Although it is difficult to determine the financial losses caused by this insidious disease even approximately, estimates, based mostly on actual losses in various communities, have varied from 30 million dollars annually to much larger amounts. No definite, detailed survey taking into account the tremendous intangible losses has yet been made, and hence all estimates have probably fallen far short of the real situation. It is not enough to figure the probable value of a calf that is born dead or that is weak and soon dies, the shrinkage of beef in the beef animal, the diminished production of milk in the dairy animal, the temporary or permanent sterility that may follow the infection, and, not infrequently, the loss of the cow itself through infection; there is also the financial loss that the breeder of selected purebred cattle suffers from interference with his breeding program because of the presence of the disease in his herd.

A careful study of a herd maintained at an experiment station showed that the loss per cow in milk production alone was over $100 a year. In another study it was determined that the loss resulting from abortion in a good commercial-grade herd of 16 cows was about $135 annually, and in a typical purebred herd, $486. Veterinarians and cattle breeders know the wide distribution and economic importance of brucellosis, and the trouble it has caused them makes them more interested in it than in any other infectious disease of cattle. From general observation and special studies, it is known that at the time the cooperative State and Federal campaign to eradicate brucellosis was inaugurated in July 1934 the disease was more widespread than it had been some years before.

REMEDIES WORTHLESS

There is no drug, chemical, or medicinal compound that has been proved to be effective in the prevention or cure of brucellosis, but livestock owners of this country have spent large sums annually for worthless remedies in an effort to stop abortion in their cattle due to bovine brucellosis. These remedies have gained popularity because in most instances they are used and their value is judged at a time
when the disease has run its course and is becoming chronic. At this stage abortions can be expected to decrease as a result of acquired immunity, and a large percentage of the cows produce apparently normal calves. Perhaps no other disease is so deceptive in its apparent response to treatment as brucellosis. Though the Department had frequently warned the public that no drug or combination of drugs had been found to be effective in combating this malady in cattle, traffic in so-called cures continued for a time to flourish. It was decided therefore, in 1936, to conduct some experiments with two of the remedies that had been widely advertised. One hundred heifers were selected to be the subjects of the experiments, which were carefully controlled. The two products were proved to have no value whatever in preventing abortion or curing brucellosis in cattle.

CONTROL AND ERADICATION

Brucellosis of cattle may be controlled in several ways, the method used depending on herd conditions and the severity and extent of the disease in the herd. Four methods of control have been used successfully: Test and slaughter, calfhood vaccination with a culture of reduced virulence, sanitary control or herd management, and test and segregation.

THE TEST-AND-SLAUGHTER METHOD

Since 1896 methods of control have been established, but unfortunately none of those thus far receiving recognition are easy of operation or inexpensive. Consequently, there was little organized effort to control the disease until July 1934, when funds were made available by Congress for a cattle-reduction program associated with the severe drought of that year. Since such a program was to be inaugurated, it seemed logical to direct it in part toward the elimination of diseased cattle, and part of the funds were allotted for this purpose. Thus in July 1934 the present brucellosis control and eradication project was begun in cooperation with the livestock sanitary officials of the various States. Since then the cattle owners' losses have been gradually reduced and are now very much less than they were at that time. Figure 1 shows the estimated extent of infection by States at the beginning of the project.

The plan promulgated at the beginning of the campaign, when it was estimated that there were 10 million surplus cattle in the United States, called for subjecting all dairy and breeding cattle over 6 months of age to a blood-agglutination test. It also provided for the slaughter of the animals that reacted to the test, since it is accepted as a fact that such animals are affected with bovine brucellosis.

This was a huge undertaking. It was necessary to draw a sample of blood from each animal under supervision and forward the samples to a laboratory for test. A corps of technicians had to be trained to make the tests, and in order to meet the emergency the laboratories of many of the States were expanded and new ones established. The Department purchased a number of trailer labora-
tories that have proved very satisfactory. They are usually set up in the county seat where cattle owners may see the blood of their animals being tested and thus gain a clearer understanding of the methods employed to detect diseased animals. High-school teachers and students are invited to view the work conducted in the trailer laboratories, and this has proved very interesting as well as educational to the young people.

