

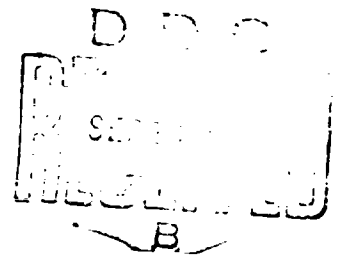
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## ON ANTHRAX

### An Epizootological-Clinical Study

By Ivar Christenson

Skandinavisk Veterinär-Tidskrift for Bakteralogi, Patologi  
Saint Kott-Och Mjalkhygien, 32 : 225-256, 1942.

Until the present time Swedish veterinary literature has contained relatively little concerning anthrax, but this disease is by no means to be regarded as of no importance for our country. As both the scientific and practical experiences in controlling the disease have substantially increased during the past forty years, and the author has had many opportunities, both at home and abroad, to study the subject, perhaps a review of the disease's occurrence and prevalence as well as past experience in various areas in its control and clinical treatment might be in order.

In Denmark G. Petersen and N. Plum, in 1932-1933, conducted thorough and interesting investigations of the disease's local clinical and epizootiological conditions.

In Norway A. J. Brandt described the attack in a severe outbreak of anthrax near Drammen in 1937 and also gave a very interesting report of the presence of anthrax in that country during the past few decades. There are also many reports on anthrax from various veterinarians and doctors both here and abroad which in this connection are worth noticing.

The State Medical Board's annual report Civil Veterinary Practice makes clear that the confirmed cases of anthrax in the country fell considerably in number during the period 1900-1901 (Table 1). As in Denmark, Norway, Germany, and other countries, the number of cases decreased greatly during and immediately after World War I. This condition was closely related to

decreased or occasionally complete discontinuation of imports of foreign products, such as fodder cakes, furs and skins from such countries where anthrax was epidemic (Russia, certain Balkan countries, South America, India, etc.).

In Germany G. Francke and V. Goertler blame much of the incidence and prevalence of anthrax on the discharge water from tanneries and thereby contaminated water sheds, which flow through pasture lands or infect wells and other watering places for the animals.

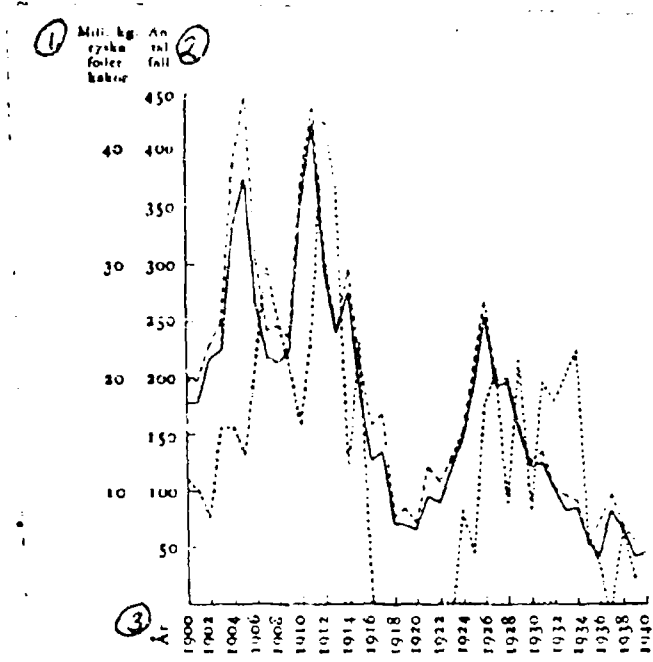


Table Ia.

#### Occurrence of Anthrax in Sweden, 1900-1940

- Number of infected herds
- Number of deaths of domestic animals
- ..... Number of infected humans according to data in veterinarian reports
- oooooooo Import of oil cake from Soviet (millions of kg per year)

1 -- Millions of kg of Russian fodder cakes; 2 -- Number of cases; 3 -- Year.

In Norway, Denmark, and England, however, the opinion is that foreign fodder is the cause of most cases of anthrax.

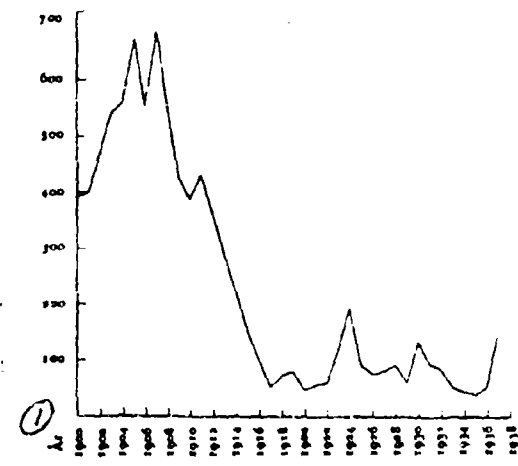


Table Ib.

Incidence of Anthrax in Norway, 1900-1937  
(according to Brandt).

1 -- Year.

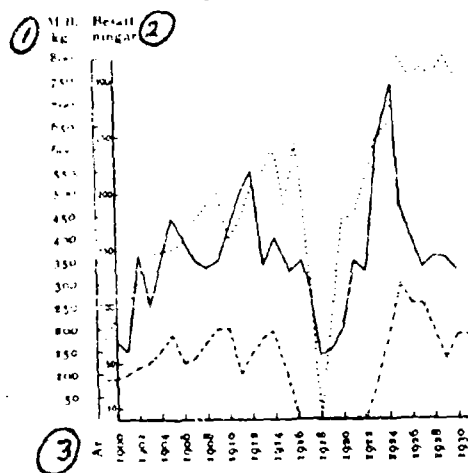


Table Ic.

Incidence of Anthrax in Denmark 1900-1930 (according to Petersen), compared to import of oil cake during the same period.

———— Outbreak of anthrax among cattle  
..... Total import of oil cakes  
----- Import of Russian oil cakes

1 -- Millions of kg; 2 - Herds; 3 -- Year.

Knowing a little about the cultivation of raw materials for such fodder components (especially sunflowers) in Russian swamp areas, for example, and the inadequate methods used to prevent contagion in cases of anthrax in that country (see below), there is a good possibility for the spread of anthrax via the fodder and animal products imported from there.

Petersen's report of 1932 seems to show that the number of cases of anthrax followed very closely the curve for the import of Russian oil cakes by Denmark (Table Ic).

But even if many, perhaps most, of the new infections each year in our country are caused by such importation, one cannot state, even with present rules and regulations relating to prophylaxis against anthrax, that cases of the disease would cease if this importation was completely prohibited. Anthrax spores can survive in the soil for more than forty years, so that the disease is a latent threat to our domestic animals and our people.

In respect to the incidence of the disease during different seasons, Plum has shown that statistically, as far as Denmark is concerned, during the 30-year period 1901-1930, the number of confirmed cases decreased during the summer months, June to September. Brandt has shown that, for the period 1926-1936 (11 years), the number of cases in Norway decreased sharply during the summer and the maximum number of cases occurred in the month of April.

A corresponding investigation for a 15-year period (1925-1940) in Sweden does not agree with the foregoing conclusions. Instead, most cases occurred during the second and third quarters (Table II).

