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BANG'S DISEASE OF CATTLE WITH A SHORT ACCOUNT OF THE DISEASE IN SWINE AND SHEEP

By C. P. Fitch, W. L. Boyd, and C. R. Donham
Division of Veterinary Medicine



UNIVERSITY OF MINNESOTA AGRICULTURAL EXTENSION DIVISION

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BANG'S DISEASE CONTAGIOUS ABORTION OF CATTLE

The disease known as Bang's disease, infectious abortion, contagious abortion, slinking, or dropping of calves, is infectious in character. Abortions resulting from injuries or causes other than germs are very uncommon. "Abortion" means the birth or expulsion of an immature fetus and this is one of the most prominent symptoms of this complex disease. "Sterility" (failure to breed) very often follows infection with the germs causing abortion. Retained placenta is also usually closely associated with abortion infection and the premature expulsion of a living fetus (premature birth), which usually dies, is most often due to the abortion germ, *Bact. abortus* Bang. Approximately 85 per cent of all abortions are due to this germ. Diseases of calves, such as white scours and calf pneumonia, while they are not due to the same germ that causes abortion are often found in a herd in which the adult animals are harboring the abortion infection. Diseases of calves may occur, however, entirely independent of abortion infection. To sum up, Bang's disease, or bovine infectious abortion, is widespread, the most pronounced symptom of which is the birth of a dead fetus before time. Sterility, or failure to breed, is commonly associated with abortion.

HISTORY OF BANG'S DISEASE

Contagious abortion has been recorded since early times. In Germany the disease seems to have existed in a severe form in the latter part of the Eighteenth Century. Among the early investigations as to the nature of the infection, were those of Nocard in France in 1885, of the Highland Agricultural Society of Scotland in 1885, of Bang and Stribolt in Denmark in 1897, and the Departmental Committee of the Bureau of Agriculture and Fisheries of Great Britain in 1909. In this country, MacNeal and Kerr, in 1910, pointed out the significance of the Bang organism in relation to abortion of guinea pigs. Since then many American investigators have devoted much time and thought to the study of bovine infectious abortion.

GEOGRAPHICAL DISTRIBUTION

According to available data, this disease exists with more or less constancy in all countries where cattle raising is an industry. It appears to be world wide. In the United States the disease has spread until in many herds of either purebred or grade cattle there are animals that have been or are infected with the organism causing the disease.

It has spread widely in the United States during the last twenty years, owing in large measure to the increased traffic in purebred cattle. It has been only within the present century that cattle born in the New England states mature in California. In other words, the active interchange of purebred livestock has offered an opportunity for the spread of Bang's disease.

IMPORTANCE OF THE DISEASE TO THE CATTLE INDUSTRY

The lack of reliable statistics concerning animal diseases in the United States makes it difficult to estimate even approximately how great are the losses that must be charged against a widespread, insidious, common disease like bovine infectious abortion. The estimates have varied from \$25,000,000 annually to much larger amounts; but most of them have been based largely on tangible or actual losses in various communities. No definite, searching, universal survey has ever been made that took into account the tremendous losses that are not tangible. Consequently, all estimates that have been made may have fallen far short of the actual losses.

One must not be content to figure the probable value of a calf that was expelled dead or is weak or does not live; the shrinking 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 herself through infection. Serious as these are, we must yet take into account the enormous financial loss that the breeder of select purebred cattle may suffer because of the disease in his herd. A careful study made at Storrs (Connecticut) Agricultural Experiment Station showed that the loss per cow in milk production alone was over \$100 annually.

Rich, studying the economic factors of abortion of cattle, found that the total loss resulting from abortion in the University Farm herd over a period of 29 years was \$12,760. This did not include losses from cows giving birth to dead calves over 260 days calving period.

He also determined that the loss resulting from abortion in a good commercial grade herd of 16 cows was \$136, and in a typical purebred herd, \$486 annually.

Veterinarians and cattle breeders indicate that Bang's disease is a widespread, economically important evil. The trouble they are having because of it make them as eager to discuss it as tuberculosis or any other infectious disease of cattle, and we know from general observations and special studies that it is more widespread and more common than it was 12 years ago. It will continue to spread and become more common unless a real fight is made to control and check it.

CAUSE OF ABORTION

The most frequent cause of abortion is a short oval-shaped germ (*Bact. abortus*) about 1.5 microns in length. (A micron is one twenty-five thousandth of an inch.) (See Plate I, Fig. 1.) Artificially, it is difficult to cultivate at first, but after one or two generations of transfers it grows readily. In the diseased cow the germ lives in the pregnant uterus, and remains there a short time after abortion or normal calving. It soon leaves the nonpregnant uterus (see Plate II),

PLATE I

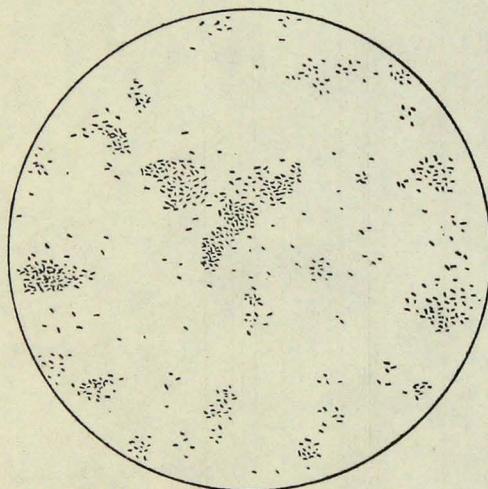


Fig. 1. *Bact. abortus*, the Germ Causing Contagious Abortion. Magnified 700 Times

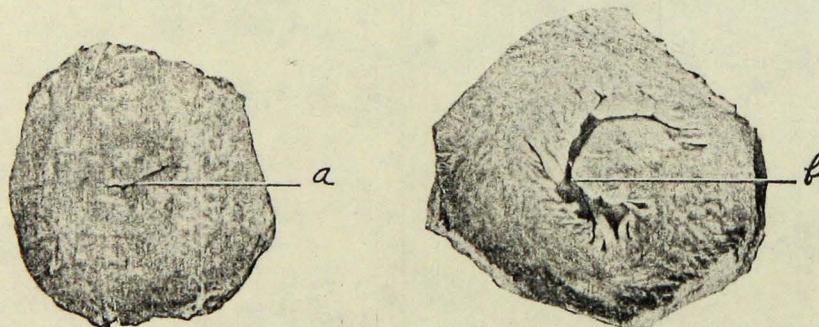


Fig. 2. a. Cross-Section of Cervix or Neck of Womb Showing Normal Small passage from Vagina to Womb

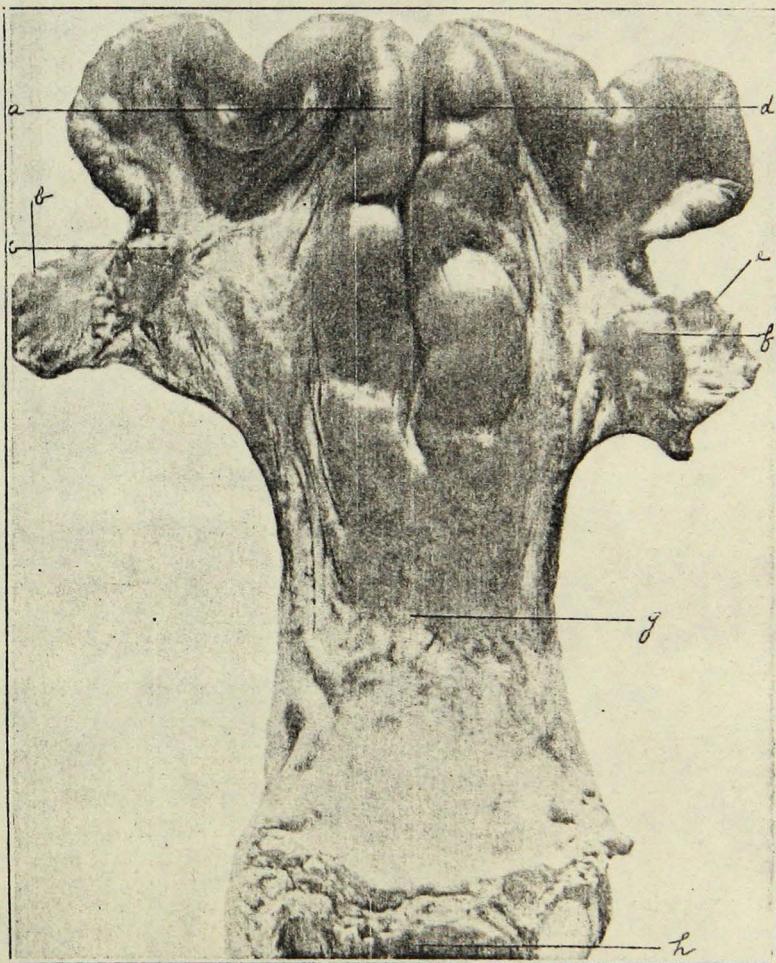
b. Same Passage Near the Vagina

This opening is completely closed only when the animal is pregnant, and contrary to popular opinion seldom requires "opening" in order for the animal to breed.

however, and has not been found in the discharges, usually, longer than 25 days after abortion.

We have made careful bacteriological examinations of the discharges of cattle following abortion and the maximum time that we were able to isolate the germ from these discharges was 25 days fol-

PLATE II



Normal or Healthy Bovine Uterus

- a. Left horn of uterus
- b. Left Fallopian tube
- c. Left ovary
- d. Right horn of uterus
- e. Right Fallopian tube
- f. Right ovary
- g. Body of uterus
- h. Location of opening of cervix

lowing calving or abortion. This indicates that the germ, at least in living form, disappeared from the discharges in three or four weeks after abortion.

It has been found in the milk and udders of animals that have aborted, and in certain instances in the milk of those that have not been observed to abort. It has been isolated from the genital organs of the bull. Abortion bacteria also inhabit the intestinal canal of the infected fetus and may be isolated in pure culture from this source. Outside the animal body, little is definitely known concerning its distribution. Observations and experience seem to indicate that this germ is able to live for some time on litter that has been soiled by the discharge from aborting cows. It is not, however, a long-lived germ outside the body of the infected individual. It has not been isolated from any source where its presence could not have been accounted for as coming from an infected animal. The germ is easily destroyed by disinfectants and heat. A $2\frac{1}{2}$ per cent solution of cresol destroyed the organism in fifteen minutes. A temperature of from 55 to 60 degrees C. (131 to 140 degrees F.) kills the organism in ten minutes.

Germs other than the Bang organism occasionally cause abortion.

METHOD OF DEVELOPMENT

The act of abortion, which is the most prominent symptom of Bang's disease (contagious abortion of cattle), is produced by an inflammation of the cotyledons or so-called "buttons" which unite the inner lining of the uterus (womb) of the mother and the coverings or membranes which cover or envelop the fetus (calf). The severity and extent of the inflammation of the cotyledons and other portions of the membranes determine largely whether or not a pregnancy will terminate in a full-time or a premature birth, or in abortion. If the involvement of the attachment between the maternal and fetal membranes has been severe and occurred during early pregnancy, it often results in the expulsion of a dead fetus, while a lesser involvement may result in the birth of a live, tho much weakened, calf. Such calves frequently succumb shortly after birth. If they continue to live, they offer little resistance to the germs that cause white scours and pneumonia, the common diseases of the new born and young calves. Infected or diseased cows may produce strong and vigorous calves and promptly expel the fetal membranes (afterbirth), but still be a grave source of danger by spreading the germs through the fetal fluids during the act of birth, and later through discharges from the genital tract. Retention of the fetal membranes is a common symptom of infection within the uterus, and various germs may cause this condition, tho the Bang germ is the one most often responsible.

CHANNELS OF INFECTION

The germ usually gains entrance to the body of the cow through the digestive tract. The vagina does not seem to be an important way by which the germ gets into the body. Infection by way of the digestive tract usually occurs by the animal consuming food that has become contaminated by the genital discharges of an infected animal. Also, animals are accustomed to lick themselves or other cattle and in this manner virulent abortion germs may gain entrance to the body. In recent years it has been shown that cattle can readily be infected by placing the germs in the eye. The importance of the eye as an avenue of natural infection is not known, but it may be of some importance. It has also been shown that the germs will enter the body of laboratory animals through the unbroken skin. The importance of this method has not been determined, but it suggests another probable channel through which animals may contract the disease. The part played by the bull in the transmission of the disease has long been a matter of much dispute. Experimental evidence shows a possibility that the bull may transmit the disease by being actively infected and eliminating the germ in the semen. There is also experimental evidence indicating that there is a possibility of the germs entering the udder of a cow through the teat canal.

