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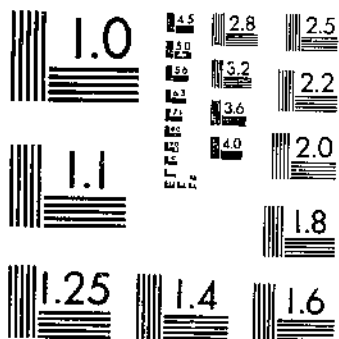
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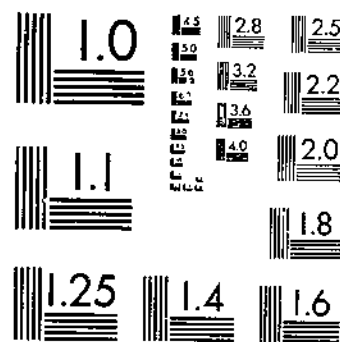
COMMUNICABILITY OF INFECTIOUS ABORTION BETWEEN SWINE AND CATTLE

ROBERT W. BUCK, JAMES SMITH, H. E. ... 1 OF 1

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UNITED STATES DEPARTMENT OF AGRICULTURE  
WASHINGTON, D. C.

COMMUNICABILITY OF INFECTIOUS ABORTION  
BETWEEN SWINE AND CATTLE<sup>1</sup>

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## INTRODUCTION

Knowledge relative to the communicability of infectious abortion (brucellosis) between swine and cattle is somewhat indefinite regardless of the fact that considerable work concerning the problem has been done. Some of the earlier work was reported before reliable and practical means for differentiating the bovine type of *Brucella abortus* from the porcine type were available. Hence this fact should be taken into account in considering the results reported.

Connaway, Durant, and Newman in 1921,<sup>4</sup> in discussing this subject, stated:

The presumption that the disease in the two species is intercommunicable is so strong that it justifies the breeder in taking proper precautions to prevent the spread of the disease from cattle to swine or the reverse.

Hadley and Beach in 1922<sup>5</sup> reported results following the intravenous injection of two pregnant heifers. One received a suspension prepared from four porcine strains and the other a suspension prepared from four bovine strains. Both heifers aborted in about the same length of time, although definite proof was not obtained that the uterus of the animal injected with the swine strains contained the infection at time of aborting. Both animals gave agglutination reactions of high titer following the injections.

<sup>1</sup> Submitted for publication Mar. 29, 1938.

<sup>2</sup> Retired Sept. 30, 1937.

<sup>3</sup> Died May 2, 1938.

<sup>4</sup> CONNAWAY, J. W., DURANT, A. J., and NEWMAN, H. G. INFECTIOUS ABORTION IN SWINE. Mo. Agr. Expt. Sta. Bull. 187, 26 pp., illus. 1921.

<sup>5</sup> HADLEY, F. B., and BEACH, R. A. AN EXPERIMENTAL STUDY OF INFECTIOUS ABORTION IN SWINE. Wis. Agr. Expt. Sta. Research Bull. 55, 33 pp., illus. 1922.

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Cotton<sup>6</sup> reported in 1922 that Schroeder and he had succeeded in infecting a pregnant cow by injecting her intravenously with a suspension of porcine *Brucella abortus*. The cow gave birth to a weak calf 220 days after service. The calf was killed before it had nursed its dam. Guinea pigs inoculated from organs of the calf and from the afterbirth developed the characteristic lesions of porcine *Br. abortus* infection.

In 1925 Schroeder and Cotton<sup>7</sup> reported that they had exposed a considerable number of pregnant cows and heifers to the porcine type of *Brucella abortus* both by repeated feedings of cultures and by direct contact with cows that had been caused to abort by the intravenous injection of suspensions of *Br. abortus* (porcine). The result was only a very transient infection manifested by the development of agglutinins for *Br. abortus* which persisted in the blood for only a few weeks. Failure was also experienced in all attempts to infect swine with the bovine type of *Br. abortus* through natural exposure. The results of these and other experiments led these investigators to believe that there is a distinct bovine and a distinct porcine type of *Br. abortus* as dissimilar as the human, bovine, and avian types of the tubercle bacillus.