This difference between neighboring countries can possibly be explained by the fact that, until 1920, it was not obligatory for veterinarians to have proven microscopically the presence of the anthrax bacillus in the animal's blood before making a diagnosis, a procedure which had been necessary in Sweden for a long time. Petersen, Plum, and Brandt conclude that many positive diagnoses before 1920 were made simply from the history and autopsy findings and that certainly many of these cases were not anthrax. The number of cases of anthrax decreased quickly in Norway after the Law of 1912 placed controls on the district veterinarian's diagnosis.

He who has learned during laboratory work how difficult it is to make an exact diagnosis of anthrax simply from microscopic studies, must realize that even in our country certainly a few faulty diagnoses are made during the course of a year and, above all, certainly many such mistakes were made in earlier years.

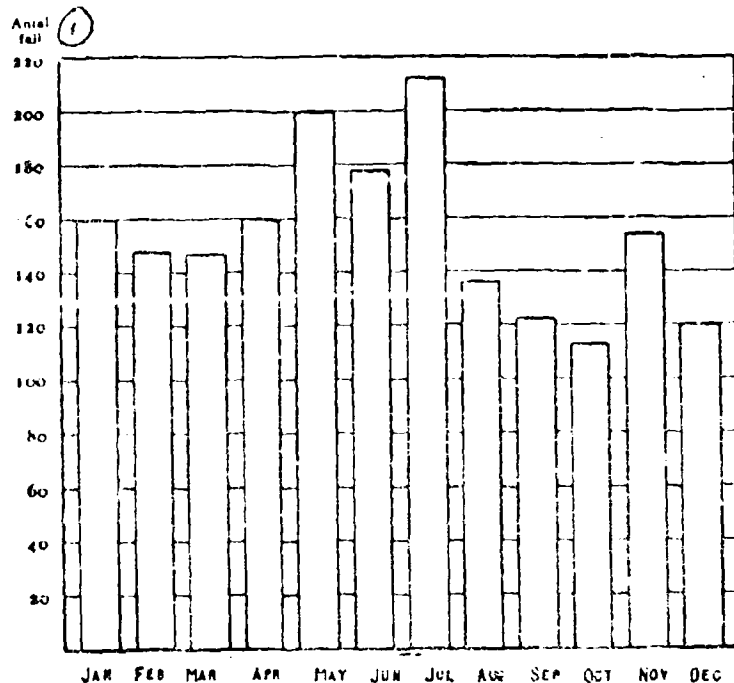


Table II.

Number of Anthrax-Infected Herds in Sweden for Various Months of the Period 1925-1940.

1 -- Number of cases.

Plum estimates that veterinarians made two percent incorrect diagnoses. It should be noted in this connection that during 1914-1928 approximately 58 positive anthrax diagnoses were made in Swedish sheep (about four per year), but during 1930-1940 only one single case was found in this species of animal.

Plum writes, concerning anthrax in sheep, "One must realize that in all of 31 years the laboratory found anthrax in only three sheep, namely in 1910, 1921, and 1927, so there is good reason to assume that the positive diagnoses of anthrax (made by district veterinarians), were wrong, generally, and this may be explained by the fact that the organs often show a certain type of putrifying bacilli a few hours after death which closely resemble anthrax bacilli.

The figures must be taken with reservation, but since the laboratory found only three cases of anthrax in sheep which

were seldom, if ever, fed on processed food, it seems to be a good indication that Denmark's soil is very little infected with anthrax."

Available Swedish statistics show that during the 25-year period 1914-1939 no less than 3,523 animals died of the disease (206 horses, 3,149 cattle, 59 sheep, 63 hogs, and 46 other animals, 41 of which were fur-bearing.

From these statistics, however, one cannot come to any real conclusion concerning the percent mortality rate of affected animals. The relative number of deaths of different animal species, i.e., horses, cattle, sheep, hogs, which have been reported as caused by anthrax, has been in this country about 4:50:1:1. In Denmark, Plum's investigations showed that while the relationship between the animals, calculated from the veterinarian's tests on animals which he suspected had anthrax and sent to the serum laboratory, was 5:80:1, the laboratory's positive diagnosis of anthrax in horses, cattle, and hogs showed a relationship of 1:120:4. Thus, this shows that the deaths of horses was too often blamed on anthrax.

The average percent mortality rate of domestic animals was estimated by Plum to be as follows: cattle 74.3 percent, horses 91.4 percent, sheep 78 percent, and hogs 45.9 percent (the figures varied considerably for the latter animal), and for dogs 54 percent. For several reasons he feels that the figures are certain only for cattle and hogs.

As far as humans are concerned, 79 cases were brought under medical care in Denmark during the period 1901-1931. For Norway Brandt reported that during 1889-1938, some 109 cases of human anthrax were found, 12 of which were fatal (11 percent). One case of anthrax of the face from an insect bite was described.

For Sweden not even relatively accurate figures can be given. From reports made to the Medical Board by veterinarians, there were only 80 persons who contracted anthrax during 1901-1940. This is by no means an exact figure, certainly many more were infected, as far from all cases of human anthrax are brought to the attention of the veterinarian. Compulsory reporting of anthrax to doctors does not exist in any Scandinavian country. According to Plum, of the 79 cases in Denmark, 7 were veterinarians (1 fatal), 68 butchers (8 fatal). Of the other types of workers, one milkmaid died of anthrax. In addition to the above-mentioned, one professor of medicine died of anthrax after being infected by a shaving brush (which often was made with foreign hog bristles). As far as this is concerned, Plum states that in some other countries, anthrax in

humans is rather common. In Bulgaria it was shown that in 1927, 1,425 cases occurred among domestic animals and 185 cases in humans (15 fatal). In 1928 the figures were 1,576 and 519 (50 fatal), respectively. The ratio between cases of animals and humans can in certain areas equal 1:1. Petersen states that in Germany, for instance, in 1913, 1924, and 1925 there were 221, 135, and 173 cases, respectively, of anthrax in humans.

Secondary cases of anthrax in domestic animals occurs in Denmark on the average in every fourth infected herd. In our country (Sweden), secondary cases appear even less. Certain years seem to have more secondary cases than others; thus we can justly call some years "anthrax years" (Table I). The years 1905 and 1911 were especially severe infection years for Sweden, Norway, and Denmark with approximately 400 deaths in this country [i.e., Sweden].

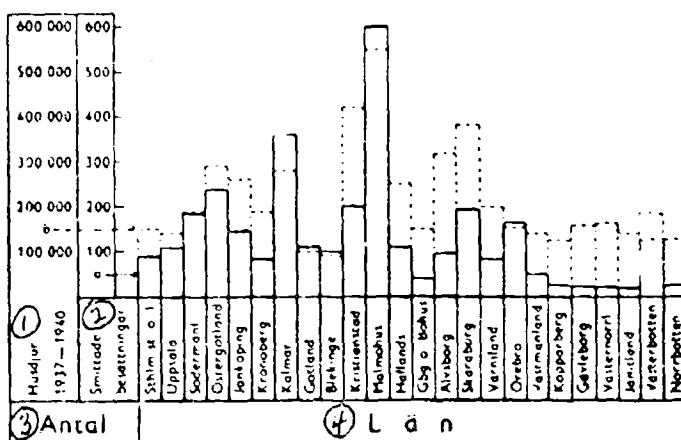


Table III.

a -- Total number of anthrax-infected herds during the 25-year period 1914-1939 in different districts; b -- Number of domestic animals in Sweden, 1940 (for Norrland 1937).