Calves do not usually harbor infection from birth nor do they usually become permanently infected with the germ through nursing mothers harboring abortion bacilli in their udders, providing this practice is discontinued early in the life of the calf. Experimental evidence has shown that calves fed on milk containing abortion organisms may eliminate living abortion bacilli in the feces, and this must be considered as a factor in the spread of the disease. Heifers that have begun to come in heat, however, should be carefully kept from all material contaminated with abortion germs.

SUSCEPTIBILITY TO BANG'S DISEASE

Altho Bang's disease is chiefly a disease of heifers in their first and second pregnancies, adult cows often abort. An animal may be infected and yet never give positive evidence of such infection by the act of abortion or by premature birth or by retention of the fetal membranes. Frequently animals of this type will fail to expel the fetal membranes. Numerous heifers will abort during the first pregnancy and then carry their second calf to full term. A smaller percentage will abort the second calf and even the third and fourth pregnancies may be terminated by abortion. Again, a heifer may carry her first calf to term and abort during the second pregnancy. Such incidents indicate that very little immunity (resistance) is acquired.

from the effects of the disease, and only a small percentage of animals have a natural immunity. Cows and heifers reared in abortion-free herds will frequently abort and not uncommonly become thereafter difficult to breed successfully when placed in infected or diseased herds. Bang's disease is not confined to any breed or type of cattle, nor is it more prevalent in any one breed than another. The bull is much less susceptible, but often becomes diseased. The testicles, or the glands which produce the germ cells, are the organs which are most often invaded by the Bang germ. Spontaneous or sudden occurrence of inflammation of one or both of the testicles is usually due to the activities of this germ. If such cases are not given special care, they will have, temporarily, a reduced fertility and not infrequently the animals will become permanent non-breeders.

SYMPTOMS

The period of incubation (the time elapsing between the exposure of an animal to infection and the development of the signs of the disease) varies. According to Bang it is about 10 weeks. In producing the disease experimentally, the period of incubation has been determined as approximately 130 days. The symptoms preceding the expulsion of the fetus are a dough-like swelling of the udder ("making bag") together with swelling of the vulva, followed by a yellowish brown, odorless discharge from the vagina. Restlessness and stamping of the hind feet may also be noticed. These symptoms usually appear two or three days before the fetus is expelled. Occasionally heifers have been observed to make bag and even give milk at the sixth month of gestation, the abortion not taking place until about the seventh month. Swelling of the udder in advanced pregnancy does not always indicate infectious abortion, as heifers usually make bag a few weeks before parturition.

Cows will sometimes abort without manifesting any symptoms beforehand. When heifers or cows abort in the early stages of pregnancy, the fetus will be expelled enclosed in its membranes, but when the abortion occurs after the fifth or sixth month of gestation, the membranes (afterbirth) are frequently retained. The largest percentage of observed abortions takes place between the fifth and seventh months of pregnancy, altho abortion may occur at any time during the period of gestation. An animal may abort during the first or second month of pregnancy and the act pass unnoticed. Following abortion, some excitement may be noticed in cows and at times they will show signs of being in heat. The discharges following an abortion continue for two weeks, or longer if the lining of the uterus is severely inflamed. If there is little or no inflammation, only a slight discharge may be noticed, especially in the early abortions (first and

second month). The discharge becomes yellowish-gray in color, sticky in character, and accumulates on the tail and other parts with which it comes in contact. The appetite is at times impaired, the back is arched, and there is more or less straining, owing to the irritation of the uterus. The milk flow is slight at first and one or more quarters of the udder may remain swollen for several days. The calf is born dead, as a rule. If alive, it frequently dies shortly after birth.

The calf born alive is usually weak and undersized and often dies from diarrhea or remains in a stunted condition. In rare cases the fetus becomes mummified (dried up). In every herd where abortion occurs or gains a foothold, some of the animals that have aborted and apparently recovered will fail to conceive (breed), tho served by the bull numerous times. Such animals are known as non-breeders. Enlarged joints, especially the knee and stifle joints, are of frequent occurrence in cattle affected with Bang's disease.

RETENTION OF THE FETAL MEMBRANES

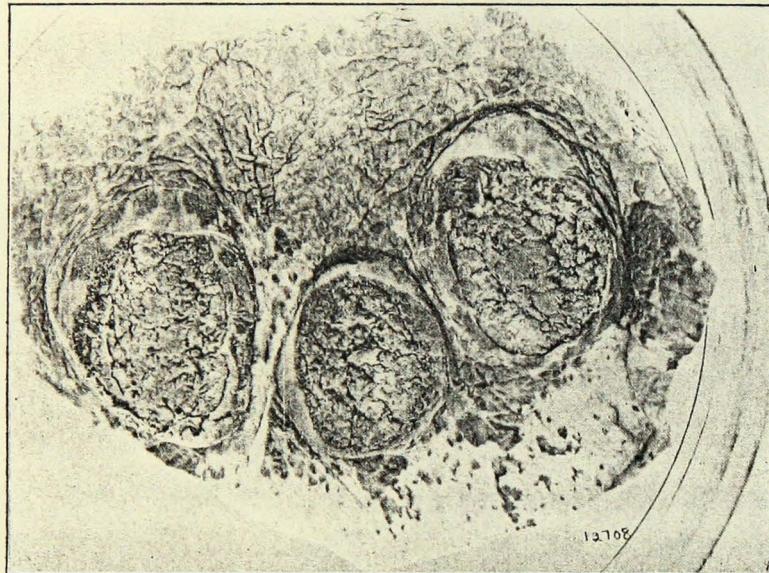
Retention of the fetal membranes is recognized as the most common symptom of infection of the uterus. It is a common condition in cows in which infectious abortion is known to exist, and frequently interferes with the future breeding efficiency of the affected animal. The arrangement of the attachments of the fetal membranes is quite complex in the cow, and consists of from 70 to 100 vascular cotyledons (buttons) scattered over the envelopes enclosing the calf (see Plate III) and directly attached to the same number of cotyledons on the lining of the uterus of the mother. These areas of attachments, which are round to oval in shape, form the only paths for the interchange of nutrition and waste material. The blood vessels of the fetus (calf) and those of the mother are not continuous, but are separated only by a thin membrane. The fetal membranes have an important duty, but following the birth of the calf they are of no further value. Unless they are promptly expelled or removed by hand they rapidly undergo putrefactive changes which may be responsible for a decreased milk flow, and for changes in the reproductive organs, resulting in temporary or permanent failure to again successfully get in calf. Retained afterbirth occasionally terminates in death. The fetal membranes of cows free from infection are usually expelled within 4 to 6 hours following birth of the calf. When the afterbirth has been retained for more than 9 or 10 hours, inflammation is evident and the afterbirth should be removed by hand.

Failure to breed, in most cases, probably is due to inflammation of the lining of the uterus, or to pus in the uterus (see Plate IV), often the result of retained afterbirth. Cystic degeneration of the ovaries (see Plate V) is not uncommon in aborting cows and is undoubtedly

responsible, in certain cases, for temporary or permanent failure to breed. Cows in which the ovaries are extensively degenerated (see Plate V) have irregular and frequent heat periods, and tho they are bred numerous times they fail to conceive.

In cattle, as in other mammals, during a heat period an egg bursts from the ovary and is conveyed to the uterus by the Fallopian tube.

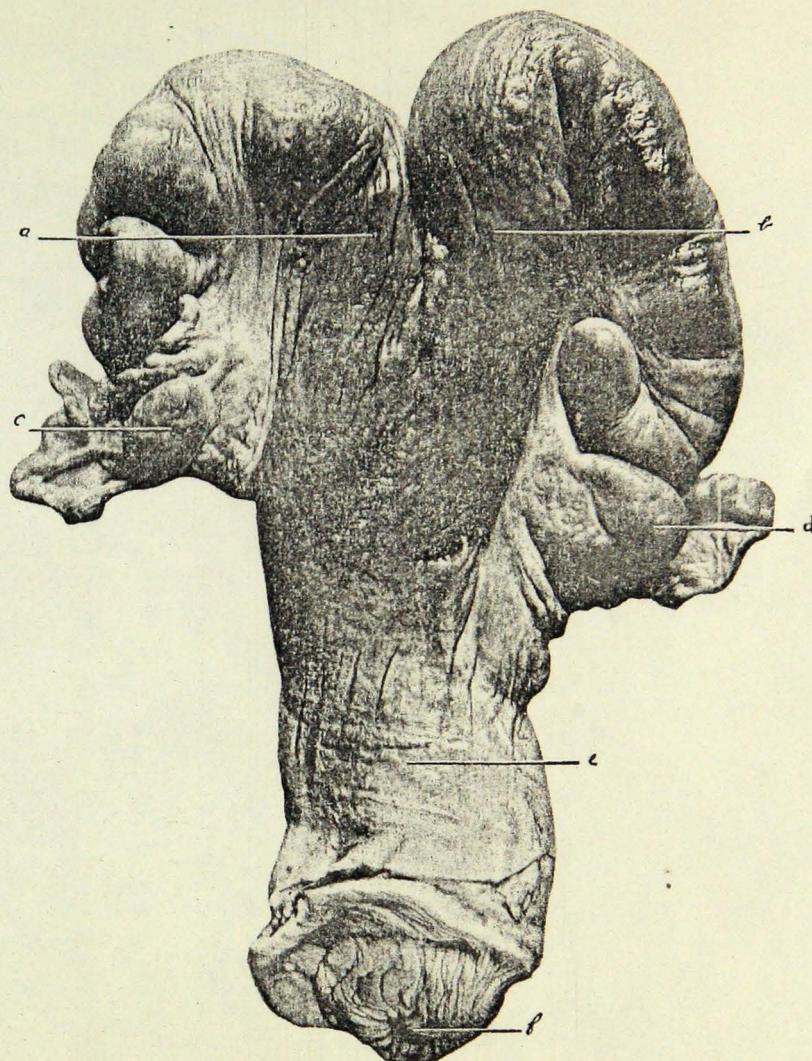
PLATE III



Part of the Fetal Membranes Showing Cotyledons or "Buttons" Extensively Diseased as a Result of Infection with the Abortion Organism

The union of the egg (the female element) with a spermatozoon (the male element) results in the formation of an embryo, or young. The place left in the ovary by the rupture of the egg sac (Graafian follicle) is taken by cells having a peculiar yellowish pigment, which together make up what is termed the *Corpus luteum* or "yellow body" (see Plate VI). If the ovum (egg), which was discharged at this time is fertilized and pregnancy results, this so-called yellow body, or *corpus luteum*, grows to considerable size (three-quarters of an inch to an inch or more in diameter) and remains in the ovary during pregnancy. Following parturition (giving birth) the *corpus luteum* is gradually absorbed. If the ovum is not fertilized, the cells of the *corpus luteum* lose their yellow color and the body begins to disappear or be absorbed within two weeks following a heat period. This process is followed by the formation of a small, white body known as a *corpus albicans*.