Huddleson, in discussing a paper by Moore,<sup>8</sup> mentioned having studied about 100 strains of *Brucella* isolated from cattle. His results indicated that 86 of these were of the bovine and 8 of the porcine type. Two of the eight were mentioned as having been obtained from the milk of cows, one from the testicle of a bull, and the others from aborted fetuses. Two of the strains obtained from cattle were regarded as being *Br. melitensis*.

To gain more definite knowledge on intercommunicability of the two types of *Brucella*, investigations were conducted along two different lines, by the present authors, the work being done at the Bureau's Experiment Station, Bethesda, Md. Attempts were first made to infect pregnant cows and heifers with *Br. abortus* of the porcine type by subjecting them to severe artificial exposure through the conjunctiva, conjunctiva and digestive tract, and the skin. In later experiments pregnant cows and heifers negative to the agglutination test for Bang's disease were given contact exposure by confining them in a small enclosure with sows and boars artificially infected with *Br. abortus* (porcine). This procedure was followed to simulate conditions that obtain on farms where infected swine run with cattle free from Bang's disease. The exposure provided, however, was probably more intense than that which usually occurs on farms.

#### EXPOSURE OF PREGNANT CATTLE TO BRUCELLA ABORTUS (PORCINE) THROUGH CONJUNCTIVA, DIGESTIVE TRACT, AND SKIN

Six heifers and two cows were used to test the effects of exposure to *Br. abortus* (porcine) through the conjunctiva, through both the

<sup>6</sup> COTTON, W. E. THE CHARACTER AND POSSIBLE SIGNIFICANCE OF THE BANG ABORTION BACILLUS THAT ATTACKS SWINE. Jour. Amer. Vet. Med. Assoc. 62 (n. s. 15): 179-192. 1922.

<sup>7</sup> SCHROEDER, E. C., and COTTON, W. E. RECENT BUREAU OF ANIMAL INDUSTRY EXPERIMENT STATION BOVINE INFECTIOUS ABORTION STUDIES. Jour. Amer. Vet. Med. Assoc. 66 (n. s. 10): 550-561. 1925.

<sup>8</sup> MOORE, VERANUS A. RELATION OF UNDPULANT FEVER IN MAN TO LIVESTOCK SANITATION. (U. S. Livestock Sanit. Assoc. Proc. (1928) 32) Jour. Amer. Vet. Med. Assoc. 74: 605-621. 1929. Discussion, pp. 617-621.

conjunctiva and digestive tract, and through the intact skin. The procedure and results obtained follow:

Heifer 1541: Estimated to be about 5 months pregnant September 5, 1929. Agglutination test September 6 was negative. On September 15, 4 drops of a *Br. abortus* (porcine) suspension was deposited in left eye. Suspension had a density 25 times that of tube 1 of the McFarland nephelometer and was prepared from the sixth transfer of a *Br. abortus* (porcine) strain. Agglutination tests: September 25, 1 to 50; October 9, 1 to 200; November 6, 1 to 500; December 19, 1 to 500; January 8, 1930, 1 to 1,000; January 22, 1 to 2,000; and March 5, 1 to 2,000. Animal aborted January 2. A few placental cotyledons showed necrotic areas typical of *Br. abortus* infection. *Br. abortus* (porcine) was isolated from the viscera of the fetus, and guinea pigs injected with uterine exudate and colostrum of dam developed typical lesions of *Br. abortus*.

Heifer 1448: Estimated to be about 3 months pregnant September 6, 1929. Agglutination test September 6 was negative. On September 15 she received conjunctival exposure like that of heifer 1541, and on the same date and also on the following day she consumed about 2 gallons of water to which was added the growth of *Br. abortus* (porcine) on two agar slants. These slants were cultures of the same *Br. abortus* (porcine) strain used for the conjunctival exposures. Agglutination tests: September 25, 1 to 50; October 9, 1 to 500; November 6, 1 to 200. On December 19, 1929, and on January 8, January 22, February 19, March 5, and April 12, 1930, the animal continued to react in a titer of 1 to 200. This animal gave birth to a seemingly normal calf March 3, 1930. Six guinea pigs injected with an emulsion of cotyledons and the same number with colostrum failed to acquire abortion disease.