When work was inaugurated in the cooperative eradication of bovine brucellosis and until more cattle owners understood the advantages to be derived from a herd free from this disease, only scattered herds were tested. Then, as owners who had freed their herds of the malady realized that bovine brucellosis is easily spread from one farm to another, there were urgent requests to test all cattle in an area and destroy diseased animals that might serve as reservoirs of infection from which the disease might be carried back into the tested herds. Acting on these requests and requests from owners whose herds had not been tested, many of the States took up cooperative eradication work on an area basis.

The Area Plan

Under the area plan, all the cattle in an area, except steers and calves under 6 months of age, are tested and the reactors removed and slaughtered. Retests are applied at the proper intervals. The owners are given instructions as to the sanitary methods to follow, since proper sanitation is a very important factor in eliminating the disease. In December 1939 the plan of designating areas as practically free of brucellosis was inaugurated. Whenever the tests of all cattle in a county 6 months of age and over, except steers, indi-
cate that the percentage of cattle with positive reactions does not exceed 1 percent of those tested and that the number of infected herds does not exceed 5 percent of the total number, the regulations provide that such a county may be declared a "modified accredited Bang's disease-free area" for 3 years by the cooperating State and Federal officials in charge of the work, provided all infected herds are placed in quarantine. The cattle in these herds must be retested for the disease at intervals of 30 to 90 days until all of them pass two successive negative tests, and they must also pass a third negative test not less than 6 months from the date of the second. The reactors in any test are of course removed from the herds and disposed of in accordance with the State and Federal regulations. On February 1, 1940, the first counties—209 in 17 States—were declared modified accredited areas in recognition of progress made in combating brucellosis. By November 1, 1941—almost 2 years later—the total of such counties had reached 446. They were located in 23 States and constituted 14.5 percent of all the counties in the United States.

Almost all the States also have provisions for accrediting individual herds of cattle as free from brucellosis.

It may be seen in figure 2 that in approximately 50 percent of the nonaccredited areas, the infection does not exceed 2 percent. In such areas brucellosis can be eradicated at relatively small cost and with very small loss to the cattle owners by continuing the testing program and slaughtering the reactors. This is undoubtedly the quickest and most practical procedure except in the badly infected herds in such areas in which infection persists after several tests have been made.

**Indemnity Payments and Progress**

The cooperative program inaugurated in July 1934 provides for partially reimbursing cattle owners for animals slaughtered as reactors to the test for brucellosis. During the first few years of the campaign the Federal Government provided a major part of the indemnity payments. Since May 1, 1939, however, the Bureau of Animal Industry has been forbidden by Federal statute to make indemnity payments to owners for the slaughter of reactors unless the State or municipality pays a sum equal to or greater than that paid by the Bureau. Federal payment is made on the basis of one-third of the difference between the appraised value and the salvage value, but this amount is not to exceed the amount paid by the State, and it is not to exceed $25 for a grade and $50 for a purebred animal.

During the first 7 years in which this project was conducted, agglutination blood tests, including retests, were applied to approximately 48,117,000 cattle and disclosed about 2,134,000 reactors. At the end of the 7-year period, approximately 1,184,000 herds, containing about 13,933,000 cattle, were under supervision throughout the United States for the control and eradication of brucellosis. About 1,175,000 cattle were in the herds of cattlemen who had applied for the test and were on the waiting list.
Figure 2.—“Modified accredited Bang’s disease-free areas” and the estimated extent of infection in the remaining counties, November 1, 1941.
Benefits of the Campaign