PLATE IV

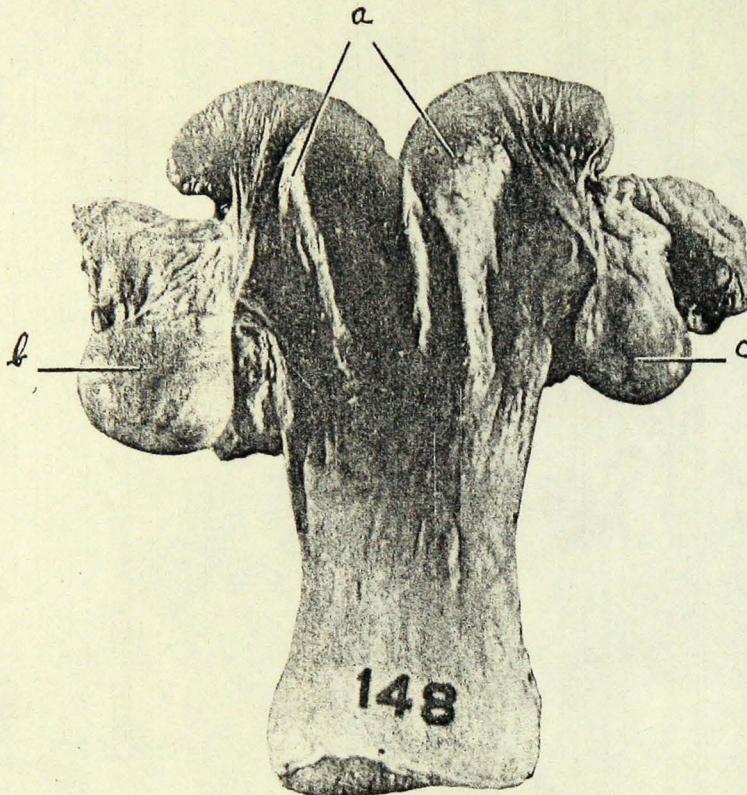


Diseased Uterus of Non-Breeding Cow (Note increase in size)

- | | |
|-------------------------|------------------------------|
| a. Left horn of uterus | d. Right ovary |
| b. Right horn of uterus | e. Body of uterus |
| c. Left ovary | f. Opening of cervical canal |

It not infrequently happens, as a result of deranged functions of the genital organs, that the *corpus luteum* is not absorbed or the retrogressive changes resulting in the formation of the *corpus albicans* do not take place. The *corpus luteum*, tho pregnancy has not taken place, remains unchanged. This condition frequently interferes with the

PLATE V



Uterus and Large Diseased Ovaries Which Are Cystic, from a Non-Breeding Cow

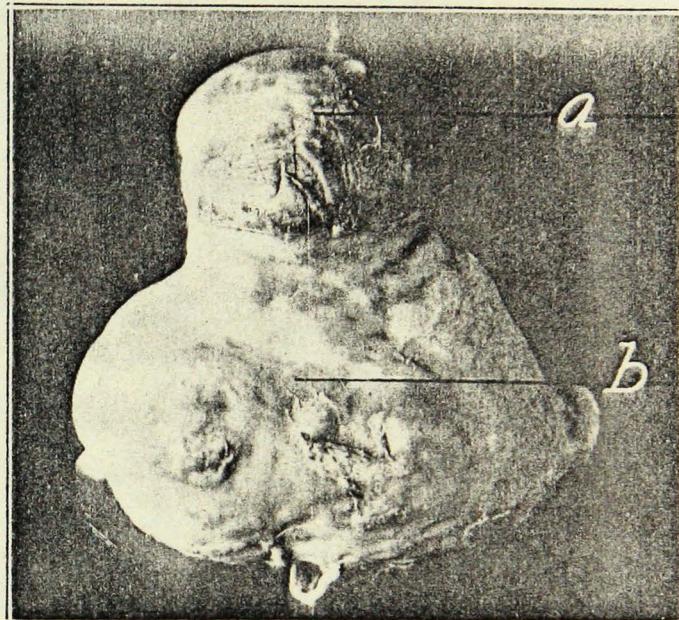
- a. Horns of uterus
- b. Cystic ovary, left
- c. Cystic ovary, right

further ripening and escape of ova by mechanical interference and also by an internal secretion. Both of these, that is, the one resulting when pregnancy has not taken place and the one which is not absorbed after pregnancy is terminated, are termed "retained *corpora lutea*" (see Plate VI). As a result of these retained yellow bodies the animal may fail to come in heat, often leading the breeder to suppose that the animal is pregnant or permanently sterile. A retained *corpus luteum* may become cystic (cavities develop within, filled with fluid), which interferes with the function of the ovary and results in constant or irregular heat periods. Animals thus affected imitate the male animal and are often called "bullers" (see Plate VII).

To sum up, then, the observed act of abortion is only one of the symptoms of this disease. The animal may abort during the early

stages of pregnancy and the fact pass unnoticed, the owner simply thinking that she did not conceive at the previous service. Discharges from the vagina, especially of a brownish or yellowish color, abundant, and at first odorless, indicate infection. Failure to breed is frequently the result of an initial infection by *Bact. abortus*.

PLATE VI

Ovaries Showing a Large Retained *Corpus Luteum*

- a. Retained yellow body or *corpus luteum*
- b. Body of ovary

HOW BANG'S DISEASE (CONTAGIOUS ABORTION) IS SPREAD

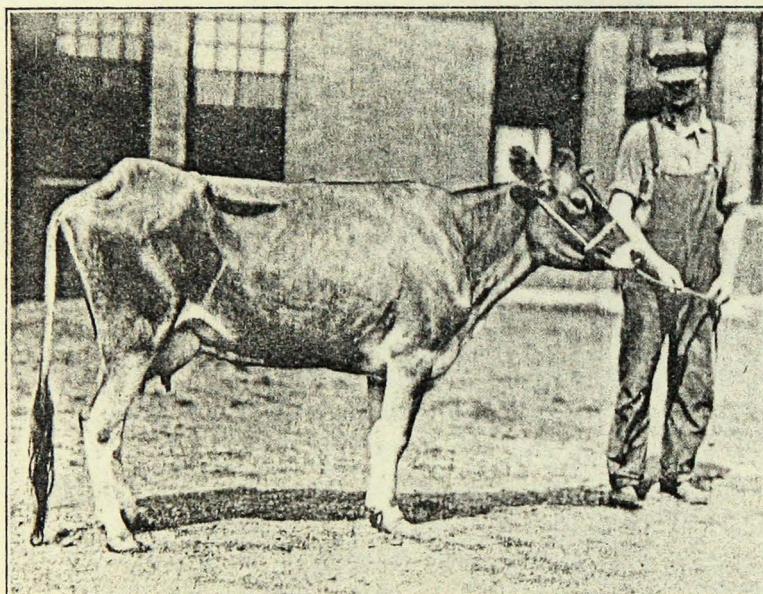
The introduction of diseased females into healthy herds is the most common method of spreading from one herd to another. Traffic in cattle has been a most important factor in the dissemination of this disease into the large number of herds in which it exists at present. Owners of cattle should be exceedingly cautious in selecting animals to be added to healthy herds. Not all diseased females abort their young. The fact that a female has a normal calf is not conclusive evidence that she is free from this disease. Many cattle buyers have been misled by the appearance of a normal number of calves in ratio to the number of females in a herd from which purchases are to be made. The only reliable or practical method of selecting animals

for introduction into healthy herds is the intelligent use of the agglutination blood test.

Susceptible females may contract the disease if they are housed in stalls in which animals have aborted. Common carriers (trucks and railroad cars) should be considered as possible sources of infection unless they have been thoroly cleaned and disinfected.

Diseased females are a constant source of danger to other animals in the herd. They are particularly dangerous at the time of calving

PLATE VII



Sterile Cow as a Result of Cystic Ovaries (Note condition of tail head.)

or aborting and during the period preceding and following the expulsion of the fetus from the uterus, during which there is a discharge from the genital organs. The contents of the uterus (fetus, fetal membranes, and fluids) contain myriads of the germs and when expelled become agents by which the disease spreads. A diseased female may give birth to a normal calf and yet be an important source of danger to healthy animals. Experimental work has shown that 25 days is the maximum time following abortion that the germs will be spread by the discharges.

Abortion germs are commonly discharged in the milk of diseased cows. Mature animals do not usually have an opportunity to contract the disease from this source. However, the milk of diseased cows should be considered an infective agent. The opening in the teats of

a few animals are excessively large (leakers) so milk is more or less continuously discharged. In these cases, when the milk contains abortion germs, they may contaminate grass or other foodstuffs. Careless handling of milk, such as milking onto the floor of the barn, may provide an opportunity for the abortion germs in the milk to gain access to healthy animals.

Young calves are usually not susceptible to infection with abortion germs. It is advisable to allow the new-born calf to get the first milk (colostrum). The first milk of diseased cows can usually be fed without serious danger to a young calf, altho the calf should not be fed milk from diseased cows any longer than is absolutely necessary. In most cases it is possible to select healthy animals to provide milk for calf feeding. Considerable evidence indicates that some young heifers take in abortion germs with milk and retain them without showing any evidence of the disease until later. This is not, however, a common occurrence. When heifers have reached the age of sexual maturity, some of them are very likely to contract the disease if allowed to drink milk containing abortion germs.

The germs taken in with the milk are eliminated through the manure of young calves. The statement has frequently been made that heifers under 6 months of age are the safest females to add to healthy herds. Such animals are usually safe providing they are negative to the blood test and are isolated for 2 or 3 weeks, until the germs are eliminated from their bodies, before they are allowed to enter the premises used by healthy animals. The feet, legs, and abdomen of such calves should be washed with an antiseptic solution (2 per cent sheep dip) before they are moved to the quarters occupied by the abortion-free animals.

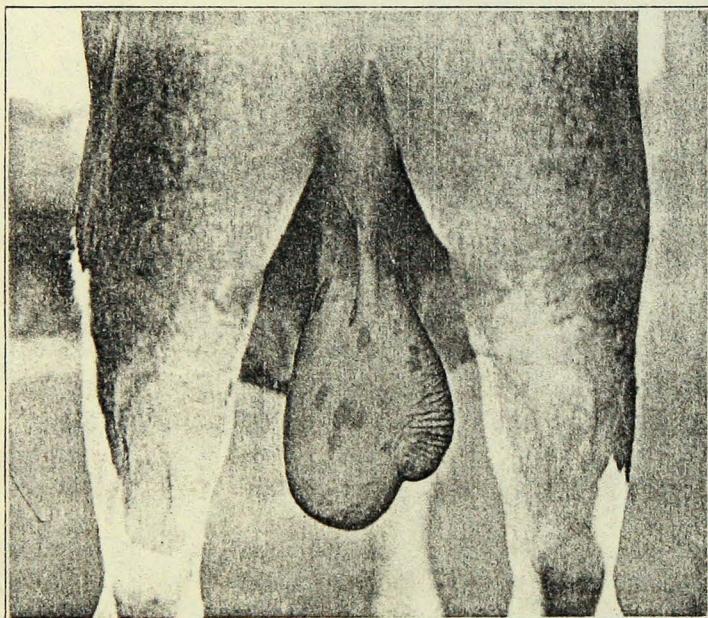
This disease probably spreads as frequently in the pastures and paddocks as in the barns. Animals abort without giving any warning and the fetus has been expelled before the herdsman realizes that anything is wrong with the animal. Many early abortions pass unnoticed. Pasture calving has been advocated by some persons, but it frequently is responsible for the spread of abortion disease. The use of clean maternity stalls for all calving or aborting animals is of great value in preventing spread of the disease.

The segregation of infected and healthy animals in different parts of the same barn will not prevent the spread of this disease if a common pasture or paddock is used.