1 -- Domestic animals; 2 -- Infected herds; 3 -- Number; 4 -- States.

The frequency of infected herds in relation to the number of domestic animals in different districts is graphically illustrated in Table III. Kalmar, Malmöhus, Gotland, Blekinge, and Örebro districts show remarkably high relative figures. While the average number of fatal cases of anthrax in domestic animals during 1900-1915 was approximately 300 per year, the number of deaths for the past ten years has decreased to about 100 and during the past five years has decreased to 77. From

the Medical Board's annual report it can be seen that during 1900-1915 quite often the same place was declared infected two or more times during the same year, a situation which has seldom existed during the past few decades. These results were reached partly by more careful diagnosis on the part of veterinarians, partly by better prophylaxis, and, finally, partly by better therapy, of which more shall be said later.

To really understand the importance of using more appropriate methods to control anthrax both from the legal as well as clinical aspect, I will first describe some of the more typical outbreaks of this disease as found in available literature.

I) In Humans. The typical course of skin anthrax in human beings can be seen from the following examples:

a) Prof. Aage Moller-Sorensen, of the Veterinary School in Copenhagen became infected while dissecting anthrax-infected tissues in 1926. The dissection was of a slaughtered cow, for which neither the history nor clinical course indicated anthrax. The dissector had, at one time, a fresh, superficial sore on the left index finger, but he did not use rubber gloves.

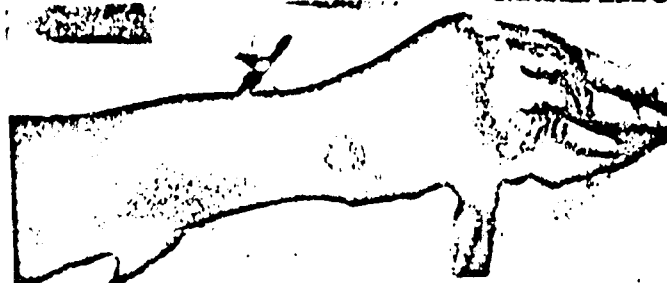


Fig. 1. Anthrax. Beginning Blister on Skin. (As per P. Aaser, and others.)

Immediately after the autopsy, which in conjunction with microscopic studies indicated anthrax, the hand was treated prophylactically with great care, even using disinfectants. Six days later, three small pinhead-sized, very itchy, red pimples appeared in the wrist. The next day, the pimples were several times as large and appeared like lice bites but had a hemorrhagic center. Two days later the red areas were as large as beans and the hemorrhagic centers were slightly depressed and surrounded by a well-demarcated erythema. Some of the serous exudate from these areas showed anthrax bacilli on microscopic examination, which varied somewhat from the normal form (involution forms). The same day a reaction was noticed in the axillary glands and the following day typical lymphangitis was seen

in the arm and the patient received a severe headache. The process in the skin enlarged to the size of a 25 cent coin and became very tender, red, and black in the center. Body temperature rose to 101.9°, but dropped to normal within a few days after large doses of quinine were given. Local treatment with warm sublimate soaks stopped the lymphangitis quickly but the swelling in the axilla and the tenderness remained longer. The pustulae malignae coalesced and began to demarcate and granulate within a few days. Not until about a month later did the scar production cease. The portal of infection was believed by Moller-Sorensen to be the hair follicles and thus not the fresh sore.

b) A similar, less severe case of anthrax after autopsy was described shortly thereafter by veterinarian J. Norrelund of Denmark. The incubation period was four-five days and the duration of the disease about one month.

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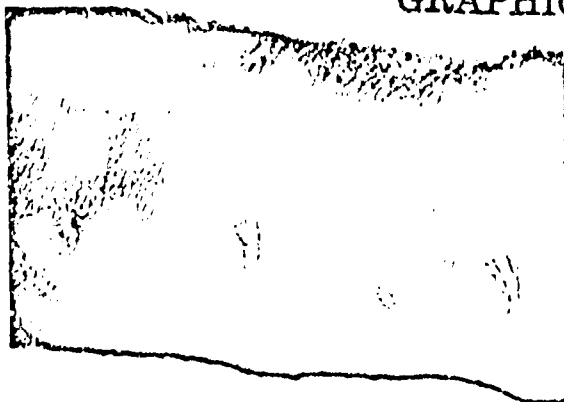


Fig. 2. Anthrax of the Skin with Some Broken Blisters (according to P. Aaser et al).

c) Veterinarian E. Breitenstein, Denmark, incurred that same year an anthrax infection on the dorsal surface of his hand while doing an autopsy on a suspect cow carcass. No skin lesions were seen. Extremely careful hand hygiene had been observed at the autopsy and subsequently. The local signs, appearing later, were mainly like those previously described, even here a small blister containing a serous fluid was also seen, and later, several more of these appeared in the edematous part of the hand.

In this case, the local signs appeared as soon as three-four days later, but not until the 13th day after the autopsy did the glands in the axilla and the lymph vessels in the arm react. At about the same time, the temperature rose to 102.2°, and at this time a doctor was consulted. He immediately and

positively wanted to operate on the patient, but the latter was against it, using Moller-Sorensen's experiences (see below) as argument. During the following three days the temperature rose to 105.5° as did the pulse, relatively. Because the patient became worse, the doctor visited him again on the 18th day, p.i., and was unable to resist cutting away the skin around the carbuncle. The patient himself stated later that he was too ill to oppose this measure. He did not comment on the worsened condition but did say that a necrosis had set in, caused by the removal of the skin (Fig. 3).

GRAPHIC NOT REPRODUCIBLE



Fig. 3. Skin Anthrax. Middle Finger Extensor Tendon Injured. Edema remains. Necrotic tissue sloughed off after Pustula maligna (according to E. Breitenstein.)

B. entered a hospital that same day and remained for 17 days. Lymphangitis had swelled the entire arm. Fever remained for approximately 30 days, post infection, secondary bullae with serous contents (which showed staff bacilli) appeared on the fingers, and the skin partially degenerated in the axilla. The doctors opened each secondary bulla as it appeared. The general treatment was warm soaks with proper medication against the sores and lymphangitis. Finally, after four months, the sore remaining from the removal of the carbuncle healed, but much scarring remained. The fingers lost some function for a long time, partly because of the scarring and partly because some of the extensor tendons became necrotic. B states that he went to the hospital in tropical heat but did not feel that this was the cause of the fever or had any effect on his general condition.

d) District veterinarian O. Sultan, of Kila, Sweden, became infected in the spring of 1931 during examination of a piece of meat sent to his office from a slaughtered cow. A few tiny skin lesions were on his hand. As soon as anthrax had been diagnosed after microscopic study of the foul meat and its lymph glands, careful hand hygiene was observed, and the skin disinfected with "saturated sublimate solutions, disinfecting alcohol, and tincture of iodine." This, however, was unable to prevent the

infection. As soon as three days later, general symptoms were observed, including 103.1° fever, chills, etc., and the axillary lymph glands began to swell. From the 8th day hospitalization was necessary, which lasted two and one half months. On the 10th post-infection day, a penny-sized pustula maligna with a central ulcer appeared on the middle joint of the index finger. Anthrax bacilli were found in this pustule. The temperature rose to 104.6° and the pulse was 140. The axillary lymph glands became as large as hen's eggs. None of the usual lymphangitis signs appeared between the portal of entry and the axilla.

