PARATUBERCULOSIS OF CATTLE (Johne's disease) is a disease that develops slowly, is characterized by long periods of unthriftness, gradual loss in body weight, and an obstinate diarrhea. Affected animals appear to have normal appetites, yet they gradually dwindle to skin and bones.

_Herds can be protected against paratuberculosis by:_

1. Enlisting the cooperation of the local veterinarian in the diagnosis of the disease.
2. Promptly eliminating reactors from the herd.
3. Practicing strict sanitation in stables.
4. Keeping pastures, feed, and drinking water clean.
5. Adding to the herd only breeding animals that give a negative paratuberculin test.

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Urbana, Illinois

Printed in furtherance of the Agricultural Extension Act approved by Congress, May 8, 1914.

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Paratuberculosis of Cattle
(Johne’s Disease)

By ROBERT GRAHAM, FRANK THORP, Jr., and J. P. TORREY

PARATUBERCULOSIS, or Johne’s disease, is a chronic, infectious, bacterial dysentery, principally affecting cattle but also occurring in sheep, goats, deer, and occasionally in buffalo and horses. Animals of all ages and breeds may be susceptible altho, probably because of the long period of incubation, symptoms are very rare in animals less than two years old.

The spread of paratuberculosis is difficult to control because of the chronic nature of the disease, the absence of symptoms in many infected animals, and the fact that many stockmen are not aware of the prevalence of the disease.

Paratuberculosis is frequently confused with tuberculosis, parasitic enteritis, gastritis, coccidiosis, or malnutrition; therefore it is probably more widely distributed than available reports indicate. During the last ten years practicing veterinarians have reported cases resembling paratuberculosis in various counties in Illinois—Ford, Champaign, Putnam, LaSalle, Iroquois, Sangamon, Cook, Richland, Montgomery, Madison, and Woodford.²

The occurrence of paratuberculosis in an increasing number of Illinois herds has led to the preparation of this circular to help Illinois stockmen and veterinarians to recognize the disease and to employ the proper measures for prevention.

Symptoms of Paratuberculosis

Animals infected with paratuberculosis may not show symptoms for several weeks, months, even years, after infection occurs. In young animals the microorganisms seem to propagate very slowly or even to remain dormant.

A gradual loss of flesh and a watery, persistent or recurrent diarrhea are the most marked symptoms in the advanced stage of the disease. The appetite and general attitude of infected animals remain quite normal in the early stages, but as the disease advances excessive

¹ROBERT GRAHAM, Chief in Animal Pathology and Hygiene; FRANK THORP, Jr., Associate in Animal Pathology; and J. P. TORREY, Assistant Pathologist, assigned to the Division of Animal Pathology and Hygiene by the State Department of Agriculture to assist in diagnostic work.
²See footnote, page 5.
thirst, emaciation, and a subnormal appetite may be noted (Fig. 1). The milk flow in lactating animals is reduced and finally ceases. No febrile disturbances have been noted in diseased animals at the Illinois Station. The absence of fever has probably been a factor in the failure of stockmen to recognize the infectious character of the disease.

![Fig. 1.—Symptoms of Advanced Paratuberculosis](image)

The extreme emaciation of this animal is one of the symptoms of the advanced stage of paratuberculosis. This case was further confirmed by the paratuberculin test, the presence of acid-fast rods in the feces, and autopsy findings.

Mature animals infected with paratuberculosis frequently manifest symptoms following calving, abortion, an attack of pneumonia, or garget. In fact any condition that lowers the vitality of exposed animals is regarded as a predisposing factor in the development and progress of the disease.

Some animals may show symptoms of the disease and survive for a number of years, or recovery may seem apparent and then be followed by a relapse after weeks or months; other animals may die within a few weeks after symptoms appear. There is no evidence to show that paratuberculosis is ever completely overcome.