The bull is not an important factor in the spread of abortion disease. It has been stated that the sire may carry the germs in his penis. This is not an important method of spread. The bull himself may become infected and eliminate the germs in his semen. When the

bull is harboring abortion germs they may be discharged into the vagina of the female at the time of service. As a rule the germs will not enter the circulating fluids (blood or lymph) of the cow's body from the vagina. The germs that enter the vagina at the time of breeding may later pass out of the genital tract and contaminate the tail and external genitals and drop into grass or other foodstuffs. Other females may then take these germs into their bodies through the mouth by licking the cows or consuming foodstuffs that became contaminated in this manner. In the present state of our knowledge,

PLATE VIII

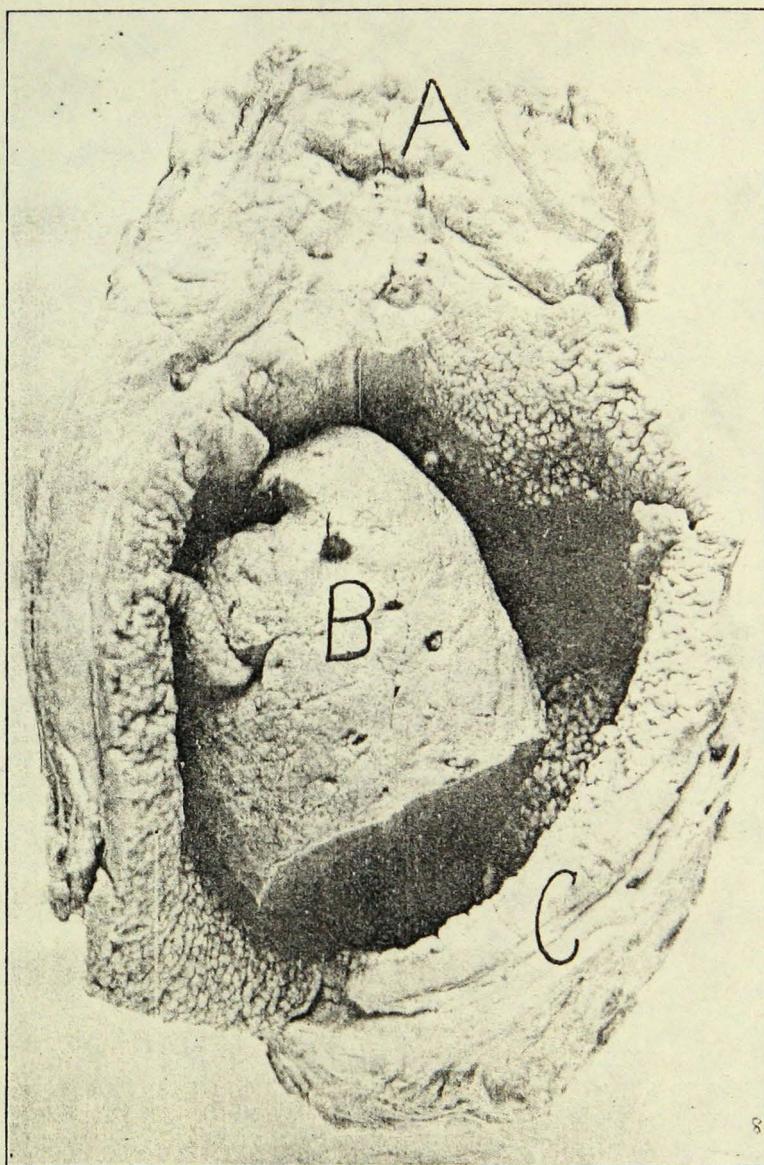


Enlarged Left Testicle of Bull, Resulting from Inflammation

the digestive tract is the chief way by which the animal becomes naturally infected with the germ.

While it is not a desirable practice, experience has shown that the breeding of healthy bulls to diseased and healthy cows rarely, if ever, results in the spread of Bang's disease if the mating occurs on neutral ground, that is, not used by healthy or diseased animals. Some other germ diseases of the genital organs of cattle are regularly transmitted by the bull from one cow to others through the act of service.

There are numerous other ways, such as drainage, contamination of barn equipment and shoes and clothing of attendants, and pastures separated by single fences, in which infective material may be trans-



8

Testicle of Bull Infected with *Bact. abortus*

- a. Cord very much thickened
- b. Testicle
- c. Coverings (Note how thick they are.)

mitted to healthy females. It is likely that not all of the methods of spread of this disease are understood. When the various ways in which this infection spreads are considered, the difficulties met with in its control are realized. It is not easy to prevent the spread of this disease, but experience has shown that it can be done successfully. Light, cleanliness, and ventilation are prime factors from the stand-point of control and should be observed as carefully and rigidly as possible. Taking into consideration the foregoing facts, the breeder will readily appreciate the need of good stable sanitation, the proper disposal of infective material, and the danger of introducing new animals into the herd.

DIAGNOSIS

An absolute diagnosis of the presence or absence of Bang's disease can not be made without a laboratory examination. The history of abortions and other symptoms in a herd may be strongly suggestive of this disease. There are causes of abortion in cattle other than the Bang germ. Approximately 85 per cent of all abortions in Minnesota cattle are due to *Bact. abortus Bang* (abortion disease). It is therefore safer to view all abortions as being due to *Bact. abortus Bang* until laboratory examinations have eliminated this germ as the cause. Infected cows may abort their young once or twice and thereafter give birth to calves at full term. Some diseased cows never abort. It is therefore evident that we can not rely entirely on the history and symptoms for arriving at an accurate diagnosis of the cause of abortion in cattle.

The only satisfactory method of diagnosis is a laboratory examination. Such studies include:

1. Bacteriological examination (or a study of the invading germs).
2. Blood tests for evidence of infection in the bodies of suspected animals.

BACTERIOLOGICAL EXAMINATIONS

By bacteriological examinations it is possible to isolate the germs and grow and study them in the laboratory. These methods are, however, too expensive and require too much time to be adaptable for the routine diagnosis of this disease in many animals. They are an excellent check on the results and dependability of the blood test.

Blood Tests

A safe, reliable, and practical method of diagnosis of abortion disease is available in the blood test known as the agglutination test. This test will not determine which of the diseased females have or

will abort. It will determine which are or have been harboring the Bang germ and are consequently possible sources of infection.

It is not claimed that the agglutination test is 100 per cent reliable, but it is sufficiently reliable to permit the successful control of abortion disease. Animals that are tested for Bang's disease are divided into three groups: (1) Positive, (2) suspicious, (3) negative.

Positive animals are or have been harboring the germs and should be considered dangerous to other animals.

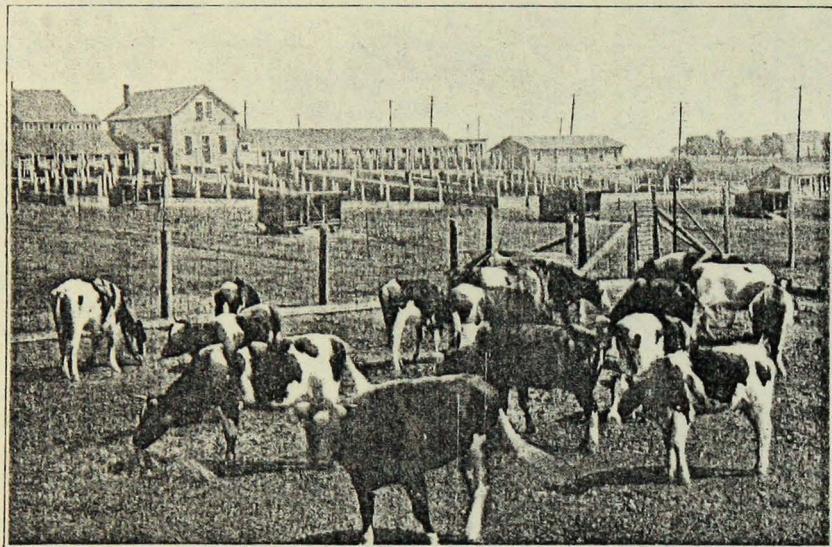
Suspicious animals are those in which a single blood test does not justify classifying them either as positive or negative. They should be re-tested in about 30 days.

Negative animals are not at the time of the test infected with *Bact. abortus*, except those that have very recently contracted the disease and have not yet developed evidence of it in their blood. An occasional diseased animal will have a negative test if the blood sample is obtained either a few days before or after a calving or abortion. The explanation of this negative phase is not known, but in such cases it often causes persons to unjustly question the accuracy of the agglutination blood test. The fact that an animal has a negative test does not mean that it will remain negative, because there is always danger of subsequent infection. Too much reliance should not be placed on a single negative test, especially if there is evidence of active infection in the herd or if the blood sample has been taken a few days before or after a calving or abortion.

It is of interest to note the percentages of cattle tested in Minnesota that fall in the foregoing groups. Approximately 22 per cent are positive, 5 per cent are suspicious, and 73 per cent are negative. Recent extensive experiments have shown that the slight discrepancies in the results of the agglutination blood test are confined to the tests of the group of suspicious animals. Even in this group, the blood test has been perfected to a high state of efficiency. This means that the agglutination blood test has an efficiency considerable in excess of 95 per cent, which is as near perfect as is necessary for its successful and practical use as a diagnostic method.

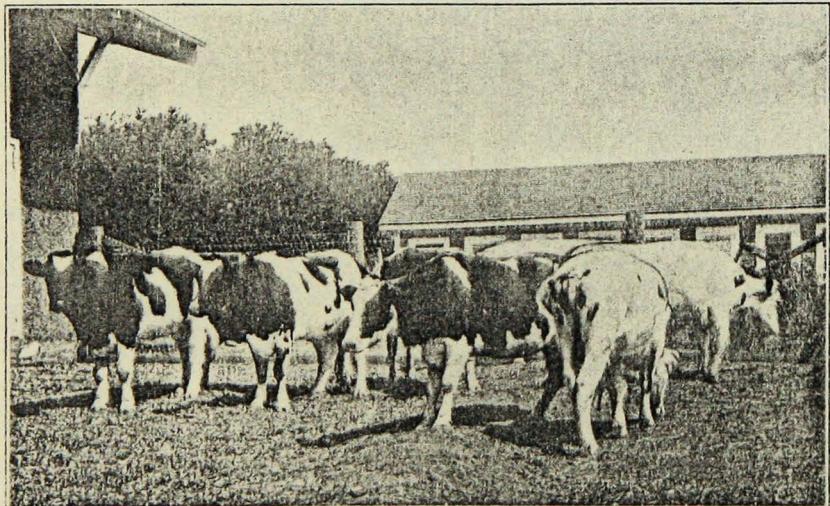
Two methods of conducting the agglutination test are in use. (1) The test-tube method, which has been used successfully for many years. (2) The rapid method, which has been developed and used by some during the last few years. Both involve similar principles and differ only in the method of applying the agglutination blood test. The rapid agglutination test has the advantage of saving two days in obtaining results. It offers promise of supplanting the old test-tube method. However, we do not feel justified in discarding the test-tube method until further experiments have been conducted to determine the factors governing the use of the rapid method and its dependability.

PLATE X



The Clean Herd of the Experiment Mentioned on Page 23

PLATE XI



The Infected Herd of the Experiment Mentioned on Page 23

One of the principal factors limiting progress in the control and eradication of this disease is a lack of faith on the part of many cattle owners in the results of the agglutination blood test. When this test is thoroly understood, properly conducted, and rightly interpreted, it is an invaluable aid in the recognition and control of this disease.

PREVENTION AND CONTROL

The most successful method of treating contagious abortion is to prevent its spread. Various drugs have been used for its prevention and treatment, and while the results obtained vary considerably, none have proved of value. There is yet no reliable cure for contagious abortion.

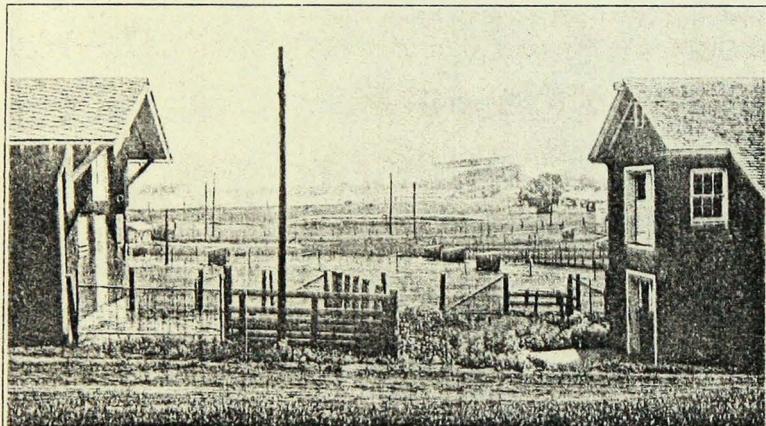
The most active source of spread of this disease is the recent aborter. This animal should be separated from the rest of the herd for 30 days, when the germs will have disappeared from the discharge. Sometimes a cow may calve normally and still scatter the abortion germs with the fetal and uterine fluids. It is therefore very important that animals be kept apart from the herd at the time of calving. Usually the germs disappear from the uterus in a few weeks. The longer isolation can be continued, up to 30 days, the safer, but if this period is not practicable on the farm, all animals that have recently calved should be classed as infected and kept apart until all discharges cease. Cleaning and carefully disinfecting the parturition stall are important, also the proper disposal of all infected material and bedding soiled by the discharges. These should be burned. The bull should be kept apart from the herd and breeding should be only on neutral ground (that is, ground not used by male or female cattle). This is necessary because of the danger of contaminating the food of cows with discharges from the sheath and penis of infected bulls. The seminal fluid sometimes contains virulent organisms. After breeding, cows should be confined in stanchions where there is little danger of licking themselves or being licked by other animals. It is an excellent precaution to wash the back parts of the cow which has been bred with soap and water before allowing her to associate with other animals. It is always advisable to keep her confined until the heat period passes.