Operation was performed which consisted of "burning out" the pustula maligna and peeling out the entire lymph node "package." Histological examination of the tissue confirmed anthrax. Two hours, p.o., the temperature fell. At this time, 20 cc of anthrax serum was given, upon which the patient vomited and developed a general urticaria. One week p.o. the abdomen became secondarily infected, with slight temperature rise, cramps, tenderness, vomiting, and pains with increased peristalsis. A few days later, the symptoms were localized to an area under one of the kidneys and finally even these symptoms disappeared a few days later.

These four cases have been presented to give colleagues who are involved with this type of infection guidance in its treatment. They also show that anthrax in veterinarians must be considered an occupational disease, which means that extreme care must be used in handling suspect materials. Autopsy on naturally dead animals as well as on animals killed for meat control must always be done using rubber gloves! As has been seen from what has been presented, the absence of visible lesions and observance of strict hand hygiene is no guarantee against anthrax infection through the skin. One must remember that to be nonchalant with an early anthrax carbuncle on a veterinarian is not only risky for the patient himself, but carries with it the risk of spreading the disease to other patients.

In foreign veterinary and medical literature one often reads about severe cases of anthrax even in workers in other fields. During a study tour of the Baltic States and Poland in 1931 several such cases were presented to me. Among longshoremen in Riga many cases of anthrax of the skin and lung were found after unloading cattle skins and hides from Russia (Prof. Kirchenstein). From Germany, England, and France one reads of rather common cases of anthrax of the skin in tannery workers and lung anthrax in spinning mills and wool processors using wool from "anthrax countries." Though the soil in the north

countries must be considered relatively free of anthrax spores as a result of good drainage and destruction of carcasses, as well as prophylactic measures taken during outbreaks of anthrax, this cannot be said for Russia and certain other countries poorly drained, or in fact, undrained marshlands. To control anthrax, the countries bordering on the Soviet Union have set aside certain areas in each village where all carcasses are to be destroyed by modern methods. It was recently stated that in Russia as late as 1931 it was not at all unusual for domestic animals who had died naturally to be placed in the woods as food for wild beasts and dogs -- the East's sanitation department -- so that the latter, out of hunger, would not eat the farmer's grazing animals. Naturally, among these carcasses were some which were infected with anthrax. In Poland doctors and veterinarians stated that there were more cases of anthrax in the eastern border areas than anywhere else in the country.

From the literature concerning human anthrax cases we learn that, among other things, anthrax bacilli are usually found in the pustules for about one week, after which they die because of the bactericidal substances and the development of pus bacteria. There are cases in which anthrax has been introduced into humans by insect bites as well as through the irritation caused by fur caps and fur collars made from the fur of infected animals. Anthrax is usually more localized in human cases. Localization to the head and neck has a poorer prognosis (glottis edema, foreign body pneumonia, and swallowing difficulties) than localization in the extremities (Fig. 4).

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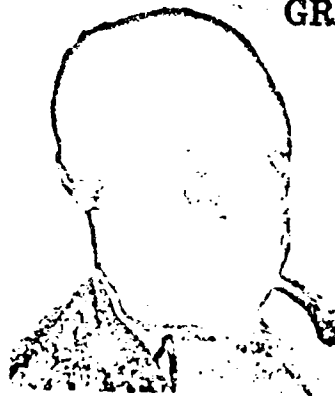


Fig. 4. Anthrax of the Face with Numerous Broken Blisters and Severe Edema. Healed. (Aaser et al.)

By the use of conservative treatment, the mortality of localized anthrax should be between 10-15 percent, but with

generalized, internal infection it is 50-80 percent. Sclavo reports that the mortality among 164 serum-treated cases was only 6 percent, while the mortality without serum was 24 percent. Concerning treatment of human anthrax cases, Moller-Sorensen says: "Extreme conservative treatment of localized anthrax combined with serum treatment and Neosalvarsan in more serious cases is mandatory, as irritation of the pustule by incising, scraping, etc., often makes the condition worse." Loxer states: "In treating external anthrax, anything that can cause absorption of bacteria must be avoided. This danger mostly exists when cutting into and scraping the carbuncle or lymph glands. In the most serious cases, however, in which general infection has already set in, operative procedure can no longer be of benefit." He suggests covering the sore or pustule with a thick layer of some antiseptic ointment on gauze and complete immobilization of the affected part (mitella, bed rest, etc.). This, to hinder irritation from the bandage and also hinder disturbing the sequestration. The same attitude can be seen in textbooks for doctors. J. Borrelus, P. Aaser, et al., state this quite definitely. In order partly to prevent the development of lymphangitis and general infection from a local focus of infection, and partly to heal the local infection quickly, A. Wassen, of the Sahlgren Hospital in Gothenburg, feels that without a doubt the method of Lawen, Henner, et al., namely autoinjection, which has given very good results in severe skin and mucous infections in humans should be tried. This method consists of the injecting of some of the patient's own blood, subcutaneously, at a certain distance from the focus of infection, for example, a ring around the wrist when the infection is in a finger or around an infected lymph gland. About 20 cc or more of venous blood, to which citrate has been added, is injected. The dose varies, depending on the absorption coefficient of the tissue in the injection area. By this means, a rather effective screen is immediately achieved against further spread of infection. This method, according to the author, should be tried on domestic animals even with other infections (such as lymphangitis, joint sores, etc.). Cold treatment (see below) which does not seem to have ever been tried on humans, may have to be tried in critical cases.

Concerning serum treatment of anthrax-infected humans, which is accorded great importance, P. Aaser and others feel that one should give 20 cc intravenously several times and even 100 to 200 cc at one injection. During my visit to Poland, director of the Pulawy-Michalowka Institute, K. Markowicz, told me that in order to prevent anaphylaxis, the best and quickest results were achieved by giving the patient 40 cc serum intramuscularly the first day and the second day 6.5 cc of oil of camphor subcutaneously, followed one half to one hour later by

20 cc serum intramuscularly. The local condition is treated at the same time with soaks of antiviral solutions, by Besredka's method. A female technician in a laboratory, who became infected in an eyebrow, was recently treated in such a manner, and according to her own report, was in full health and working again in a few weeks. The warning has always been in existence that one should not "annoy" an anthrax carbuncle by operative measures, as easy generalization and spread of the disease may occur. Wassen advises care in giving serum by desensitizing the patient through small, intracutaneous serum injections. Anthrax serum from Park and Davis or Behring is used for humans.

With full knowledge that far from all of our doctors seem to be orientated in modern anthrax therapy, it is important that veterinarians, at least when they suspect themselves of having anthrax, should know what to do. In the future amendments to the Epizootological Laws, veterinarians should be ordered to report all suspicious cases of anthrax in humans who have been in dangerous contact with infected animals to the Medical Board or the district physician. In the future, serum for therapy might possibly be taken from previously infected humans (like our blood banks).