**Causative Agent**

The cause of paratuberculosis is a microscopic acid-fast rod known as *Mycobacterium paratuberculosis* or Johnne's bacillus, which enters
the body thru the digestive tract (Fig. 2). This microorganism is very closely related to *M. tuberculosis* and resembles it microscopically. Clumps of the microorganisms may be observed in stained cultures made from the thickened mucous membrane of the intestine of an infected animal as well as from the neighboring lymph glands. Culturing *M. paratuberculosis* is a somewhat slow and difficult process and requires a special medium.

**Post-Mortem Appearance**

The lesions of paratuberculosis are confined to the intestinal tract. The mucous membrane of the affected area may be four or five times its normal thickness and wrinkled or folded deeply either longitudinally or transversely (Fig. 3). These folds may be spotted with small hemorrhages. The regional mesenteric lymph nodes are frequently edematous, or watery. Sometimes the small intestine is normal, the lesions occurring only in the large intestine.

The severity of the intestinal conditions does not, however, always correspond with the severity of the symptoms. Thus advanced cases may show limited inflammatory areas with large numbers of acidfast

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*The causative agent of paratuberculosis was first described in Germany in 1895 by Johne and Frothingham. Since then the disease has been reported in various European countries, India, Sumatra, South Africa, and in the United States. It was probably first introduced into the United States thru cattle imported from Europe. How prevalent it is in the United States is not definitely known. Cases have been reported in 27 states, but all these have been in herds where losses have been excessive or in herds attended by veterinarians who are on the lookout for sporadic occurrence of the disease.*
The lining of the small intestine may be thickened and the surface wrinkled and folded as a result of infection with paratuberculosis (A). The lining of the small intestine of a healthy noninfected animal is thin and smooth (B).

Methods of Diagnosis

Diagnosis of paratuberculosis may be made on the basis of symptoms, post-mortem examination of intestines, bacteriological findings, and paratuberculin tests. Clinical symptoms may so closely resemble those of other diseases that a diagnosis cannot be made unless other means of differentiation are used. Differentiation from tuberculosis may be made by the tuberculin test or, in autopsy cases, by observation of the gross lesions and by inoculation of guinea pigs, which are not susceptible to paratuberculosis unless given massive doses but are
highly susceptible to bovine tuberculosis. Fecal examinations will aid in determining the presence of intestinal parasites. The possibility of nutritional disturbances should also be taken into consideration before a diagnosis of paratuberculosis is made.

**Microscopic Examination**

At post-mortem examination, lesions resembling those of paratuberculosis may be identified by microscopical examination for acid fast rods. In animals which show symptoms of paratuberculosis, the presence of a large number of acid fast bacteria on slides made from feces and rectal scrapings is indicative of, but not absolute evidence of, the disease. The possibility of contamination of such specimens with non-pathogenic, or nondisease forming, acid fast microorganisms makes identification by means of cultural characteristics and pathogenicity tests essential.

Microscopic examinations cannot be relied upon in animals incubating the disease, since the *M. paratuberculosis* microorganisms may not be present in the mucous membrane or in the feces in large enough numbers to be detected until the advanced stages of the disease have been reached.

**Paratuberculin Test**

The paratuberculin test, which has been developed in recent years, is the best-known diagnostic procedure for detecting paratuberculosis before symptoms are evident. Paratuberculin, a sterile extract of *M. paratuberculosis* cultures to which phenol or some other preservative has been added, is prepared and used similarly to tuberculin in the tuberculosis test. Avian tuberculin can also be used. These extracts cannot cause the disease in healthy animals.

*Application of Test.*—The presence or absence of paratuberculosis is determined by a comparison of the temperatures of the animals before and after the injection of paratuberculin.

Three consecutive hourly temperatures should be taken preceding the injection of paratuberculin. Animals showing temperatures of 103°F. or higher should not be tested. Following the three preinjection temperature readings, 5 to 10 cubic centimeters of paratuberculin (the larger amounts used for the older and larger animals) should be injected aseptically into the jugular vein with a hypodermic syringe.

1Both paratuberculin and avian tuberculin have been used at the Illinois Station for testing cattle, with results which indicate that either product, if properly administered, may be used successfully for the diagnosis of paratuberculosis. Avian tuberculin is prepared from the cultures of *Mycobacterium avium.*
Following injection, temperatures should be taken at hourly intervals for ten hours, or longer.

