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# Anthrax and Anthracoid Diseases

( BLACK LEG. )

BY

CHAS. GRESSWELL,
State Veterinary Surgeon of Colorado.

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# Anthrax and Anthracoid Diseases.

## HISTORY.

Anthrax is the most rapidly fatal of all the malignant contagious diseases affecting animals and man, and is the earliest disease recognized and described by ancient and modern writers. It is known by a variety of names in different parts of the world, depending upon its varied malignancy, frequency and different manifestations. In Biblical history it is called "blain," which affected both man and beast. By the ancient Greeks it was called "Oidema" when occurring in animals, and "Anthrax" when affecting man. The Latin writers termed the disease "sacra ignis" in animals, and carbunculus in man. In later years it has received the English names of splenic apoplexy, gangrene of the spleen, anthrax fever, apoplectic anthrax, malignant anthrax, malignant carbuncle, carbuncular fever, bloody murrain, black murrain, black quarter, gloss anthrax, black leg, blood striking, braxy, etc., etc. It is also known as charbon in France, milzbrand and rauschbrand in Germany, Cumberland disease in Australia, carbone in Italy, jaswa and Siberian plague in Russia, loodianah disease in India, paard-zietke in South Africa, and by a variety of other names in other countries.

A distinction, however, has of late years been drawn between the diseases designated above as "black leg," "black quarter," "rauschbrand," etc., and "anthrax proper," as two distinct germs have been found to be the direct cause of the different manifestations. The germs causing these diseases, though not identical, become active under very similar conditions, and require the same preventive measures for their eradication and suppression, and on account of the similarity of their symptoms the disease of "black leg," "rauschbrand," etc., have been classed as "anthracoid." The anthracoid diseases differ from true anthrax mainly in the minor malignancy of their germ; in the fact that usually only young animals are affected, and that the attack is usually confined to the external muscles of the fore or hind quarters, and of the head and tongue.

Anthrax affects all animals, including man, but especially herbivora, in the following order of frequency: Cattle, sheep, horses, mules, goats and swine. It is contracted by man either by direct inoculation, as in the case of the "wool sorters' disease," or by eating the flesh of diseased animals. In the former case it is called "malignant pustule," and is generally local and frequently cured; in the latter, anthrax fever, which is invariably fatal.

The disease is of universal distribution, no part of the world being known to be free from it, and although climate and conditions of soil have a marked effect in increasing or diminishing its frequency and malignancy, yet it has occurred under all conditions of weather and management of stock.

In Europe, it has, in times past, been of exceptional virulence, notably in the sixteenth and seventeenth centuries, and in 1617 around Naples, it is reported that 60,000 persons perished from partaking of the flesh of animals which had died of the disease. In 1731-1732 it raged as an epizootic in Central and Southwestern Europe. The years 1757-1763, 1779-1780 and 1800 were especially marked in France. In Great Britain the disease has been greatly diminished in frequency by the universal custom of land drainage, but certain sections of country seem to be permanently affected. The general loss, however, even in modern times, in Europe, outside of Great Britain, Norway and Sweden, among stock generally, antecedent to the discovery and practice of Pasteur's system of protective inoculation, has been from 5 to as high as 60 per cent. per annum.

In the United States the losses have been at times very severe in localized sections, but no records have been kept, and it may be presumed that as yet no large extent of soil has become permanently infected. History, however, proves that the disease gradually increases in frequency when established in any country, and preventive measures are of especial value in the early invasion of a territory. The outbreaks investigated in Colorado in 1893 and 1894 showed the loss to be about 1,000 head of cattle per annum, whereas the number already reported in 1895 will show a mortality of over 1,500 head.

## DEFINITION.

Anthrax is an acute infectious disease of rapid development and extreme fatality, and characterized by the presence and rapid multiplication in the blood of the spore-bearing anthrax bacillus, and in its occurrences it is more or less restricted by conditions of soil and moisture to definite geographical localities.

The anthracoid disease of "black leg" and "black quarter," etc., is a rapidly fatal infectious disease of young cattle, associated with external swellings, which emit a crackling sound when handled, and it is also characterized by the presence in the blood of a germ very similar to the anthrax germ in its life history, and which is the result of similar conditions of soil and moisture, and it also remains an infective factor in certain localities by the manner of developing spores in its interior.