Cow 1449: Estimated to be about 4 months pregnant January 2, 1930. Agglutination test January 2 was negative. On January 6, she was turned into a small lot occupied by heifers 1541 and 1448. Since heifer 1541 had expelled a dead calf January 2, 4 days previously, it was suspected that she, as well as heifer 1448, might act as sources of infection for cow 1449. Agglutination test of cow 1449 was negative January 22, February 5, February 19, March 5, and March 19. Since the results of the agglutination tests indicated that she had not acquired the disease by contact, she was subjected to conjunctival exposure March 19. The suspension used was prepared from the thirteenth transfer of the same strain of *Br. abortus* (porcine) as was used for furnishing exposure to heifers 1541 and 1448. Its density was about 20 times that of tube 1 of the McFarland nephelometer. Agglutination test April 12 was 1 to 1,000. On May 21, cow gave birth to what appeared to be a full-term calf. Uterine exudate was copious and in appearance was suggestive of *Br. abortus* infection. Six guinea pigs injected with uterine material acquired abortion disease as did also six guinea pigs which were injected with colostrum. Lesions shown by the guinea pigs were typical of those caused by *Br. abortus* (porcine).

Heifer 1460: Estimated to be about 3 months pregnant July 8, 1931. Agglutination test July 9 was negative. On the same day approximately 5 cc of a heavy suspension of *Br. abortus* (porcine) was applied to an area of the skin posterior to the right shoulder from which the hair had been clipped. Suspension was prepared from the twenty-ninth transfer of the *Br. abortus* (porcine) strain previously used in this experiment. A patch of heavy cotton cloth was used to cover the exposed area, and the animal was confined in such a way as to prevent contact between her head and the exposed part. This method of exposure, when used in connection with the infection of cattle with the bovine type of *Br. abortus*, had infected 10 of the 16 cattle so exposed. Agglutination tests: July 23, 1 to 25; August 12, 1 to 25; August 25, negative; September 9, negative; and September 28, negative. On September 28, the animal was exposed a second time through the intact skin, a heavy suspension prepared from two *Br. abortus* (porcine) strains being used at this time. Agglutination tests October 6, October 23, November 4, November 28, and January 28, 1932, were negative. The animal gave birth to a vigorous calf December 27. Guinea-pig-inoculation results with uterine material and colostrum were negative.

Heifer 1457: Estimated to be about 4 months pregnant July 8, 1931. Agglutination test July 9 was negative. On the same day 4 drops of a suspension 50 times the density of tube 1 of the McFarland nephelometer and prepared from the twenty-ninth transfer of the *Br. abortus* (porcine) strain previously used

was deposited in the right eye. Agglutination tests: July 23, 1 to 100; August 12, 1 to 50; August 22, 1 to 25; and September 9, negative. On September 28, animal received a second conjunctival exposure, the suspension used being prepared from two *Br. abortus* (porcine) strains. Agglutination tests: October 6, 1 to 25; October 23, 1 to 50; November 4, 1 to 25; and November 28, negative. Gave birth to a vigorous calf December 2. Guinea pigs injected with uterine material as well as those injected with colostrum failed to acquire abortion disease.

Heifer 1611: Estimated to be about 3 months pregnant July 8, 1931. Agglutination test July 9 was negative. Received conjunctival exposure like that of heifer 1457 on two occasions. Gave an agglutination reaction of 1 to 50 titer for a brief period following the first exposure but remained negative following the second exposure. Gave birth to a vigorous calf December 17. Guinea pigs injected with uterine material and colostrum at time of parturition failed to acquire abortion disease.

Cow 1610: Estimated to be about 4 months pregnant October 6, 1931. Agglutination test October 5 was negative. Received conjunctival exposure October 6, 1931. Suspension used was prepared from one of the *Br. abortus* strains used to expose heifers 1457 and 1611, but recently had been passed through guinea pigs as a result of which there seemed to be a possibility that its virulence might have become enhanced. Four drops of a heavy suspension was deposited in the right eye. Agglutination tests: October 23, 1 to 50; November 4, 1 to 25; November 28 and January 28 and February 25, 1932, negative. Gave birth to a vigorous calf March 7, 1932. Absence of *Br. abortus* infection in uterine material and colostrum of the dam at time of parturition was indicated by the guinea-pig-inoculation results obtained.