*Interpretation of Test.*—The injection of paratuberculin does not cause a rise of temperature in healthy animals, but the majority of infected animals receiving paratuberculin intravenously show an elevation of temperature, and not infrequently systemic symptoms (Fig. 4). Such disturbances as roughened hair coat, depression, diarrhea, and dyspnea may accompany a thermal reaction. Infected animals show a gradual rise and subsequent fall of temperature, with the maximum temperature usually occurring between the fourth and eighth hours. Delayed reactions may, however, occur as late as the thirteenth hour.

A rise of 2 degrees over the highest preinjection temperature, if the maximum reaches 104°F., constitutes a reaction. Post-injection temperatures which approach a maximum of 104°F. and show an elevation of less than 2 degrees are regarded as suspicious reactions. All doubtful or uncertain reactors should be retested in 60 to 90 days.

**FIG. 4.—TEMPERATURE REACTIONS IN PARATUBERCULIN TEST**

Temperature reactions of five animals tested with the paratuberculin test are shown above. The two animals in which post-injection temperatures reached 104°F. between the fourth and eighth hours following the test are classed as reactors. Reactions may, however, occur as late as the thirteenth hour (delayed reactor). An animal that shows a rise in temperature of less than 2 degrees over the highest preinjection temperature but approaches 104°F. is regarded as a suspicious reactor and should be retested in 60 to 90 days.
Tho assurance of complete success in eradicating paratuberculosis by annual testing cannot yet be made, results obtained in European countries and at various experiment stations in the United States justify the application of the test for the diagnosis and control of paratuberculosis as well as for preventing the introduction of the disease into healthy herds.

Experience of Herd Owners With Test

Symptoms of paratuberculosis were recognized in a herd of over 100 cattle in Champaign county, Illinois, in 1917. During the following ten years, twelve valuable animals in this herd died after showing symptoms of paratuberculosis. The disease was definitely identified in 1927 by applying the paratuberculin test to all animals in the herd. Gross lesions suggestive of paratuberculosis were encountered in the small intestines of affected animals which were examined at autopsy. This herd has since been tested annually and reactors removed, and while it has not been possible to eliminate the infection entirely, no symptoms of the disease have developed in this herd since annual testing was inaugurated.

Tho testing helps to control the disease, it is very difficult to eradicate it completely in infected herds, as shown by the data in the accompanying table. The number of animals reacting positively to the tests decreased from 36 out of 120 (30 percent) in the first year of the test to one out of 111 (.9 percent) in the sixth year, but increased again to 6 out of 151 (3.97 percent) in the seventh year and to 2 out of 130 (1.5 percent) in the eighth year.

In badly infected herds retests and elimination of reactors may not be as economical as shipping the entire herd to market and selling

<table>
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<th>Date</th>
<th>Total number of animals tested</th>
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<tr>
<td></td>
<td>number</td>
<td>perct.</td>
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<tr>
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<td>87</td>
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</tr>
<tr>
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<td>120</td>
<td>84</td>
<td>70</td>
</tr>
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<td>1929</td>
<td>61</td>
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<td>128</td>
<td>98.5</td>
</tr>
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them subject to inspection. In one Illinois herd the large number of reactors, as determined by annual test, made it advisable to dispose of the entire herd. A federal veterinarian\(^1\) describes a herd of 207 animals from which 27 cows were removed during 18 months because of paratuberculosis. After this a test was made and nearly half the remainder were found to be infected.

**Death Losses From Paratuberculosis**

The losses reported in herds in which paratuberculosis has been identified by the use of the paratuberculin test and autopsy examinations are suggestive of the high death toll that this disease is taking annually. There are, of course, many untested herds on which no data are available, but which probably suffer similar losses. Even in herds in which the affected animals show marked symptoms, the disease is not always recognized by the herd owner.