It has been stated that many cows give off the germs of abortion in their milk. This is true of animals that have never aborted. Milk, therefore, should be considered an infective agent and carefully kept from contaminating the food of heifers or cows. Milk does not seem to be infective to calves. Infection can take place through the teat canal, altho this is probably an unusual channel. Care must, however, be taken to have the hands clean and the suction cups of the machine disinfected before the milking of each animal.

These precautions do not eliminate all the possible sources of infection, but they do look toward the proper disposal of certain of the most active sources of infection and go to make up good stable sanitation, which should be practiced by every breeder whether or not his herd is infected with contagious abortion.

Various bacterins, vaccines, and serums are on the market for the prevention and control of abortion disease. Numerous experiments have been conducted at University Farm to determine, if possible, the actual value of these agents. The published data are very conflicting in regard

PLATE XII



The clean and infected herds are stabled in these barns with only this short distance between them.

to their efficiency. As a result of the experiments, we have come to the following conclusions :

1. The living vaccine produces some immunity to invasion of the placenta by *Bact. abortus* Bang. The degree of immunity varies according to the individual and the variations are marked.

2. The dead bacteria or bacterins have very little immunizing value.

3. Abortions occur in animals that have been treated with vaccines. It is true that living vaccines will reduce the abortion rate, but not to the desirable minimum. A large dairy herd in which we conducted experiments for three years showed an abortion rate of 11.9 per cent among the vaccinated animals. In the controls, or unvaccinated cattle, the rate was 16.6 per cent.

A breeder can never expect to eradicate the disease from his farm if he employs living vaccines. It should be borne clearly in mind that the disease is kept alive on the farm where living vaccines are used.

The only feasible method for controlling Bang's disease, in the light of our present knowledge, is on the basis of the agglutination blood test and the maintenance of a herd free of the disease. Before we outline the methods that may be used in freeing herds from this disease, we wish to point out several important things: (1) Traffic in cattle indicates that it will not be long before all animals sold for dairy or breeding purposes will have to pass a negative blood test for Bang's disease. At present 21 states require a health certificate for this infection. (2) Altho the public health aspects of undulant fever in man, in our judgment, are not prominent, nevertheless consumers of raw milk, pasteurized milk, butter, and cheese are going to demand that they come from animals free from contagious abortion. (3) Herd owners should fully understand that even the Bang's disease is entirely eliminated from the herds, abortions will occur. We estimate, as stated before in this bulletin, that the Bang organism is responsible for only approximately 85 per cent of the abortions. Occasionally abortions occur in any medium sized herd. Sterility will also occur in herds free of Bang's disease. The number of abortions and sterile cows is materially reduced when this disease is eliminated from a herd.

Experiments conducted at University Farm show that it is possible to keep a clean herd and an infected herd on the same farm but having no physical contact. These herds were taken care of by the same men and no unusual precautions were taken to prevent the spread of the disease. It is possible for a farmer to dispose of his infected animals economically. The following results obtained in the experiment mentioned indicate clearly the advantage of the clean herd.

Clean herd—33 females
148 services for 87 pregnancies.
Ratio 1.7 to 1.
56 living calves for 64 terminated pregnancies, 87.8 per cent.
3 abortions for 64 terminated pregnancies, 4 per cent.
4 retained placentas for 64 terminated pregnancies, 6 per cent.

Infected herd—16 females
103 services for 43 pregnancies.
Ratio 2.4 to 1.
20 living calves for 38 terminated pregnancies, 52.6 per cent.
17 abortions for 38 terminated pregnancies, 44 per cent.
18 retained placentas for 38 terminated pregnancies, 47 per cent.

Breeders are coming to realize that testing for abortion is as important as testing for tuberculosis. Many require that all purchased animals be tested before being added to the herd. In co-operation, the State Live Stock Breeders' Association, the State Live Stock Sanitary Board, and the Division of Veterinary Medicine, at University Farm, have drawn up a series of agreements, lettered A, B, and C, which are used in connection with the control of this infection. These agreements are printed at length in this bulletin. The services of the diagnosis laboratory of the Live Stock Sanitary Board, located at University Farm, in the Veterinary Division, are given without charge to

those who desire to free their herds of this disease and who sign one of these agreements. Already more than 1,000 breeders in this state have availed themselves of this privilege. Several herds have been accredited and more than 100 are approved at the present time. Plan C can be signed and lived up to by any cattle owner in the state. Essentially, the only thing that the animal owner has to agree to in this plan is not to dispose of reacting animals except under permit from the Live Stock Sanitary Board. This permit is granted in nearly all cases. The only thing that is essential is that the individual who purchases animals known to be infected shall be fully cognizant of the animal's condition at the time it is bought.

RELATION OF BANG'S DISEASE TO HUMAN HEALTH

In recent years it has been shown that undulant fever in man may be caused by the same germ that causes Bang's disease in animals. There have been cases of undulant fever which apparently resulted from the ingestion of Bang's disease germs in raw cow's milk. This has not yet been proved to be a very common source of undulant fever. At present, undulant fever is not classed as a major public health problem. The dairyman should consider the possibility of persons contracting undulant fever from Bang's disease germs in raw cow's milk and also the possible influence that this aspect of the disease may have on his market for dairy products.

CARE OF ANIMAL DURING PREGNANCY AND PARTURITION, AND CARE OF NEW-BORN CALF

The proper handling of cows during advanced pregnancy is a very important part in the general campaign against abortion. Place the animal in a clean disinfected box-stall. It should be kept clearly in mind that thorough cleansing is worth as much as disinfection, if not more.

When the calf is born, rub it dry with a clean cloth. Disinfect the stump of the navel cord with a 1 to 1,000 corrosive sublimate solution (tablets of this material may be purchased at any drug store) or tincture of iodine, by placing the solution in a tumbler. Stand the calf on its feet and immerse the stump in a tumbler of disinfectant. Keep it submerged from 15 to 30 seconds. The stump may then be dusted with an antiseptic powder composed of equal parts of boric acid and powdered alum.

All calves should be allowed to remain with their dams for the first day in order that they will get enough colostrum (first milk), which has certain properties that aid in protecting the new-born calf against various diseases. Cows with retained afterbirth should

be kept separate from the rest of the herd, and the udder should be carefully cleaned before the calf is permitted to nurse. Retained afterbirth is accompanied by discharges that stain the udder, and if not carefully watched may cause scours in the calf. Milk from the cows with retained afterbirth, if mixed with other milk being fed to calves, may be responsible for causing a sudden outbreak of scours, in which a large percentage of the animals will become ill at or near the same time.

Researches have shown that most new-born calves do not become actively infected with *Bact. abortus* from milk. The organisms may, however, locate in the lymph glands in the region of the throat, where they remain for a few weeks.

TREATMENT OF ANIMALS AFFECTED WITH BANG'S DISEASE

No attempt should be made by the layman to irrigate or disinfect the uterus (womb). Not only is it impossible to disinfect the cavity of the uterus, but it is also dangerous as the lining is easily injured and at times the walls of the uterus may be ruptured. Rupture, or severe injury, to the lining and walls of the uterus reduces the fertility of the animal or renders it a permanent non-breeder. In some instances death follows in a short time. The vagina only should be irrigated, with a mild saline solution.

Coal-tar disinfectants should not be employed as douches for the genital tract of cattle. The apparatus used in douching aborting cows should not be used around Bang abortion-free cattle. The vagina can be douched by the use of a soft rubber tube one-half inch in diameter, one end of which is introduced into the vagina, the other end being furnished with a funnel into which the solution is poured, and which is then elevated so that the fluid will gravitate into the vagina. It is not necessary to siphon the fluid off. The cow that has recently aborted or has failed to expel the fetal membranes (afterbirth) should be isolated and not permitted to mingle with other cattle until all discharges have ceased. The irrigation should be repeated daily for 10 days and then twice a week until there is no further evidence of discharge. Retention of the fetal membranes requires early treatment in order to maintain the health of the cow and in order to prevent the development of disease conditions which may seriously interfere with her ability to again get in calf. Successful handling of cows that fail to clean is very important and the advice or services of a veterinarian should be obtained early.

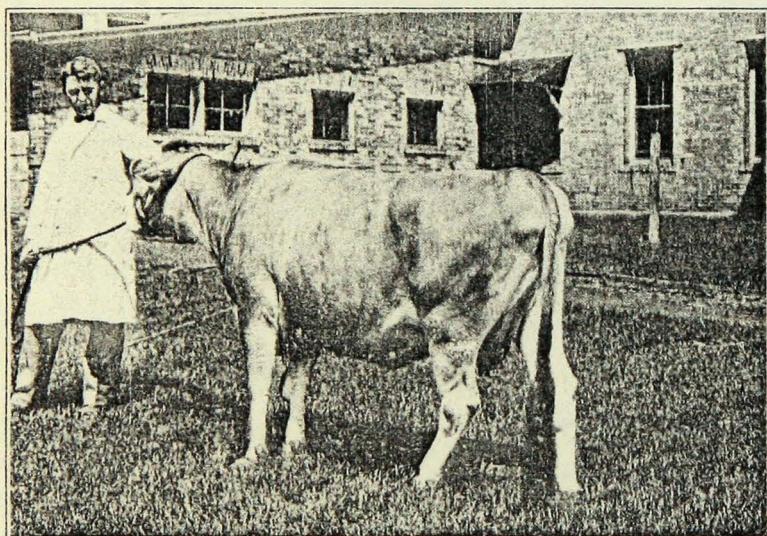
Heifers and cows in herds free from Bang's disease or in herds in which the control of Bang's disease by use of the blood test are being

attempted, may abort from causes other than the Bang germ, but they should be separated from all other cattle and not returned to the herd until it can be definitely determined by repeated agglutination tests that they are not affected with Bang's disease.

BREEDING COWS THAT HAVE ABORTED

An animal that has aborted should not be rebred until her genital organs are healthy. A healthy condition usually can be restored with proper care, altho some animals will remain diseased even after the best treatment known has been applied. It is folly to breed a cow that has

PLATE XIII



This cow has aborted six times and had one living calf at full term,
as a termination of seven pregnancies.

a discharge from the uterus. She will not only be unlikely to conceive but she may also expose the bull to a virulent infection other than Bang's disease, thereby tending toward the spread of the disease in the herd. Further, in case the cow does conceive, the fetus will frequently be expelled while quite small and in a short time the heat period will recur. As stated, many abortions of this type are not noticed.

It is impossible to say how long a time is necessary for the genital organs to become healthy. In some animals, with the proper treatment, it may not be more than from 30 to 60 days. In other animals it takes months of careful treatment. The advice and services of a competent veterinarian are necessary in cases that stubbornly refuse to respond to treatment.

TREATMENT OF THE SIRE

It is highly advisable to have all bulls used for service tested for Bang's disease. In this way actively infected animals can be removed from the herd and this source of spread of the disease be eliminated. Sterility is not uncommonly induced in the female by bulls infected with pus-forming bacteria. Tuberculosis, also, may be transmitted during copulation. Sires developing sudden or spontaneous inflammation of one or both testicles should be carefully examined for Bang's disease. Those with unnatural discharges from the sheath should not be mated.

TREATMENT OF STERILE COWS

Sterility, temporary or permanent, is a frequent sequel to abortion and is often the result of retention of the afterbirth, cystic ovaries, or inflammation of the uterus. In cows that fail to clean, certain pus-forming organisms gain entrance to the genital passages, where they cause temporary or permanent changes (see Plate IV). In herds in which reduced fertility exists, there is a decrease in milk production as well as a failure to produce calves. In many instances sterile cows are bred every time they appear in heat. Frequent service not only aggravates the condition of the cow but endangers the health of the sire as well. The treatment of sterility requires surgical skill and should be attempted only by expert veterinarians. All cows that fail to breed should be examined, the incurable ones sent to slaughter, the others treated and put into service again as soon as possible.

IMMUNITY

The hope of controlling Bang's disease by vaccination has not yet been realized. Vaccination for this disease is in the experimental stage and is not recommended. There is evidence of resistance to this disease by some animals under special conditions. This tendency toward immunity has acted as a stimulus to investigators in the attempt to produce a satisfactory artificial immunity.

The only method of vaccination that has shown much promise of success consists in inoculating the animals with living abortion germs. Experimental evidence and experience have shown that vaccination frequently reduces the percentage of abortions in a herd; however, the resistance resulting from vaccination is not consistent and the results have not been sufficiently satisfactory to justify this method of combating Bang's disease. Further experimentation may evolve a method of vaccination which is satisfactory for the control of this disease.