II) In Animals. Only very seldom is anthrax transmitted from one person to another. But, as stated above, secondary cases in domestic animals occur often. Some descriptions of such cases of typical enzootic spread from the Scandinavian literature will now be presented.

a) Weirum, in Denmark, describes a general epidemic of anthrax in 1923 with 24 cases in a herd of 47 animals. No clear diagnosis could be made of the primary case. The animal died one and one half days later, at night, and the carcass lay in the stall until the morning. Meanwhile, blood had been oozing from the nose and rectum. Secondary cases appeared quickly with two cases the second day, ten cases the third day, ten cases the fourth day, and two cases the fifth day. Of interest was the fact that an unusual number of animals showed stomatitis with dribbling, uttering peculiar, wet sounds when the mouth was open, much like the symptoms of hoof-and-mouth disease. In general, however, the clinical picture varied considerably. Most of the 24 diseased animals showed, in addition to high fever and rapid pulse, edema of the throat, diarrhea, and tympanitis. The first secondary cases were isolated in a cold shed but were moved a few days later to a barnyard where both cold and fresh air was provided to all the animals for the duration of the sickness. At first, the treatment was with antifibrin, camphor, Kreolin, and Lugol's solution per os. Later, only subcutaneous injections of Swedish anthrax serum.

As soon as the animal's temperature was over 103.1° twice in the same day, this treatment was instituted. The fever normalized in 14 animals, after only one injection of serum. The dosage varied from 20-100 cc. The other animals required several shots, in two cases five injections, a total of 390 and 450 cc, respectively. In a few cases the temperature fell after the first or second injection, but rose again after a few days, at which time more injections were given (intermittant course). In other cases the temperature fell a few hours after injection; in others, a day or more later. Three cases were treated prophylactically with serum, and the isolated cases remained healthy. The edema of the throat remained four to seven days after serum treatment.

In a few cases, however, there was difficulty in swallowing for a few days, even after the edema disappeared. In some cases the diarrhea continued for 12-14 days, resulting in severe weight loss. All the 24 secondary cases recuperated completely. The disease had spread throughout the entire barnyard but had begun where the first case was found, at which time the neighboring animals became sick also. The duration of the disease varied between 1-14 days. W. believed that the cold weather, which helped to keep the barns cold, worked to the advantage of the sick animals. In most cases the disease was subacute, although it was acute in a few cases. W. maintains that the serum should be used as early as possible and in large, refractory doses until the temperature stabilized.

b) J. V. M. Christensen, in Denmark, tells of an analogous case occurring in January 1909, consisting of 11 secondarily infected animals and one from 1935 with four secondary cases. In the first enzootic, the primary case's meat had been given to hogs, but they did not become infected! Instead, the cattle in the barnyard did. A baby pig, however, died of throat anthrax. Cold treatment was consequently used by allowing the sick animals to stay out in the snow-covered paddock, and treatment with antifibrin and Kreolin per os. One case had edema of the throat. This animal had become better through the cold treatment, but the owner felt sorry that the animal had to stay out in the severe cold and placed the cow in the barn overnight with relapse and death of the animal as a result. Serum, which, at that time (1909), was not as easy to obtain as now, had not been used.

In the enzootic of 1925, where the primary case had been slaughtered and a few secondary cases followed, cold treatment was employed in the form of isolation in a drafty passageway with cold showers. By these means the temperature fell one or two degrees within a few hours. During the critical period,

the temperature was taken every hour. The sick animals received 40 cc serum and healthy animals 20 cc. In spite of the serum injection, the temperature rose two or three times a day but was forced down again by antifibrin and cold showers. (Author's note: Dosage too small!) An animal which had been treated prophylactically became sick nine days after the primary case. In spite of immediate showers and antifibrin treatment, the temperature rose from 104° to 107° the first half hour, but slowly fell to 104.7° after showers. The cow had repeated temperature increases for the next few days but they were treated with cold showers. After one week, the animal became healthy again.

C's second case occurred in the summer of 1925. He had confirmed anthrax clinically in a cow with edema of the throat. The same treatment as above was given and the cow improved the same evening. Because of this, no more attention was paid to it, and no more showers were given during the night, with the result that the cow died the next morning. Anthrax was later confirmed by microscopic examination. He feels that the absence of the cold treatment that first night led to the lethal result.

C. H. Flindt-Larsen, in Denmark, described in 1926 an enzootic in January with five secondary cases in a herd of 83 animals. The primary case had been slaughtered and the blood had run into a manure trough. At the autopsy of this animal the assistant veterinarian, Norrelund, was infected (see above). The next five neighboring animals became sick. In one case the disease began with cramps, high fever, and inability to stand up. The treatment consisted of isolation, antifibrin, and serum injections subcutaneously. In general, the fever dropped within a few hours. In one case throat edema appeared. The last two cases were not isolated. All the secondary cases recovered from the disease within five days. Cold treatment was not mentioned. Flindt-Larsen feels that prompt serum treatment had good effect.

d) N. M. Mose, in Denmark, had one death from anthrax after "drum disease" [a disease of one of the cow's stomachs] in a herd of 72 animals. Investigation showed that in the adjacent farm that same day one animal had died, this one, too, of anthrax. In the first farm, eight cows were secondarily infected and in the neighboring farm one ox. Immediately after the first secondary case, the entire 72 animals in the herd was given a prophylactic dose of serum, intravenously. The sick animals were isolated in a cold loading shed, where the temperature was under 10°, for several days. They received large doses of serum, camphor, acetanilid, and Kreolin as long as the

temperatures were over 103°. In spite of the prophylactic serum injections, three cows became sick on the first, second, and fourth day after injection. Altogether, two oxen and three cows died. One of the dead cows had been treated with serum therapeutically and prophylactically, and one of the dead oxen and one of the dead cows had only received a therapeutic serum dose and symptomatic treatment. In September 1923 M. had a similar case in a 97 animal herd. Altogether, 22 animals were infected and 3 died of anthrax. As a result of the 1921 experiences, this herd was treated symptomatically only, while the sick animals were isolated in a cold barn. M. feels that serum is of doubtful value either prophylactically or therapeutically.

In this herd, the disease appeared here and there in which the best, well-nourished milk givers died. The course of the disease varied from a few hours to, at most, six days. M. feels that it is very important to watch the animals both night and day and, as soon as any animal shows a temperature over 103° to isolate it immediately in the cold, and give it camphor to stimulate the heart.

The various results from the use of serum therapy which our Danish colleagues have had is probably caused by the more or less immunizing ability of the serum (Author's note).