As a result of investigations made in 1927 of 76 Wisconsin herds, 135 animals were removed from five herds, averaging 188 cows each, because of paratuberculosis infection.\(^2\) The yearly loss varied from 2.2 to 12 percent of the herd. Lash and Mohler\(^3\) in 1930 observed a herd of more than 200 dairy cattle in which paratuberculosis had been present for a number of years. Approximately 10 percent of this herd died annually from paratuberculosis. The deaths occurred in cows from 2½ to 9 years of age. When tested with paratuberculin, 45.4 percent of the herd were classed as suspects or reactors.

European investigators report still greater losses than those reported in the United States. In some areas in England the losses from paratuberculosis are estimated to be greater than from tuberculosis.\(^4\)

**Indirect Losses From Paratuberculosis**

Besides the annual death loss occurring in herds infected with paratuberculosis, there are other losses occasioned by a decrease in milk production, unthriftiness, and a decline of as much as 20 to 30 percent in breeding efficiency.

Observations over a period of seven years of one Illinois herd infected with paratuberculosis indicated that mastitis occurred more

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frequently in paratuberculin reactors than in nonreactors, and that breeding efficiency was lower in reactors, the efficiency of nonreactors being 83.89 percent and reactors, 48.27 percent. The occurrence of infectious abortion in the normal breeding unit of one herd was 7 percent in the animals that did not react to the paratuberculin test and 35.7 percent in the animals that did react to the test. Among the abnormal breeding animals, only 3.16 percent of the animals that did not react to the paratuberculin test, reacted to the test for infectious abortion, while 50 percent of the paratuberculin reactors gave positive agglutination tests for infectious abortion.

Apparently the lowered resistance that develops as a result of infection with paratuberculosis may be a predisposing factor to mastitis and infectious abortion.

No Successful Treatment Known

Many attempts have been made to discover vaccine and chemicals which may be used as cures for paratuberculosis in cattle, but none seems to have been very successful. Symptoms may disappear only to reappear at a later date; and it is therefore impossible to determine whether the treatments employed had any retarding effect or whether the disease might have been naturally quiescent during the period when no symptoms were observed.

If the disease is discovered in a pregnant animal, the feeding of dry food and the administering of astringents may check diarrhea and so help prolong the life of the animal until after the offspring is born.

Control Depends on Annual Testing and Strict Sanitation

Success in suppressing paratuberculosis is dependent upon the detection and removal from the herd of infected animals before they show clinical symptoms. This can be done by means of an annual paratuberculin test, as described above. Likewise no animal should be introduced into a clean herd unless it has shown negative paratuberculin tests or has come from a noninfected herd. One favorable factor in the control of paratuberculosis is that it does not spread so rapidly as do such diseases as tuberculosis and infectious abortion.

In addition to the annual testing of herds and the removal of reactors, sanitary measures are particularly important in controlling the spread of this disease, since the digestive tract is the only known avenue of paratuberculosis infection. Unless stables and yards are kept clean, water and feed supplies may become contaminated with *M. paratuberculosis* excreted in the feces of an infected animal. Pas-
tures and ponds may also be contaminated. It is not known how long \textit{M. paratuberculosis} may live outside the body, but it seems certain that it is somewhat resistant to sunlight and drying and that it may live for several weeks in stables, yards, and pastures.

Frequent cleaning and disinfection of barns and the scraping or plowing of lots, combined with methods of management that keep animals away from manure piles, stagnant pools of water, or slaughterhouse offal, are essential. Continuous use of the same pastures and overstocking should also be avoided if the spread of the disease is to be prevented.

The increase in number of cases of paratuberculosis noted during summer months in some infected herds may be due to continuous reinfection of pastures by infected animals. The succulent diet of cattle during the summer months may also be a predisposing factor in the progress of the disease. Surface drainage, streams, drainage canals, and dust may account for the distribution of infection from infected to noninfected farms.

Protection against paratuberculosis in cattle is dependent upon cooperation with the local veterinarian in the diagnosis of the disease, prompt elimination of reactors, strict sanitation in stables, clean pastures, food, and drinking water, and insistence that all animals added to the herd come from herds that do not react to the paratuberculin test.