Vaccination and blood testing can not be satisfactorily used in a herd at one time because some vaccinated animals become positive reactors to the blood test. Further, some vaccinated animals become actively

infected with Bang's disease and eliminate the germs in their milk. In recent years it has been shown that undulant fever in man may result from abortion germs in raw milk. It seems that vaccination with living germs is at times a dangerous procedure from this standpoint.

Under favorable conditions, some diseased females have overcome this infection and become essentially negative to the blood test, and have become profitable animals. In our experience the percentage of animals that overcome the disease under ordinary conditions is far too small to be of any practical economic importance. The existence of such animals has in many instances merely served to build up a false hope on the part of owners of diseased herds.

DISEASES OF NEW-BORN CALVES

The losses occurring in new-born calves are enormous. The great majority of the losses are the result of infection and are classified in three main groups of diseases: (1) Calf scours and navel infection; (2) calf pneumonia, a disease occurring independently of that frequently observed in connection with scours and navel infection; and (3) poisoning, especially from paint containing lead. Scours in calves sometimes results from coccidiosis.

White scours is usually manifested by diarrhea, the result of inflammation of the intestines, but in other forms there is no diarrhea, which makes the recognition difficult. The disease usually attacks the calves suddenly when they are from 48 to 72 hours old, with marked depression and diarrhea (scours); the typical course of the disease is short and the death rate varies from 50 to 100 per cent. Once the disease has become established, it has little regard for the age limit, often affecting calves several weeks of age. The disease, besides being influenced by age, has a seasonal occurrence. Frequently it begins during the fall, in a mild form, becoming more severe and fatal in late winter and early spring. The disease may also assume a severe form in summer.

The causes of white scours have been investigated by many workers. Of the causes described, the germ theory gained most prominence. The germ most often found in calves affected with white scours is the colon bacillus, a germ that occurs widely in nature and is always present, sometimes harmful and again harmless. The early investigations led to the production of a serum to be used as a preventive. More recent investigations indicate that the colostrum (first milk) contains antibodies (protective agents) and is beneficial to new-born calves in which it would build up a resistance to various diseases, particularly white scours. Up to this time the colostrum was thought to be of value only because of its laxative effects.

Predisposing Causes

The colon germ and its associates frequently do not attack the calf unless the resistance is lowered. Calves of the dairy breeds are surrounded by more hazardous conditions than those of the beef breeds. They are removed from their dams usually within 3 or 4 days and fed a mixed milk from pails. It is difficult to keep the milk at a certain temperature and often the calves are greatly overfed during the first few days or weeks. The pails may also frequently be a contributing factor to scours, as they are hard to keep scrupulously clean and sanitary. Many calves have a ravenous appetite and often receive more milk than they can consume. We are of the opinion that overfeeding is the most common cause of scours. The symptoms are, as a rule, not difficult to recognize. Often the calf is dull and will be found to have a higher temperature before diarrhea begins. Diarrhea begins suddenly, the depression is more marked and the calf eats sparingly or not at all. Death may follow within a day or two following the first signs of illness. The disease soon spreads, as it is contagious.

Methods of Control

Systematic and careful feeding will do much to prevent scours. The calf should be allowed to remain with its dam for 12 to 24 hours in order to obtain sufficient colostrum. After that it must be carefully fed to develop a strong, vigorous calf. Some authorities recommend giving the calf only 5 per cent of its own weight in milk the first day and increasing this one per cent daily for 10 days, when it will be receiving daily 15 per cent of its own weight. Calves affected with scours should not be given any milk, but fed on barley water, being given the same quantity as they were receiving of milk. This method should be carried out for 4 or 5 days, or until the calf has recovered. The use of muzzles to be worn between feeding periods is highly recommended. The muzzle prevents the calf from eating its bedding and other material, the result of a depraved appetite, which often occurs in connection with scours. The drug that may be given by the layman are 2 to 4 ounces of castor oil. Six to 8 ounces of soda water or lime water every 4 hours is beneficial. Scours is so destructive and spreads so rapidly that the services of a veterinarian should be obtained early in order to prevent heavy losses.

Calf Pneumonia

Pneumonia, or inflammation of the lungs, of a primary nature, not the type associated with scours, is hard to control. It attacks calves at from one to 3 months of age. Coughing is one of the first symptoms to be noticed, and tho the disease may produce death in a short time, the

course is usually prolonged. The temperature of the calf is slightly above normal and the appetite is more or less deranged. The disease spreads rapidly in certain herds, particularly during the winter months, while in others it spreads slowly. Death results from extensive involvement of the lungs, in which small abscesses (boils) are of common occurrence. Some calves will recover, others only partially, being left with large cavities in the lungs, which are evidenced by a chronic cough, a roughened coat, and a more or less stunted condition.

Prevention consists of good housing. Provision should be made for well lighted, roomy stalls or pens and ample room for play and exercise outdoors. The calf with pneumonia should immediately be removed from other calves. Medicinal treatment is of little value.

Lead Poisoning

Lead poisoning, which usually develops suddenly, is responsible for a considerable loss each year among new-born calves. Paint containing lead, especially lead carbonate, should not be used for painting barns or barn equipment. This is also true of paddocks or outside enclosures where calves exercise or feed. Symptoms of lead poisoning consist of excitement, such as bellowing, grinding the teeth, and running in a circle. The disease terminates frequently in sudden death.

Coccidiosis

Coccidiosis affects calves at a later period in life than does scours or pneumonia. The cause is a small parasite, which may be found on the ground. The parasite may be taken up through the drinking water or the feed. The symptoms consist of a diarrhea containing small clots of blood. The presence of blood clots in the passages of calves affected with scours should be looked upon as suspicious of coccidiosis. The fact that young cattle and even aged animals may contract this condition is helpful in differentiating this disease from scours as a result of over-feeding or infection. The droppings of calves affected with coccidiosis contain the parasites, which can be easily demonstrated by the microscope. Treatment consists of removing the animals to new pastures or fencing off the low, badly drained places to prevent contact with the parasite. A veterinarian should be called to medicate the animals.

STABLE SANITATION

Intelligent sanitation practices are generally recognized as an important part of the successful management of any livestock enterprise. Just as a matter of precaution it is advisable to clean thoroughly and disinfect the barns once or twice a year.

Disinfection, as it is frequently practiced, is of little or no value. The most common cause of failure is inadequate cleaning of the walls

and floors that are to be disinfected. As germs are so small and can be carried about in numerous ways, they may lodge in the smallest and most remote portions of the stable and in places most difficult to reach with a disinfectant. Hence, the usual so-called "disinfection," which consists in scattering a strong-smelling substance about the barn, can not be efficient. No disinfectant can destroy germs unless it comes in contact with them. Unless a thoro job of cleaning has been done before the disinfectant is applied it can not reach the germs and destroy them. If only part of the germs are destroyed, little real good has been accomplished, because in most cases, only a very few live germs are necessary to produce disease if they are taken into the body. In other words, the most important part of the job is frequently slighted. A large part of the time and money spent in this operation should be used in cleaning the barn; otherwise the expense of disinfection is wasted.

The use of boiling hot water and soap or lye or washing powders with stiff scrub-brushes can hardly be overdone. Rotten woodwork and loose boards should be removed. Iron work should be repainted. It must be remembered, however, that paint usually contains lead and that lead, even in small amounts, is poisonous to animals, especially cattle. It is not advisable to use paint containing lead in or around the cow barn. All manure and litter should be either burned or placed where animals can not come in contact with it. Manure should be put on fields that are to be plowed in the near future, or upon fields that are not to be used as pastures. Old straw stacks to which the diseased animals have had access should be handled in the same way, or fenced off to prevent well animals from coming in contact with them. If the floors of stables or sleeping sheds are earth, it is advisable to remove 4 to 6 inches of the surface soil. This should be replaced with soil from an uncontaminated source, or, better, install a new floor of concrete or some other permanent type.

Water troughs that are used by groups of animals should be carefully cleaned and disinfected.

The coal-tar products, commonly sold under various trade names, as cresol, kreso dip, sheep dip, lysol, and others, are among the most efficient disinfectants available. Their value depends upon the amount of the active material known as cresylic acid. Products that contain 50 per cent of this active material are highly destructive to abortion germs in a 3 to 4 per cent solution in water. These products are non-poisonous to livestock in these dilutions and can be freely used in the disinfection of water tanks, mangers, and feed boxes. Two gallons of a coal-tar disinfectant containing 50 per cent cresylic acid dissolved in 60 gallons of warm water is sufficient to disinfect 1,000 square feet of surface.

These products all have a strong, pungent odor which makes them undesirable for use in dairy barns, because milk readily absorbs them and renders it unsalable. This objection can be largely overcome by removing the milk from the barn as soon as it is taken from the animals. After a thoro disinfection of a dairy barn with any of the coal-tar products, it is usually necessary to guard against odors in the milk for approximately two weeks.

Various products that liberate chlorine, a gas, are commonly used in stable sanitation. They are doubtless of considerable value but are not so efficient in destroying germs in these places as are the coal-tar products. They readily lose their power to destroy germs when they are exposed to the air. The mistake of relying upon chlorine products exposed to the air for varying lengths of time is common. Chloride of lime is the one most commonly used. Its value as a disinfecting agent is unquestioned, but is probably over-rated by many persons because it is a powerful deodorant.

The value and economy of the work will depend in a great measure upon the method of applying the disinfectant. Economy requires that the disinfecting solution be applied rapidly. Efficiency requires not only that it cover the entire surface, but that sufficient force be used to drive the solution into all cracks and crevices. The best method of applying a disinfectant is a strong spray pump equipped with a hose and spray nozzle.

Whitewashing is advisable in many stables, as it makes the interior brighter and lighter. The lime wash should be applied only after the barn has been made scrupulously clean and disinfected. The addition of chloride of lime, 8 ounces to each gallon of whitewash, will increase its disinfecting properties. Whitewash is best applied with a spray pump such as is used in spraying orchards. The solution may then be forced into all the cracks and crevices of the barn with little difficulty.

SUMMARY

1. Bang's disease (contagious abortion) is widespread and from an economic standpoint is probably the most serious disease affecting cattle.
2. The disease may exist in herds wherein apparently healthy calves are being dropped, yet retention of the afterbirth, mastitis, diseases of young calves, or sterility indicate the presence of the infection.
3. The act of abortion, or the premature expulsion of the fetus from the uterus, is only one symptom of this chronic infectious disease of the genital organs, and may be absent.
4. A laboratory examination of the blood of heifers, cows, or bulls is the only practical way of determining the presence of the disease.

A single negative test is not conclusive proof of the absence of the disease.

5. White scours and calf pneumonia often co-exist in herds affected with abortion. They may occur independent of abortion infection.

6. The use of vaccines in the control of this disease is not to be recommended.

7. The treatment of sterile or non-breeding cows requires surgical knowledge and should be attempted only by competent and skilled veterinarians.

8. Breeders, when purchasing animals, should have them tested.

9. It is much safer to purchase young animals, 3 to 6 months of age, than older ones.

10. Calves may receive colostrum, or first milk.

11. The aim of all cattle owners should be to maintain a herd free of this disease on the basis of the blood tests.

IMPORTANT FEATURES IN THE PREVENTION AND CONTROL OF BANG'S DISEASE (CONTAGIOUS ABORTION) AND STERILITY, AND DISEASES OF CALVES

1. All the animals of a herd should be tested to determine whether they are infected with Bang's disease (contagious abortion).

2. All reactors should be considered as potential spreaders of the infection.

3. Reactors must be kept separate from non-infected animals, not only in the stable but in the pasture and paddock.

4. A laboratory examination is absolutely necessary before one is justified in making a diagnosis of the presence or absence of the disease due to the Bang germ.

5. Isolate all females at the time of calving or aborting. Keep them separate for two or three weeks if possible, or at least until all vaginal discharge ceases.

6. Breed all animals on neutral ground, i.e., ground not frequented by any bovine animal. Restrain the female so she can not become re-infected by licking herself. Test the bulls used for service.

7. Consider milk as a source of infection for all bovine animals except young calves.

8. Retention of the afterbirth is an important symptom of abortion disease and is a frequent forerunner of sterility.

9. The manual removal of the afterbirth requires considerable skill and practice and its removal should not be attempted by the inexperienced.

10. The care and feeding of the calf should be given close attention, as many calves healthy and strong at time of birth succumb later to scours or pneumonia or a complication of both.