Heifer 1705: Estimated to be about 3 months pregnant March 30, 1932. Agglutination test March 30 was negative. Received conjunctival exposure March 30. Strain of *Br. abortus* (porcine) used in this instance had been recently isolated from the milk of a cow which had been artificially infected with a swine strain about 5 years previously. Suspension was prepared from the second transfer of the strain and had a density of 20 times that of tube 1 of the McFarland nephelometer. Animal also consumed about 2 gallons of water to which 20 cc of the suspension was added. Agglutination tests: April 5, negative; April 15, 1 to 1,000; May 10, 1 to 200; June 1, 1 to 200; June 29, 1 to 500, and August 17, 1 to 500. On June 13 animal aborted a fetus of about 6 months' development. Appearance of placenta indicated presence of *Br. abortus*. *Br. abortus* (porcine) was isolated from fetus, and guinea pigs injected with uterine material and colostrum acquired abortion disease and developed lesions typical of those caused by this type of infection.

Table 1 summarizes the results obtained from subjecting the pregnant cattle to severe *Br. abortus* (porcine) exposure.

TABLE 1.—Summary of results obtained from subjecting cattle to severe *Br. abortus* (porcine) exposure

Animal	Exposure	Outcome of pregnancy	Results of uterine examinations for <i>Br. abortus</i>	Results of colostrum examinations for <i>Br. abortus</i>
Cow:				
1449.....	Conjunctival.....	Vigorous calf.....	Positive.....	Positive.
1610.....	do.....	do.....	Negative.....	Negative.
Heifer:				
1448.....	Conjunctival and ingestion.....	do.....	do.....	Do.
1457.....	Conjunctival.....	do.....	do.....	Do.
1460.....	Intact skin.....	do.....	do.....	Do.
1547.....	Conjunctival.....	Abortion.....	Positive.....	Positive.
1611.....	do.....	Vigorous calf.....	Negative.....	Negative.
1705.....	Conjunctival and ingestion.....	Abortion.....	Positive.....	Positive.

Of the eight cows and heifers which were subjected to *Br. abortus* (porcine) conjunctival, conjunctival and ingestion, or intact-skin exposure, the infection became established in two which received con-

junctional exposure and one which received conjunctival and ingestion exposure. Two of these animals, heifers 1541 and 1705, aborted; and the third, cow 1449, produced a vigorous calf. Of the remaining five animals, guinea-pig-inoculation results indicated the absence of *Br. abortus* in their uterine material and colostrum at time of parturition although these animals reacted in some degree to the agglutination test following their exposures. One heifer, No. 1448, reacted in a titer of 1 to 500 on one occasion and 1 to 200 at time of parturition. Animals 1460, 1457, 1610, and 1611 gave less-marked reactions to the agglutination test following exposure and negative results on or near the dates of calving. There is a possibility that reduced virulence of the *Br. abortus* strain used in furnishing the exposures was a factor of some importance in failure to transmit the disease to Nos. 1457, 1610, and 1611, which received conjunctival exposure, although for guinea pigs the *Br. abortus* suspensions used for their exposure gave evidence of being no less virulent than those used for the exposure of heifers 1541, 1449, and 1705.

#### EXPOSURE OF PREGNANT SUSCEPTIBLE CATTLE BY CONTACT WITH ARTIFICIALLY INFECTED SWINE

The second method of obtaining data on the intercommunicability of infectious abortion of swine and cattle consisted in artificially infecting swine with *Brucella abortus* of the swine type and exposing pregnant susceptible cows and heifers to them through close association for several months, making repeated agglutination tests of all the animals, and determining at times of parturition whether *Br. abortus* was present in their uterine exudates or colostrum. Two experiments of this kind were made, the first being inaugurated in October 1932 and the second in September 1933.

The enclosure used in conducting these experiments was about 30 yards square and was situated on sloping ground. On the higher portion of the land an open-front shed was constructed which provided shelter for both swine and cattle. All the animals obtained their water from a single watering trough and their millfeed from a common trough and, with the view to rendering the exposure of the cattle more severe, the hay furnished them was placed on the ground where it was trampled more or less by the swine. In addition, the lot was allowed to remain in a very insanitary condition.