Examples of anthrax epizootics of greater prevalence follow.

a) E. Sorterup in Norway describes thoroughly how, during the "anthrax season," 16 June-9 July 1931, anthrax spread to eight farms lying in a valley by a river but on opposite sides. Altogether, 11 animals died, all in the pastures. Forty years ago, a carcass of an animal dead of anthrax had been buried in a swamp near the primary case's pasture. The carcass had not been cremated. Dykes had been built around these swamps shortly before the first animal became sick. It was assumed that spores from the old carcass caused the disease. Hide from the primary case had been brought to a tannery near a public road and this caused a few secondary cases. S. believes that it has been proven that insects and birds played the chief role in the spread of the disease from one pasture to another and writes: "The first carcass lay, skinned, for several hours before I arrived on the scene, and masses of flies, ants, maggots, etc., had filled themselves with anthrax spores. Most were probably killed at the cremation, but probably many escaped. There is no doubt that flies and ticks can transmit bacilli directly from one animal to another and in this manner spread the infection from place to place. Upon orders from the chief veterinarian, all animals were removed from the pastures and placed in stalls,

received prophylactic serum, upon which the epizootic disappeared. All carcasses from this epizootic were burned with the exception of one." S. believes that this will cause the area to be dangerous for decades. He says: "The area in which the burials were made is to be burned off every year from now on, as long as I am here, and I hope my successor will do the same when that time comes."

b) That anthrax infection can be highly virulent and highly contagious is shown by the epizootic described by A. J. Brandt, 1937, in Ovre Eiker, near Drammen, in Norway. This epidemic involved scores of herds of grazing animals, and during July-October, 103 domestic animals (58 horses, 43 cows, 2 hogs) and one person died. The primary case was believed to have been a cow which had been butchered and used for fox food. On this farm four animals died. In a layer of soil more than one spade length beneath the surface where the butchering had occurred a highly virulent anthrax infected material was found. This was proven by injection and culture methods. It is interesting to note that so many horses were infected. Insects were proven to have had a hand in spreading the infection. In the intestinal contents of insects which had been on the infected carcasses were found anthrax bacilli. Mostly, the disease appeared on the edges of the woods near the pastures, where the insects thrived. Relative to the above, I wish to say that I had the same experience in 1917 while I was at the State Veterinary Bacteriological Institute. Insects and fly larvae which had been included with the specimens sent from the epizootic in Tierp district, remained virulent up to the puppae stage of development.

Seventy-five percent of the horses affected during the Norway epizootic had tender swellings of the regional lymph glands and nodes, among which the udder, prepuce, and the lower neck -- areas where the insects usually suck blood from the animal -- were most often attacked. The cattle, however, usually had alimentary infections. In some cases the horses collapsed, apoplectic-like, but most were sick 3-4 days, up to 10 days, before they died. The clinical symptoms varied greatly among the different horses, so much so that one almost had to suspect every sickness which they contracted to be anthrax. Diarrhea and bleeding from other body orifices were seldom seen in either the cattle or the horses.

Findings at autopsy of the horses were totally negative, but the cattle usually showed changes in the spleen. Treatment of the sick animals with serum as well as with various medicines had usually bad results so that B. feels that the prognosis of clinical anthrax is poor. Cold treatment was not mentioned in

the report. About 8,000 animals in the area received prophylactic German serum with relatively good results, but this did not prevent some animals from becoming sick.

The control of the epidemic succeeded only after the pastures were closed and prohibition of elective slaughter, enforced cremation of carcasses, and other vigorous legal methods invoked, much like the rules to be followed in hoof-and-mouth disease. Considerable attention was paid to careful and early isolation of such animals, insect control, etc., to prevent new focal points of infection. An intensive search for dead pasture animals gave poor results; none of the deer or domestic animals which were infected, as rumored throughout the district, could be found.

c) A. Herodes reports an epizootic in Estonia in 1939 (verbal report). On 8 August, on farm 1, a cow died, and the hide was dried in the open air. On 10 November pieces of this hide were sold to neighboring farms 2, 3, and 4 to be used for shoe leather. The skins were placed in water pails, which were later directly used to feed and water the animals. Within four to six days anthrax appeared with sudden apoplectic-like deaths. None of the deaths (four) which occurred among the cattle was reported to the veterinarian. Meanwhile, a worker from farm 5 had been assisting with burial of carcasses on farm 4 on 18 November. On 21 November a horse died on farm 5. At the cremation of this animal people from neighboring farms 6 and 7 had assisted and there too animals dropped dead on 24-27 November. The veterinarian was finally notified on 22 November. Investigation revealed anthrax in all seven places and that the epizootic started at the sale of the first hide on farm 1. Altogether, on these seven farms, 4 horses, 25 cows, plus one sheep, and one person died, and further, one more person was infected, but was saved by the use of a serum from the Bacteriological Institute.

I	II	III	IV	V	VI	VII
1 nt 1/2	2 nt 1/2	1 nt 1/2	1 nt 1/2	1 hst 1/2	1 nt 1/2	2 nt 1/2
		1 nt 1/2	2 nt 1/2	1 hst 1/2	3 nt 1/2	1 hst 1/2
		1 fä	1 hst	1 nt		
		3	3			
		4 Ägaren död.				
		5 dottern sjuk				
6 Anm. 1 Käk- och halsanthrax.						

1 -- Cattle; 2 -- Sheep; 3 -- Horse; 4 -- Owner dead; 5 -- Daughter sick; 6 -- Note: Cheek and throat anthrax.

## Individual Cases

a) On 17 January 1926 I was called to Skanshill Farm in Simrishamn because of sudden, profuse diarrhea and dyspnea in a cow. On arrival a few minutes later, I found that the cow had been slaughtered and the blood had flowed into the ground. Within half an hour anthrax had been confirmed microscopically, immediate, intensive disinfecting procedures were instituted, and the carcass thoroughly burned. The temperature of the other 39 animals was taken twice a day. In spite of the immediate conservative measures taken, a neighboring cow (II) became sick on 19 January. On 20 January, four cows became sick (III, IV, V, VI), and on 23 January still another cow (VII) became sick, all standing on the same side of the fodder trough (Fig. 5).

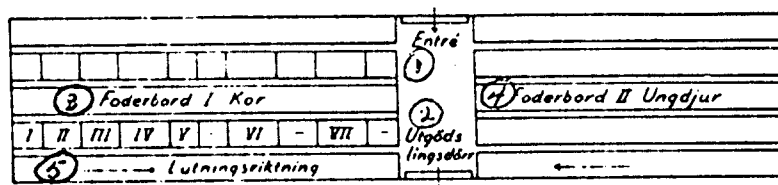


Fig. 5. Anthrax Cases Occurring in Skanshill's Herd, 1926.

1 -- Entrance; 2 -- Cleaning door; 3 -- Fodder trough 1, cows;  
4 -- Fodder trough 2, young animals; 5 - Slope of table.

All of the animals on the "threatened" side of the feeding trough, as well as those on the other side, received camphor, antifibrin and Kreolin, per os. Immediately after confirmed temperature rise over  $103^{\circ}$ , the animal was isolated in a cold, open shed, where they remained until the temperature stabilized. Usually the fever fell to under  $102.2^{\circ}$  by the 2nd-3rd day. On 22 January an injection of serum was given, 29-30 cc to healthy animals and 100-130 cc to sick animals, subcutaneously, although three of these had no fever. One of the healthy animals, however, had a fever of  $104.2^{\circ}$ ; the next day she received 130 cc, intravenously, and was isolated in the shed. After a few hours the fever became normal. Within 5-8 days all of the sick animals became well. Meanwhile, one of the previously sick cows had a relapse on 6 February (20 days after the primary case) with temperature over  $104^{\circ}$  and pulse 90, so another course of therapeutic serum was given, intravenously. The animal was isolated and became well again in 1-2 days. The picture shows that the spread of the disease was limited to one row of animals at the feeding trough.

b) Late in the evening of 25 November 1926 I was called to A. J.'s farm in Salarp to examine a seven-year-old cow which had suddenly developed fever. The herd contained 29 head of cattle.