During the progress of the cooperative control and eradication campaign the Bureau of Animal Industry has received numerous reports of benefits derived from the program. Typical benefits reported by participating cattle owners include thriftier condition of herds; calf crops, in both beef and dairy herds, approximately 20 to 25 percent greater than formerly; noticeable decreases in the number of cows affected with udder troubles and sterility; and material increases in the milk production of herds, roughly comparable to the number of diseased cows replaced by healthy ones. The following report interestingly illustrates this last point: In the first test, applied to 8,304 cattle, 2,319 reactors were reported, or an infection at the rate of 27.9 percent. Four years later the test of 7,403 cattle in the same area disclosed 59 reactors, or 0.8 percent infected. The milk report of this area showed that 7,403 cows were producing 1,450 gallons more milk a day than the 8,304 cows did when brucellosis infection was active. The benefit to the dairymen is reflected not only in increased milk production but also in lowered operation and maintenance costs. Among additional benefits reported by cattle owners are greater marketability of breeding stock and better prices, because purchasers are becoming more and more insistent on disease-free sources of animals and State legislation is restricting the entry of untested breeding stock; greater marketability of dairy products, because legal restrictions are imposed by States, cities, and towns on products from untested herds; and greater safety to human health, because raw milk from herds infected with brucellosis may transmit undulant fever.

Calfhood Vaccination

For a number of years studies have been in progress on a rather large scale for the purpose of determining the possibilities of a comparatively safe method of preventive vaccination with a vaccine developed in the laboratories of the Bureau of Animal Industry from a culture of the Brucella organism of low virulence.

This vaccine has also been subjected to rigid tests by many research workers in other similar institutions, with encouraging results. For many years the livestock interests and livestock sanitary officials alike have shared the hope that eventually some satisfactory means of artificially immunizing cattle against this malady might be perfected. Because brucellosis, particularly in dairy cattle, has a tremendous economic importance in addition to its human or public health significance, the prospect of another practical weapon in the control of this disease is of particular significance.

Field Trials

In addition to the information gained in studies of the vaccine, which, in the main, were conducted under the usual procedure employed in controlled experiments, it was decided to determine the effectiveness of calfhood vaccination under natural field conditions.
A field project was started in January 1936 to determine the value of the vaccine when applied to calves under natural conditions and the feasibility of a vaccinating procedure as a practical means of controlling brucellosis.

Since the project was to be conducted cooperatively in privately owned herds, the usual experimental procedure of maintaining control animals was omitted. The herds selected, therefore, were chosen from those in which the disease was shown by the blood-agglutination test to be present in a sufficient number of animals to insure adequate exposure of the vaccinated animals to the disease, and no herd containing less than 15 percent of positive reactors was accepted. Finally, 260 herds, containing approximately 19,000 cattle, were selected in 24 States. In the initial test applied to these herds, 29.2 percent of positive reactors and 8.4 percent of suspicious animals were disclosed. The suspects and reactors were retained in each herd for a time, after which the practice was adopted of eliminating a few each year as the vaccinated animals came into production and could serve as replacements. The vaccinated animals were permitted to mingle constantly with the infected members of the herd, and the usual sanitary practices employed in animal disease control were not applied in these herds. The only means of control employed was the vaccination of calves between 5 and 7 months of age with *Brucella abortus* vaccine strain 19.

A summary of the results during the first 41/2 years of the study, covering three pregnancies of the vaccinated animals, is as follows: In these herds 13,854 calves were vaccinated when between the ages of 5 and 7 months. There were 8,182 calvings of which 7,872, or 96.2 percent, were normal, and only 310, or 3.8 percent, were abortions. Of the 310 animals that aborted, 182, or 58.7 percent, were negative to the test after calving, and 128, or 41.3 percent, showed either a positive or a suspicious reaction. Consequently, on the basis of the blood-agglutination test, only 128 abortions, or 1.6 percent of the 8,182 calvings, could be attributed to brucellosis. Of the 1,346 animals that calved normally and showed either a positive or a suspicious reaction after calving, approximately 500, or 37.1 percent, were negative on the first retest applied 6 months later. Of the first group of 97 animals that calved normally during the first pregnancy and gave a suspicious or positive reaction to the test after calving, 75, or 77.3 percent, had returned to a negative reaction on the fifth retest, applied 21/2 years later.