#### FIRST CONTACT-EXPOSURE EXPERIMENT

Three sows and three boars were used in exposing the cattle. They gave negative results to the agglutination test for infectious abortion October 3, 1932. They received *Br. abortus* (porcine) exposure October 4. Use was made of the first transfers of two *Br. abortus* (porcine) strains in infecting the swine, boars 4150 and 4235 and sow 4171 receiving one strain and sows 4168 and 4155 and boar 4236 receiving the other. Suspensions of the strains having a density of about 25 times that of tube 1 of the McFarland nephelometer were prepared. The boars each received injections of 1 cc into an ear vein and 1 cc into one testicle. The sows each received 1 cc injection into an ear vein and 3 drops of the suspensions on the conjunctiva. The appearance of the sows indicated that they were in a somewhat ad-



vanced stage of pregnancy. Guinea pigs which were injected with *Br. abortus* suspensions used in exposing the swine acquired marked agglutination reactions and developed lesions typical of those caused by the swine type of the micro-organism.

In 16 days after the swine were injected, samples of blood serum from them were subjected to the agglutination test. Three reacted to the test in a titer of 1 to 5,000, two in a titer of 1 to 2,000, and one in a titer of 1 to 1,000. The testicles of the boars into which the suspensions were injected became much enlarged and remained so for several weeks, but the sows showed no immediate effects of the injections.

Three pregnant heifers, Nos. 1721, 1809, and 1815, which gave negative results to the agglutination test, were turned into the enclosure October 20. On November 26 two pregnant sows, Nos. 4251 and 4252, which similarly gave negative results to the agglutination test, were also placed in the enclosure in order to determine whether they would acquire the disease as a result of being subjected to the same degree of *Br. abortus* exposure as the cattle.

On December 1 one of the heifers, No. 1815, reacted in a 1 to 50 titer but the other two gave negative results to the test. On December 7 heifer 1815 reacted in a titer of 1 to 200 and No. 1721 in a titer of 1 to 25, but heifer 1809 continued to give negative results. Twenty-two days later No. 1721 continued to react in a 1 to 25 titer, but the reaction of No. 1815 had subsided to 1 to 50 and No. 1809 gave negative results to the test.

On December 29 contact sow 4251 reacted to the agglutination test in a titer of 1 to 100, but contact sow 4252 gave negative results to the test. The same results were obtained from tests of these two sows January 17, but on February 2, No. 4251 reacted in a titer of 1 to 500 and No. 4252 in a titer of 1 to 100. On March 10 both sows reacted in a 1 to 200 titer.

Two more pregnant heifers and one pregnant cow were placed in the enclosure January 8, 1933, and agglutination tests were made of the exposed cattle January 28, February 11, March 10, March 30, April 22, May 17, and June 7. All the cattle on these dates gave negative results to the agglutination test, even heifers 1721 and 1815, the latter having reacted at one time in a titer of 1 to 200 after being placed in contact with the swine.

All six cattle produced vigorous calves between March 4 and July 3. In all cases guinea pigs were injected with uterine exudates and colostrum, but in no instance was the presence of *Br. abortus* infection demonstrated.

The three injected and two contact sows were proved by guinea pig inoculation to be carriers of the infection in their bodies near the time of parturition. Contact sow 4251 was believed to have aborted about February 6, at which time guinea pigs were injected with washings of a uterine swab and others with defibrinated blood. The presence of the infection in both substances was proved. Contact sow 4252 aborted February 15. Uterine exudate and milk from this animal transmitted abortion disease to guinea pigs. Sow 4155 gave birth to eight vigorous pigs November 5, 1932. Uterine exudate from this sow transmitted abortion disease to guinea pigs. Sow 4168 gave birth to two pigs October 29. Although uterine exudate from

this sow failed to transmit abortion disease to guinea pigs, her milk was found to contain the infection. Sow 4171 was believed to have aborted November 10, when she was observed to have a vaginal discharge. Fetuses, if expelled, were consumed by some of the swine which occupied the enclosure. A swab was introduced into her vagina, and guinea pigs were injected with a suspension of the exudate collected. The guinea pigs acquired abortion disease and showed lesions typical of those caused by the swine type of the infection.

#### SECOND CONTACT-EXPOSURE EXPERIMENT

The second contact-exposure experiment, which was commenced in September 1933, was practically a repetition of the one previously made. In the same enclosure were placed six supposedly pregnant sows and a boar, all giving negative results to the abortion agglutination test.