P.E. Temperature 107.6°. Pulse 120. Palpitation, wheezing breath sounds, diarrhea. As I suspected anthrax, the animal was immediately isolated in a cold shed and given camphor, Kreolin, and antifibrin during the night, resulting in a temperature of 102.4° in the A.M. Early the next morning, a calf became sick with 104.5° fever and lost appetite and had slight "drum disease." The owner, realizing the danger of the situation, admitted that he had found a young cow dead in its stall on 23 November, without previous signs of any disease. Blood was found which had come through the anus. The carcass, which had been burned near a manure pile located only 50 feet from the farm's well, was immediately dug up. The diagnosis was made and the situation seen to be threatening. One side only of the grave was dug away so that the carcass could easily be dragged away by means of chains and a few horses, and brought to a suitable place for another burning and burial. Some of the manure was also burned. The earth surrounding the carcass was even burned off and general disinfection of the farm took place. Water for household use was boiled for a while. Fortunately, the surface water from the grave drained away from the well, preventing contamination.

By taking temperatures twice a day, secondary cases were easily found. Three cases occurred on 28 November, and one on 5 December showed only fever and a lowered general condition. They were immediately isolated in a shed, treated with medications, as above, for 4-5 days, and remained in the shed 9-10 days.

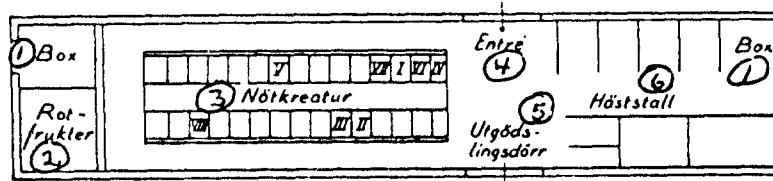


Fig. 6. Anthrax Cases Occurring in Salarp's Herds, 1926.

1 -- Storage bin; 2 -- Roots; 3 -- Cattle; 4 -- Entrance; 5 -- Cleaning door; 6 -- Horse stalls.

As Fig. 6 shows, four cases occurred next to, and on the same side of, the trough (IV, V, VI, VII) and three cases on the other side (II, III, VIII). Remembering the experience of the Skanshill case, where the infection was limited to neighboring animals on one side of the feeding trough only, it was decided, with economy in mind, to treat the herd with partial serum doses. On 26 November the sick cows plus one cow standing next to the primary case were given a therapeutic dose, intravenously, while the nine other cows on the same side of the

trough received prophylactic doses. The other animals were treated expectantly without serum.

Since there were secondary cases after 28 November, they were treated with a therapeutic dose of serum (120 cc), and all the other animals received a prophylactic dose. The cow which had become sick on 5 December had been given a prophylactic dose on 11 November, but received an additional therapeutic dose intravenously. The temperature still remained at  $104^{\circ}$ - $105.3^{\circ}$  for several days and slowly became normal. This happened to one of the earlier secondary cases as well.

As can be seen from the diagram concerning the occurrence of cases in the barnyard, the contagion, because of late reporting of the primary case, became spread over the entire feeding trough.

c) Shortly after the preceding case, anthrax was confirmed in a young cow, member of a low producing herd owned by N. N. in Rorum. This cow had had  $106.7^{\circ}$  fever and poor appetite for one day. The cow was already dead when I arrived. While in the death agony, the cow had torn off one ear and the blood had oozed onto the stall partition. In spite of careful disinfecting procedures which were immediately undertaken to protect the other cows, a neighboring cow became sick the following day, with a temperature of  $105.6^{\circ}$  and a pulse of 90. She was immediately isolated to a cold barn and received 120 cc serum intravenously, plus the usual therapy. She bettered in a few days. The other ten animals were treated prophylactically with serum and also received Kreolin for one week. No other secondary cases occurred.

d) In April 1936 I had a new opportunity to follow an anthrax enzootic, this time on Annedal's farm, with 24 highly productive animals. On 11 April a sick animal had been slaughtered in the yard by a butcher who had been hastily summoned. The carcass was hung in a corner of the barn and exenteration performed. The condition of the organs and further examination awoke suspicions of anthrax. The diagnosis was made microscopically and confirmed later by the State Veterinary Bacteriological Laboratory. Rules were closely followed. Even now, as expected, secondary cases soon appeared, seven to be exact, within four days. Treatment, with isolation in the cold and with medicines, were used as in the other mentioned enzootics. All of the animals were treated prophylactically with serum on the third day. Those which had fever received large therapeutic doses immediately. Two of the cows, which had been gravely ill for 7-8 days, showed skin edema, one in the neck, the other in the belly, which areas soon sloughed

off. The others spiked temperatures with hazy pulse and lowered general condition. All seven became well. During isolation in the cold, the owner had, on two occasions, felt sorry for the animals, because of the severe cold, and put a few newly-calved cows in the warm barn overnight, with the result that the temperature rose to over 104°. Upon return to the cold, the fever normalized.

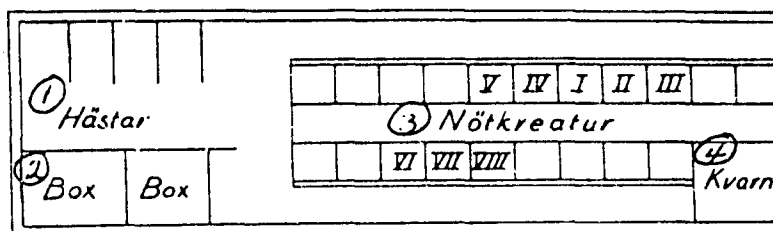


Fig. 7. Anthrax Cases Occurring in Annedel's Herd, 1936.

1 -- Horses; 2 -- Storage bin; 3 -- Cattle; 4 -- Mill.

As seen in Fig. 7, it was again the nearest animals to the primary case which first became sick. As far as I could ascertain, only one previous case of anthrax had occurred in Rorum and that was twenty-odd years ago. As the case occurred during the time when indoor feeding had to be resorted to, the cause of the three other cases must be ascribed to imported fodder, which had been used on all the farms. It is true that during this period a few isolated cases of anthrax had occurred, but without proven relationship to one another. The Skanshill case could possibly be considered to have had its origin in human contacts from a nearby large tannery, where foreign hides had been processed, but it is unlikely. One of the directors of the Swedish Tannery Association, G. Ehrenburg, of Simrishamn, presented statistics of our imports of skins and hides, the location of tanneries in this country, and the possibility of any relationship between such imports and the occurrence of anthrax in the districts. This gave no foundation at all to the idea that Swedish tanneries are spreading the disease. This, because the discharge waters from our tanneries are usually satisfactorily treated and cannot easily infect the pastures, as can happen in certain foreign marshlands. In the seaports, however, one sees all too often how skins and fodder are not adequately separated in the holds of the ship, or even covered with tarpaulins, so that food, etc., can easily pick up anthrax spores from, for example, dried hides from India. According to certain German investigations, many of the above-mentioned hides come from animals which have died naturally, and thus, not so few had anthrax.