11. All sterile or non-breeding cows should be examined as early as possible by competent veterinarians in order to restore their normal breeding condition. Cows that are found to be permanently sterile should be slaughtered immediately.

ABORTION DISEASE OF SWINE

During the last few years the literature has contained a few accounts of abortion among swine. Good and Smith described the disease as occurring in Kentucky. Traum isolated the germ of cattle abortion (*Bact. abortus Bang*) in 1914 from the liver, stomach contents, and kidney of an aborted fetus from a herd of swine in which many abortions had occurred.

Numerous outbreaks of this disease have been reported from Minnesota and we have isolated the germ of cattle abortion from three distinct cases of this disease. There seem to be more affected animals and herds each year.

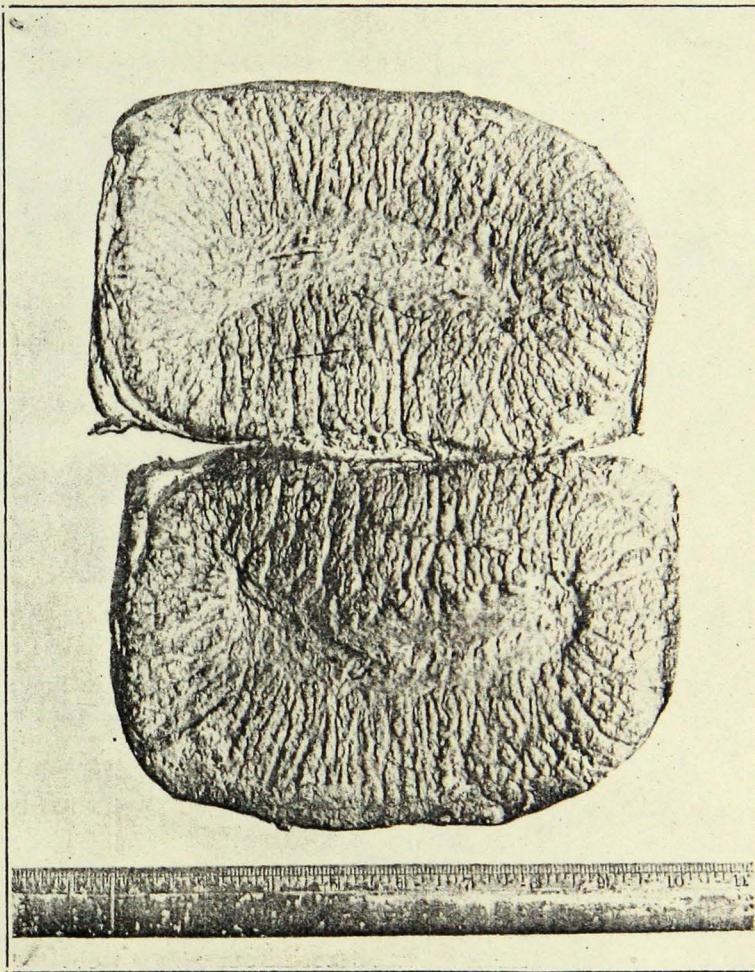
Connaway and his associates in Missouri, Hayes in California, and Huddlesen in Michigan, have made a careful study of the condition and have carried out numerous experiments. Researches indicate that abortion in swine may be due to several different organisms. The germ causing abortion in cattle (*Bact. abortus Bang*) seems to be the organism most often found in this disease of swine. This undoubted connection between abortion disease of cattle and of swine serves to emphasize several important control measures in the latter group.

Experiments have shown that the organism is contained in the dead aborted pigs, afterbirths, uterine discharges, and colostral milk of infected sows. Hogs become infected by eating materials containing the germs, as bedding, afterbirths, and milk. As in the case of cattle, a sow may give birth to healthy pigs and discharge the living and virulent germs at the time of and following parturition. The blood tests will show whether an animal is infected. The boar may become infected and become a carrier of the disease. The testicles often become greatly enlarged (see Plate XIV) and we have isolated *Bact. abortus* from one such case.

The germs may become localized in the udders of infected sows and in this way the sows may be carriers of the infection. Sterility may follow abortion, altho it is not so commonly reported as in cattle. Prevention and control measures for this disease are similar to those outlined for the disease in cattle. Swine breeders who are having trouble of this nature among their animals are urged to communicate

with the veterinary division at University Farm. This division will be glad to aid in any way possible and to make an investigation when necessary. Data are still meager in relation to this condition.

PLATE XIV

Testicle of Boar Affected with *Bact. abortus*

This organ is cut in half and the measure below shows its large size.

ABORTION DISEASE OF SHEEP

Abortion disease in sheep has long been recognized, but very little attention has been given to this affection which now, on account of the development of the sheep industry, becomes a problem of considerable

economic importance. The cause (etiology) of abortion disease in sheep is a vibrio, or S-shaped germ, which has been described by M'Fadyean and Stockman in England and by Carpenter, Welch, and Marsh, and at the Minnesota Experiment Station in this country.

While diseases of the genital organs are not so numerous in sheep as in cattle, they are fairly common and of vast importance. Reports of the presence of abortion in sheep are occasionally received from various sections of the state, but as yet we have made no extensive investigations. The symptoms, treatment, and control of this disease in sheep are similar to those for cattle. We are unable to control abortion in sheep by means of the agglutination test. Ewes having aborted as the result of being infected with vibrio fetus and unknown causes, should be separated from all other animals and not returned until all unnatural discharges have ceased. Certain investigators are of the opinion that the water supply is one of the chief ways by which the infection spreads. This is an additional reason why sheep should be provided with pure drinking water.

REGULATIONS GOVERNING THE MOVEMENT OF CATTLE THAT HAVE RECENTLY ABORTED

Adopted by the Minnesota Live Stock Sanitary Board at a Special Meeting
January 11, 1922; Approved by Attorney General, February 7, 1922

Section I. No person, firm or corporation shall expose in a public market, sale yard, fair ground, exhibition or show, a cow or heifer which has been known to calve prematurely within two months immediately preceding the exposure. This section shall not apply to cattle that are shipped to public markets for the purpose of immediate slaughter.

Section II. No person, firm or corporation shall sell a cow or heifer for breeding or dairy purposes, which has been known to calve prematurely within two months immediately preceding, without previous written notice to the purchaser.

Section III. No person, firm or corporation shall send or cause to be sent to a bull for service, a cow or heifer which has prematurely calved within the previous two months, unless before the service, the person, firm or corporation shall have given notice in writing of such premature calving to the owners of the bull.

Section IV. No person, firm or corporation shall

(a) Cause or permit to be turned out on any common or unenclosed land, or in a field or other place insufficiently fenced, or in a field or other place adjoining a highway (unless that field or place is so fenced or situated that cattle therein cannot stray or graze along the highway); or

(b) cause or permit to graze on pasture being on the sides of a highway, a cow or heifer which to his knowledge, or according to information furnished to him, has calved prematurely within the two months immediately preceding such turning out or such grazing.

**RULES AND REGULATIONS PROVIDING FOR THE CONTROL
OF BANG ABORTION DISEASE IN CATTLE IN MINNESOTA**

Adopted by the Minnesota State Live Stock Sanitary Board December 21,
1928; Approved by Attorney General, January 10, 1929

**BANG ABORTION-FREE ACCREDITED HERD
PLAN A**

1. A "Bang Abortion-Free Accredited Herd" is one in which no evidence of Bang Abortion has been found in three blood tests, at least six months apart, of all cattle, including all calves in the herd.
2. The owner must place his herd under the supervision of the Minnesota State Live Stock Sanitary Board, for the prevention and control of Bang Abortion.
3. A list of cattle tested shall be furnished to the board at each time a test is applied so that each blood sample can be identified by the name and registry number of animal, or herd tag number.
4. All reacting animals shall be placed in a separate herd, preferably on a different farm, entirely separate from the non-reacting herd.
5. Retests of herds in which reactors are disclosed shall not be made earlier than thirty days nor later than six months from the date of last test of such herds.
6. A "Bang Abortion-Free Accredited Herd" shall be retested at least annually. If reactors are disclosed in such herd it shall be subjected to the tests as required in paragraph 1.
7. Animals which have reacted to the blood tests or which have showed physical evidence of the disease, may be added to accredited herds or herds in the process of accreditation after they have passed three negative blood tests, six months apart. Provided, however, all such animals have been held in strict isolation for a period of at least sixty days immediately preceding the last test.
8. Herd bulls must not be used for service on cattle which have not been tested and found free of bovine infectious abortion. Service must be on neutral ground.
9. All milk and milk products used in "A Bang Abortion-Free Accredited Herd" or herds in the process of accreditation, shall be either produced by "A Bang Abortion-Free Accredited Herd" or shall be properly pasteurized.
10. Cattle from "Bang Abortion-Free Accredited Herds" may be added to such herds or herds in the process of accreditation without test. If shipped, the car used must be cleaned and disinfected, and public stock yards must be avoided.
11. All cattle, with the exception of calves under six months of age, to be added, other than those from "Bang Abortion-Free Accredited Herds," must pass a blood test approved by the State Live Stock Sanitary Board and must be isolated; they must pass a second blood test approved by the board, made not earlier than sixty nor later than one hundred and twenty days. Calves under six months of age may be added to the herd after having calved, and must pass a satisfactory blood test not earlier than three weeks after having calved.
12. Pregnant animals, other than those from "Bang Abortion-Free Accredited Herds," to be added, must be isolated until after having calved, and must pass a satisfactory blood test not earlier than three weeks after having calved.
13. Cattle removed from the farm for exhibition or any other purpose shall not be allowed to again associate with the herd or other cattle until they have been

- held in isolation for a period of sixty days and have then passed a satisfactory blood test.
14. Any animal which aborts in any "Bang Abortion-Free Accredited Herd" or herd in the process of accreditation, must be immediately isolated and reported to the State Live Stock Sanitary Board. The place where the abortion occurred must be immediately cleaned and disinfected; the fetus and membranes must be promptly disposed of by burning or proper burial.
 15. The premises must be maintained in a sanitary condition. After removal of infected animals the stable must be cleaned and disinfected under official supervision or direction.
 16. No herd will be placed under supervision, the owner of which is not practicing measures against tuberculosis and cooperating in its eradication.
 17. The necessary work for the accreditation of herds as free from Bang abortion disease shall be conducted cooperatively by the board and the owner. The collection of blood from each animal and sending the same to the laboratory, the tagging and proper identification of each animal and the supervision of the necessary sanitary procedures shall be made by a veterinarian approved by the board and at the expense of the owner, or by a duly authorized representative of the State Live Stock Sanitary Board without expense to the owner.
 18. Blood tests shall be made at the laboratory of the State Live Stock Sanitary Board or a laboratory approved by the board.
 19. A "Bang Abortion-Free Accredited Herd" certificate shall be issued to owners of herds in which no reactors have been found as required by paragraph 1 and provided all rules and regulations have been complied with, and further provided that the cooperative agreement executed by the owner has been fully complied with. This certificate shall be valid for one year from date of issue unless cancelled.

APPROVED BANG ABORTION HERD PLAN B

1. An Approved Bang Abortion Herd is one in which no evidence of Bang Abortion Disease has been found in one blood test of all the cattle, including all calves in the herd.
2. The owner must place his herd under the supervision of the Minnesota State Live Stock Sanitary Board, for the prevention and control of Bang Abortion Disease.
3. A list of cattle tested shall be furnished to the board at each time a test is applied so that each blood sample can be identified by the name and registry number of animal, or herd tag number.
4. All reacting animals shall be either placed in a separate herd on a different farm, or they may be kept in a separate unit on the same farm.
5. The owner must agree to have his entire herd tested regularly at least every six months (more frequent tests of the herd if found badly infected on the first test).
6. Retests of herds in which reactors are disclosed shall not be made earlier than 30 days nor later than six months from the date of the last test of such herds.
7. All non-reacting animals shall be so kept that there will be no physical contact with reacting cattle (to prevent licking) in a stable, and they must be kept in separate pastures free from contact with the infected animals.
8. An approved Bang Abortion Herd shall be retested at least every six months.