On September 12, four of the sows, Nos. 4271, 4229, 4272, and 4274, and the boar, No. 4273, were exposed in the following manner: A *Br. abortus* suspension was prepared, having a density of about 15 times that of tube 1 of the McFarland nephelometer. A single *Br. abortus* (porcine) strain that had been transferred 10 times since its isolation was used in preparing the suspension. Each of the five swine received 1 cc of the suspension intravenously and 3 drops on the conjunctiva. The two remaining sows, Nos. 4207 and 4275, received no injections but were exposed only through contact with the injected swine.

Five pregnant heifers, all negative to the agglutination test, were placed in the enclosure with the swine on the following dates: Heifers 1813 and 1821, September 12; heifer 1814, October 5; and heifers 1784 and 1890, October 12.

When blood from the swine was subjected to the agglutination test October 5, that from all five of the injected animals reacted to the test in a titer of 1 to 1,000 or higher. One contact sow, No. 4275, reacted in a titer of 1 to 100 and the other No. 4207, in a titer of 1 to 50. Two weeks later each of the contact sows reacted in a titer of 1 to 200.

The first agglutination test of the heifers, after they were exposed, was made October 12, when all gave negative results to the tests. When the second test was made October 19, heifer 1813 reacted in a titer of 1 to 200, and No. 1821 in a titer of 1 to 50. The other three heifers gave negative results to the test at this time. The same results were obtained when the cattle were tested November 1, but on November 17 heifer 1813 reacted in a titer of 1 to 100, and Nos. 1814 and 1890 had acquired titres of 1 to 100 and 1 to 50, respectively. The agglutination reactions of the heifers became less marked on succeeding tests, however, and by February 1 all were negative.

Small samples of milk serum were obtained November 20 from each of three heifers, Nos. 1821, 1813, and 1814, with the object of determining whether its injection into guinea pigs would transmit abortion disease to them. These efforts resulted negatively.

All five cattle produced vigorous calves. No. 1784 calved December 22 and the four others during the following April. In all cases six guinea pigs were injected with uterine material and six with colostrum. None of the guinea pigs acquired abortion disease.

One sow, No. 4274, which was artificially infected, gave birth to three premature pigs September 26. Guinea pigs which were injected with uterine material from this sow acquired abortion disease. One of the contact sows, No. 4275, gave birth to six living pigs and three dead ones, but guinea pigs which were injected with uterine material from her failed to contract the disease.

It was not definitely determined that any of the remaining sows produced either living pigs or aborted or that they were actually expelling *Br. abortus* organisms at times of parturition or abortion. These sows, however, had been in the breeding lot and at the time of infection were believed to be pregnant. In the absence of observed offspring from these sows, it is likely that abortion occurred and that the fetuses were eaten by some of the swine that made up the group. The fact that both contact sows 4207 and 4275 gave strongly positive reactions to the agglutination test was nevertheless considered as definitely indicating that *Br. abortus* infection was being disseminated by at least some of the injected swine.

#### SUMMARY AND CONCLUSIONS

The experiments reported in this bulletin were conducted to obtain more definite information as to the susceptibility of cattle to the swine type of *Brucella abortus*. Two procedures were followed. In the first, eight pregnant cows and heifers were subjected to severe *Br. abortus* (porcine) exposure, through the conjunctiva, conjunctiva and digestive system, or the skin. In the second, groups of pregnant cattle were confined in enclosures with swine artificially and naturally infected with *Br. abortus* (porcine).

Of the eight pregnant cattle which received the more severe type of exposure, three contracted the infection. Two of these animals aborted, and another eliminated the infection from her uterus and with her colostrum at time of parturition.

The cattle which had close contact to the artificially infected swine continuously for several months reacted at times to the agglutination test in a titer as high as 1 to 200, but in none of the cattle was the presence of the infection proved.

The results obtained from the experiments seemed to justify the following conclusions:

Pregnant cattle can sometimes be artificially infected and caused to abort by subjecting them to severe *Br. abortus* (porcine) exposure through the conjunctiva or conjunctiva and digestive tract.

When cattle negative to the agglutination test are kept for a considerable time in close contact with swine infected with *Br. abortus*, it is not unusual for them to acquire temporary agglutination reactions. Eleven cattle thus exposed, however, produced vigorous calves, and guinea-pig-inoculation results with uterine material and with colostrum at time of parturition indicated the absence of *Br. abortus* infection.

Cattle give evidence of having considerable resistance to infection with *Br. abortus* (porcine) and seldom contract infectious abortion from swine as a result of natural exposure to them.

**END**