The results of the field trials as well as those of experiments with calfhood vaccination with *Brucella abortus* strain 19 showed that this method of control is very effective as far as calf production is concerned and markedly effective in actually preventing infection. Accordingly, the results of the field study were presented to the United States Live Stock Sanitary Association during its annual meeting in Chicago in December 1940, and a general plan for the official recognition of calfhood vaccination as an aid in cooperative brucellosis control was proposed by the Chief of the Bureau of Animal Industry. According to the provisions of the plan, calfhood vaccination, as well as the test-and-slaughter method of eradication, may be used in States where the proper officials deem con-
ditions favorable, dependent on acceptance of the plan by the proper authorities in such States. Many of the States have adopted plans for using calfhood vaccination in the control of brucellosis in cattle, and interested cattle owners should consult their State veterinarian or State livestock sanitary officials before having the vaccine used in their herds.

The aim in the use of vaccine in a brucellosis-infected herd should be directed toward the eradication of the disease rather than merely toward the assurance of a calf crop. The eradication of the disease is possible only through the removal of the animals that continue to show an agglutination reaction on repeated tests. The reacting animals may be removed immediately, if necessary, or gradually as vaccinated replacements become available. It should be obvious, therefore, that two things are necessary in this connection: (1) That vaccination should be confined to calves between 4 and 8 months of age, and (2) that periodic blood tests should be made of the entire herd. To obtain the desired results, the administration of the vaccine and subsequent care of the affected herd should be entrusted to a qualified veterinarian.

SANITARY CONTROL OR HERD MANAGEMENT

Another plan of control that is both practical and economical should not be overlooked. This is the sanitary control method, with special relation to herd management, which, though it involves extra work, pays splendid dividends. In many herds the disease has been controlled by this method, which has two requirements: (1) A maternity barn, shed, or stall sufficiently removed from buildings housing the other cattle to prevent direct exposure to infection, and (2) a close, daily observation of each pregnant animal, especially first-term heifers. At the first indication of approaching calving or signs of abortion, the animal should be placed in the maternity barn and kept from the remainder of the herd until abortion or calving has occurred and discharge has ceased. Persons caring for these animals should carefully wash their hands with soap and water and thoroughly disinfect their boots or shoes before leaving the building. Implements used for feeding and watering should not be used anywhere else. The aborted fetus and afterbirth should be burned or buried with quicklime. Additional sanitary treatment should be given to aborting animals before they are returned to the herd, and they should not be bred for at least 3 months. These sanitary control measures, when used in conjunction with the test-and-slaughter method or vaccination, greatly increase the efficiency of the latter two through the removal of possibilities of exposure.

TEST-AND-SEGREGATION METHOD

This method consists in segregating the reactors to the blood-agglutination test in a separate herd apart from the nonreactors. Separate premises are necessary for each group. Retests at frequent intervals are made of the nonreacting group in order that infection
may be detected in the beginning stage and the reacting animals, if any, removed. Many valuable herds have been freed from infection by this method, but there are several reasons why it is not a desirable one: (1) Only a few owners can provide facilities for two herds; (2) it is usually some time before the reacting herd can be disposed of; and (3) a single act of negligence in the care of the nonreacting herd may result in undoing several years' effort.

PREVENTION

The old adage, "An ounce of prevention is worth a pound of cure," is sound advice in regard to brucellosis, and no possibility of preventing infection from gaining entrance to a normal herd should be overlooked. Undoubtedly the chief way in which this disease is introduced into a herd is through replacements or additions, especially of pregnant heifers or cows. All animals added to a herd should be negative to the agglutination test or be purchased from herds accredited as being free from brucellosis, and it is advisable to keep them from direct contact with the herd for a period of 3 months and not admit them to the herd until they react negatively to the test. Animals shown at fairs and livestock shows may be exposed to infection, and it is advisable to test them several months after their return. Drainage from adjacent infected premises should be diverted, if possible, and small sluggish streams flowing through and from premises known to be infected should be fenced off. The proper pasteurization of milk will make it safe for feeding. Stockmen should be careful in visiting farms where infectious diseases exist, as the germs may be brought home on shoes or clothing.