9. Animals reacting to the blood tests or showing physical evidence of the disease may be added to Approved Bang Abortion herds after they have passed three negative blood tests, six months apart. Provided, however, all such animals have been held in strict isolation for a period of at least sixty days immediately preceding the last test.
10. Animals can be added to the herd which have passed a single negative blood test. This test is preferably made while the animal is non-pregnant. (Animals to be added in advanced pregnancy should be isolated from the herd until a test can be made three weeks after parturition.)
11. Herd bulls may be used for service on cattle which have been tested and found infected with Bang Abortion Disease, provided they are bred on neutral ground. (It should be understood that this procedure is not to be recommended since occasionally a valuable bull might become infected.)
12. Milk from infected animals may be used for feeding calves, under six months of age, born from infected animals. (In beef herds calves may run with and nurse infected dams for longer than six months.) These calves, in both cases, before they are placed with clean herds may be isolated for a period of at least three weeks and pass a negative blood test.
13. Cattle from "Approved Bang Abortion Herds" may be added to such herds without test. If shipped, the car used must be cleaned and disinfected, and public stockyards must be avoided.
14. All cattle to be added, other than those from "Bang Abortion-Free Accredited Herds" and "Approved Bang Abortion Herds" must pass a blood test approved by the State Live Stock Sanitary Board.
15. Pregnant animals, other than those from "Bang Abortion-Free Accredited Herds" and "Approved Bang Abortion Herds," to be added, must be isolated until after having calved, and must pass a satisfactory blood test not earlier than three weeks after having calved.
16. Cattle removed from the farm for exhibition or other purposes should not be allowed to again associate with the herd or other cattle until they have been held in isolation for a period of sixty days and have then passed a satisfactory blood test.
17. Any animal which aborts in any "Approved Bang Abortion Herd" must be immediately isolated and reported to the State Live Stock Sanitary Board. The place where the abortion occurred must be immediately cleaned and disinfected; the fetus and membranes must be promptly disposed of by burning or proper burial.
18. The premises must be maintained in a sanitary condition. After removal of infected animals the stable must be cleaned and disinfected under official supervision or direction.
19. The necessary work for the approval of herds for Bang Abortion Disease Control shall be conducted cooperatively by the board and the owner. The collection of blood from each animal and sending the same to the laboratory, the tagging, and proper identification of each animal and the supervision of the necessary sanitary procedures shall be made by a veterinarian approved by the board and at the expense of the owner, or by a duly authorized representative of the State Live Stock Sanitary Board without expense to the owner.
20. Blood tests shall be made at the laboratory of the State Live Stock Sanitary Board or a laboratory approved by the board.
21. An "Approved Bang Abortion-Free Herd" certificate shall be issued to owners of herds in which no reactors have been found as required by paragraph 1

and provided all rules and regulations have been complied with, and further provided that the co-operative agreement executed by the owner has been fully complied with. This certificate shall be valid for six months from date of issue unless cancelled.

COOPERATING BANG ABORTION HERD PLAN C

1. The owner will agree to have his entire herd tested regularly at least every six months and to adopt such sanitary measures as may be recommended in the individual herd by the State Live Stock Sanitary Board. (The sanitary requirements will be the proper disposal of the fetus and the fetal membranes, isolation of the aborting animals, cleaning and disinfection of the stable, etc.)
2. The necessary work for the control of Bang Abortion Disease shall be conducted cooperatively by the board and the owner. The collection of blood from each animal and sending the same to the laboratory, the tagging and proper identification of each animal and the supervision of the necessary sanitary procedures shall be made by a veterinarian approved by the board and at the expense of the owner, or by a duly authorized representative of the State Live Stock Sanitary Board without expense to the owner.

AGREEMENT

For the purpose of freeing my herd from Bang Abortion, I do hereby agree to cooperate with the State Live Stock Sanitary Board and to meet all requirements and provisions incorporated in this agreement.

I do further agree to furnish sufficient help to assist the veterinarian in securing the necessary blood specimens, tagging and identifying my cattle.

I do further agree to employ at my expense a veterinarian approved by the Board, to supervise all work, collection of blood specimens for laboratory examination, tagging and identifying of cattle and the necessary sanitary requirements.

I do further agree to cause all animals that react to the test, and also all animals showing physical evidence of infectious abortion to be disposed of in accordance with the rules and regulations of the State Live Stock Sanitary Board.

I do further agree not to allow any vaccine, bacterin or other biological product to be used on my herd for the prevention or treatment of Bang Abortion without first securing a permit for its use from the State Live Stock Sanitary Board.

I do further agree to comply with the rules and regulations as herein set forth by the State Live Stock Sanitary Board as provided under Plan for a Bang Abortion Disease Herd.

I do further agree to allow any premises contaminated by animals infected with abortion, as indicated by a blood test, or by a physical examination, to be thoroughly cleaned and disinfected, at my own expense, under the direction or supervision of the State officials.

I do further agree to comply with all the sanitary measures and other recommendations for the control of Bang Abortion, adopted by the State Live Stock Sanitary Board, and failure on my part to comply with these rules and regulations shall be sufficient cause for the cancellation of this agreement. My herd is composed of (breed)

Number of Cattle	(pure bred)	(grade)
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(total)

IN WITNESS WHEREOF, I have signed this agreement this
day of one thousand nine hundred and thirty
Witness Owner (print name plainly)

Address Township County
Post Office County

MOST ACCESSIBLE POINT TO FARM BY RAILROAD

Adopted by the Minnesota State Live Stock Sanitary Board April 24, 1931;
Approved by Attorney General May 9, 1931

No cattle shall be imported into the State of Minnesota after June 1, 1931, for dairy or breeding purposes, except cattle consigned to the public stock yards at South St. Paul, unless they have passed a satisfactory negative agglutination blood test for Bang's Disease (Contagious Abortion) within thirty days prior to the date of importation, except cattle originating from herds officially designated and certified as free from this disease. The blood test must have been applied by veterinarians or laboratories approved by the sanitary authorities of the state of origin. Cattle must be accompanied by a health certificate including the date of the satisfactory negative blood test. Copies of the health certificates certified and approved by the live stock sanitary authorities of the state of origin shall be immediately forwarded to the office of the State Live Stock Sanitary Board, Old Capitol, St. Paul.

Provided, however, that cattle which have given positive or suspicious reactions to the agglutination blood test for Bang's Disease may be imported or brought into the State of Minnesota upon a special written permit issued by the Secretary and Executive Officer of the State Live Stock Sanitary Board; such permit to be issued only upon receipt of a written agreement by the owner thereof that such cattle shall remain in his possession and be kept separate and apart from all cattle except cattle that have given positive reaction to the agglutination blood test.

Adopted by the Minnesota State Live Stock Sanitary Board May 26, 1931;
Approved by Attorney General May 29, 1931

Paragraph 1. The slow test tube agglutination blood test is hereby declared as the recognized official test for the control and elimination of Bang's Disease in herds of cattle in Minnesota under Plans A, B, and C, as provided by the Rules and Regulations adopted December 21, 1928, and approved by the Attorney General January 19, 1929; such tests shall be made at the diagnostic laboratory of the State Live Stock Sanitary Board and the Veterinary Division of the University of Minnesota.

Paragraph 2. Health certificates, including a report of the rapid agglutination blood test for Bang's Disease, for exportations into States requiring that cattle must have passed a satisfactory blood test and provided such states recognize the rapid agglutination blood test, will be approved by the Executive Officer of the State Live Stock Sanitary Board only when such tests have been made by a veterinarian who has received instruction in the technique and application of the rapid agglutination blood test for Bang's Disease at the diagnostic laboratory maintained at the Veterinary Division of the University of Minnesota for the Live Stock Sanitary Board, and has been officially certified to the Executive Officer of the Live Stock Sanitary Board by the Chief of said laboratory to be qualified to make said tests.

Paragraph 3. Every veterinarian and all laboratories shall immediately report the results of the agglutination blood test for Bang's Disease, rapid or

slow test tube method, to the State Live Stock Sanitary Board, giving the name of the owner, his post office address and the name of the township and county where farm is located, and also identification of each animal tested by the ear tag number or the pure bred registry name and number, with the exception of blood tests made by the diagnostic laboratory maintained at the Veterinary Division of the University of Minnesota for the Live Stock Sanitary Board; tests made at the diagnostic laboratory will be immediately reported to the Live Stock Sanitary Board.

Immediately on receipt of the reports of such tests a reactor tag will be furnished to the Veterinarian to be placed in the left ear of each of the reacting cattle.

Paragraph 4. All cattle that have given a positive reaction to a satisfactory agglutination blood test for Bang's Disease shall be tagged in the left ear with the special reactor tag of the State Live Stock Sanitary Board. All grade cattle that have passed a satisfactory agglutination blood test for Bang's Disease shall be tagged in the right ear with the official identification tag of the State Live Stock Sanitary Board and all pure bred registered cattle shall be identified by the registry name and number.

Cattle that have reacted to the agglutination blood test may be retained on the owner's premises, as provided by the Rules and Regulations of the Minnesota State Live Stock Sanitary Board adopted on December 21, 1928, and approved by the Attorney General on January 10, 1929, for the control of Bang's Disease under Plans A, B, and C.

Permits for the sale and movement of reacting cattle to other owners' premises will be issued by the State Live Stock Sanitary Board, provided the name and address are furnished to the Board of the owner of the herd and the location of his farm by section, township, and county, to which such cattle are to be added, and provided further that the purchaser has the knowledge that such cattle have reacted to the test.

Permits for the shipment of cattle that have given a satisfactory positive reaction to the agglutination blood test, to the public stock yards at South St. Paul or to slaughtering establishments approved by the Federal Bureau of Animal Industry where the Federal Government maintains inspection, will be issued by the Secretary and Executive Officer of the State Live Stock Sanitary Board on a written request of the owner, provided that the identification tag number, the Bang reacting tag number, and the name and address of the commission firm to whom such cattle are to be consigned, are furnished.

Paragraph 5. All persons and companies engaged in the manufacture, sale (wholesale or retail) or distribution of antigen and other agents used in the detection of Bang's Disease and also vaccines containing the living virus or the infective agent of Bang's Disease of cattle, who shall hereafter, in the State of Minnesota, sell, furnish or supply such antigen or agents to any person or persons, shall report to the State Live Stock Sanitary Board immediately the date of sale, the amount sold and the name or names of persons to whom such antigen or agents are sold, furnished or supplied.

Paragraph 6. No person shall administer or inject into any cattle in Minnesota, the infective agent, living virus or vaccines of Bang's Disease, except on a special written permit issued by the Secretary and Executive Officer of the State Live Stock Sanitary Board. Owners of cattle so treated or the persons administering living virus or vaccines thereto shall immediately report to the State Live Stock Sanitary Board the identification of such cattle. All cattle, purebred and grade, that have been subjected to treatment with the living virus

or vaccines shall be identified by the official identification tag of the State Live Stock Sanitary Board placed in the right ear.

Paragraph 7. All existing Rules and Regulations, is so far only as they are inconsistent with these Rules and Regulations are herewith rescinded.

SIGNIFICANCE OF THE RULES AND REGULATIONS

The purpose of these different rules and regulations in respect to Bang's disease is to aid in the efficient control and prevent the spread of the infection. It will be noted that already 21 states require a health certificate stating that a satisfactory agglutination test has been passed for cattle shipped within their borders. The Minnesota State Fair officials this year required that all animals shown pass a satisfactory test for Bang's disease within 60 days of the date of the Fair. It is a very easy thing to act as an agency for the distribution of this infection. For example, if a laboratory or a veterinarian tests the blood of a cow and she is found positive and if there were no rules or regulations preventing it, the owner would be at perfect liberty to sell this animal to a cow dealer and the dealer in turn sell to another individual. This latter person might take this infected animal into a clean herd and as a result start an infection that would entail the loss of hundreds of dollars. It is to avoid instances of this kind and of a similar nature that certain rules and regulations have been passed to guard against the further spread of this infection to the herds of cattle in Minnesota. As yet the Sanitary Board has not placed a quarantine on known infected cattle. This has already been done by some states. It probably will be a regulation in Minnesota in the future. At the present time, however, the owner of reacting animals may not dispose of them except under permit from the Sanitary Board. This permit is always given when the circumstances surrounding the sale are explained. The essential thing is that this animal shall not be disposed of to an unsuspecting individual who might place her where she would spread the infection. It should be clearly understood that animals positively known to have Bang's disease can only be shipped to South St. Paul or other public stockyards under permit. Further, that all positive animals should be tagged in the left ear with a special tag of the State Live Stock Sanitary Board. This tag will be furnished to your veterinarian for this purpose.