The experiences from my own cases, as well as those referred to, apparently show that the results of treatment, as B. Bang had stated in 1910, depend on whether the animal was infected by spores or bacilli. In the latter case the animal usually receives a subacute attack and all, or most, of the animals recover. But the above-mentioned treatment shows good results even in acute cases (spore infection) if only the treatment is begun early. Brandt reports, as stated above, very poor results in the epizootic in Norway in 1937. It is therefore considered extremely important to use the fastest and best possible methods to control the disease, especially when blood, etc., has come out of the primary case, so that sporulation from the case cannot occur. Undoubtedly the size of the serum dose, compared to what is usually given, must be greatly increased.

III) Discussion and Recommendations. Table I shows, among other things, that the increase and decrease of anthrax cases in Sweden, Norway and Denmark generally occur simultaneously. How much of this depends on the amount of imported infected fodder or is related to a general virulence and contagiousity of infected matter cannot be answered with present scientific knowledge. Investigations in Denmark and Sweden seem to show that fodder imports, especially oil cakes, play a definite role in the appearance of anthrax in the country. This situation calls for increased prophylactic care. To further this aim, it is important to increase native cultivation of oil plants, which should be encouraged by the government (also for other reasons); stricter rules and regulations controlling the various foods, skins, hides, etc., in ships from epizootic countries, and forbidding importation from certain countries of such products without clearance and proof of adequate hygienic procedures in the country of origin by an official veterinarian.

That the graph of the occurrence of anthrax for the first 15 years of this century was so high, is most likely caused by the greater number of cases in those years. A royal decree of 5 January 1903 gave some economic relief to animal owners in cases of anthrax, so that they were more willing than before to report suspect cases to the veterinarian. About the year 1902 veterinarians first began more generally to burn anthrax-infected animal carcasses. But quite a few cases which were reported by local veterinarians as anthrax were not anthrax. This occurs even now, so that the veterinarian's microscopic diagnosis should be checked in a qualified laboratory before the case is officially registered in the medical board's statistics, as many of the above-burned carcasses proved later not to have been anthrax-infected.

The fact that anthrax cases are numerically greater during the summer half of the year in this country can be because our pastures are more contagious than those in Denmark and Norway. However, when we realize that our veterinarians have tremendous work loads during the Spring, it can be thought that this over-work causes not a few wrong diagnoses, more than at other times of the year. It is certain that, just as happened in the neighboring countries, the number of anthrax cases in the Spring would decrease if the diagnosis was checked later. It is very important that the statistics show exactly the situation in the country as far as anthrax is concerned, not the least because of our foreign export of animal products. Swedish veterinary science now has at its disposal many fine laboratories to call upon. District veterinarians, especially those in the worst epidemic areas, as well as endemic areas, should "map" out the anthrax districts. Those swamp areas where anthrax could eventually grow, should be drained, perhaps with government assistance. Although it is true that the disease occurs only sporadically in the North, still both enzootics and small epizootics are reported. This means that more effort must be extended to control the disease. Detailed directives concerning diseases should therefore be issued in this country as soon as possible. Such have already been considered and drawn up by the medical board since 1929-1930, but they have not yet become effective or official. They should be made stricter as far as checking diagnosis is concerned, and more drastic rules for carcass cremation and prohibition of slaughter should be made, especially in view of the experiences of the last few years, as described above.

This will decrease the number of official visits necessary and will cut down the number of future cases caused by building spores in the soil.

Concerning the treatment of clinical anthrax in domestic animals as well as prophylactic treatment, one sees from many sources that cooling the patient decreases the lethality of the disease bacillus, which gives more time for self-immunization. Perhaps the deep respirations caused by the cold and the increased amount of air per minute hinders to a certain extent the suffocation engendered by the blood oxygen being taken up by the anthrax bacilli. However, a clearer understanding of the mechanisms involved will have to be obtained. Treatment with Salvarsan, prontosil, etc., has not affected the course of the disease at all. The therapeutic, as well as, above all, the prophylactic, use of serum should be considered a good measure which has saved the most lives. The serum should be free of cost to the animal owner. Even as early as 1931, during my travels in the Baltic States and Poland, I saw that anthrax

serum was held in high esteem. In spite of this, when there are large outbreaks of the disease, with many herds affected, especially in "swamp" areas, one must sometimes use a "simultaneous method" (vaccination jointly with serum) to prevent an anthrax epizootic. New advice and instructions for the treatment of anthrax should be drawn up by the medical board. Circulars to the nation's doctors concerning appropriate treatment of human anthrax should be sent out.

From the favorable experiences in foreign countries using vaccination of threatened herds and areas, we should learn that such vaccine should be produced even in our country and should be stored and kept ready for instant use when necessary. The experiences in Norway in 1937 showed that anthrax epizootics are still possible in the North Countries. When peace once again reigns, and trade between countries exists as before, perhaps it will be even more important that veterinary science be armed to meet the greater risks against livestock. The war has destroyed for decades to come the veterinary organizations in various countries which are Sweden's suppliers of imported animal products and foodstuffs. Thus, anthrax, like other domestic animal infections, has greater prevalence and a stronger foothold there and will therefore be exported in greater mass with the above-mentioned commodities.

IV) Summary. A comparison between the number of reported anthrax cases in Sweden, Norway, and Denmark during the 1900's shows considerable similarity in regard to variations among years (Table I). In Sweden, more cases are reported during the second and third quarters than during the winter season, which is the time for maximum number of cases in Norway and Denmark. The frequency of anthrax is regarded by observers in these three countries to be associated with imports of food from countries with epizootic anthrax. However, the virulence and contagiousity seem to be greater some years than in others, the reason for this being unknown. During such periods, only isolated, enzootic, sporadic cases are found, and only rarely an epizootic spread within a small area. In Norway insects and birds have spread the disease during pasture time. Whenever a secondary case in a herd is found, it usually is in an animal which has been standing next to or in the vicinity of the primary case, which simply exudes bacilli. Where the primary case was not reported until much later and sporulation has been going on for a longer time, more secondary cases are found in the barnyard.

The clinical picture varies considerably in different enzootics, as does the findings on section, especially in the horse.

The author presents several typical cases and describes the results of various treatments on humans and domestic animals. Hereby is seen the importance of early serum treatment and prophylactic treatment of threatened but healthy animals and of conservative clinical treatment with anthrax serum in humans. Although few cases had poor results with serum in domestic animals, the importance of having fully efficacious serum is emphasized. The so-called "cold treatment" of animals affected by anthrax in combination with serum treatment has constantly given good results. If early treatment is instituted, practically all secondary cases could be saved. The serum should be furnished free to the animal owner.

To obtain exact statistics, the veterinarian's diagnosis should be checked microscopically by a laboratory. Cremation of all anthrax-infected carcasses should be obligatory to eliminate the risk of occurrence of spores in the soil. The "simultaneous treatment" should be used when the disease has spread to several areas in threatened herds, and an up-to-date vaccine should be prepared.

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