## CAUSES.

The direct cause of anthrax and anthracoid diseases is the presence in the blood of specific germs measuring from 1-5000 to 1-2500 inch in length, and 1-25000 inch in diameter. Like all bacteria, these rod-like bodies have the power of indefinite multiplication by becoming enlongated and then dividing into two, each new division continuing the same process, so long as suitable pabulum (or germ sustaining material) continues to exist in the blood. Outside the body they multiply in a different way. When conditions are unfavorable to the continued division of the germ, oval bodies appear within them, which are called spores, and these remain alive and capable of germination after years of drying. These spores resist heat and acids and ordinary disinfectants to a remarkable degree, whereas the bacilli themselves show only very little resistance to heat and drying.

The bacilli in the body of an animal cause death by the secretion of a poison peculiar to themselves, and herein differ from the germs of many other fevers, notably, the malarial fever of the Southern states, commonly called "Texas or Southern fever."

It may here be remarked that the germ of Texas fever is very distinct in its origin, mode of development and attack from the anthrax germ, and has absolutely no connection whatever with it, in spite of the misnomer of "splenic fever" occasionally given to Southern fever by those ignorant of its cause and spread. The germ of Texas fever is peculiar to the Southern states, and is distinctly malarial, and cannot live outside of an animal in Northern states, whereas, the anthrax germ can be transplanted anywhere and can thrive on mountain peaks and marshy bottoms. The germ of Texas fever does not belong to the class of bacteria, but to the "protozoa." It is not a microscopic plant, as is the germ of anthrax, but belongs to the lowest form of the animal kingdom. It kills by direct destruction of the red corpuscles of the blood and not by the secretion of a poison. It does not develop spores in its interior, and animals raised in districts where it is common become gradually accustomed and proof against its destructive qualities, whereas, but little, if any, immunity is ever acquired from anthrax. A correct appreciation of the differences between the two diseases is very important in regulating measures necessary for their prevention, especially as it has been claimed in the past by those ignorant of its true nature, that Texas fever was "anthracoid" in character.

The cause of anthrax then, being the presence in the blood of these minute vegetable organisms, it will be seen that all those conditions favorable to their development constitute indirect or predisposing causes of the disease, and furthermore, it is noted in this, as in all other germ diseases, that certain conditions in the blood of the animals are more favorable than others for the reproduction of the parasite. It is true that this condition of blood is not so important in the case of anthrax proper, as it is in the anthracoid diseases of "black leg" and several others of the common fevers of animals, yet it is an important factor. The virulence of the germ of anthrax proper is very great, and especially in the case of cattle. The spores will resist the ordinary changes of weather and artificial drying for many years, and will remain in soil ready to develop into the mature germ for an indefinite period. So much is this the case that certain tracts of land in Europe have been known to be infected for centuries, and can never be used without heavy losses, for animals not vaccinated. The conditions favorable for this development of spores into the virulent germs are briefly, black, loose, warm, humus soils; those rich in organic matter and salines; those subject to floods and inundations; those containing a hard, impervious sub-soil, and therefore liable to hold stagnant water after heavy rains, and all lands subject to periodic droughts after heavy rainfall. Under such conditions the spores which may have been dormant for years become active and contaminate for various lengths of time, all the grass or herbage or vegetable matter grown in such localities. Hay grown under such conditions will affect stock

even in winter. The conditions of the animal favorable to the development of the disease is that condition of blood especially rich in nutritive material, especially when it is suddenly acquired and the system has not become accustomed to a rich diet after a poor one. This is also the case when no other disease is present, and young animals in a plethoric condition are especially liable. So far is this the case in "black leg" and the anthracoid diseases, that it seems that older animals and young suckling calves, under five months old, are to a very great extent proof against the natural infection from the soil. This varied liability and immunity caused by different conditions of the animal's system to and from an attack is a very important matter in the prevention of the disease.

Meteorological conditions have also an important share in determining the severity of the disease.

## MODES OF PROPAGATION.

As it is proved that the germ itself multiplies very rapidly in the body of a living animal, and that after death, the germs, if exposed to the air, will continue to develop spores, which are well nigh indestructible under ordinary conditions, and can be carried anywhere when dry by the wind, or in water courses, unharmed, and can be also hatched, as it were, into the virulent germs by warmth and moisture in the presence of organic matter such as always exists in rich soils subject to inundations or where water can remain stagnant, it will readily be seen how dangerous an unburied carcass is of an animal which has died of the disease. One dead carcass can permanently infect a locality for an indefinite period, and such cases form the most fruitful methods of propagation of the disease. According to the researches of M. Pasteur, it is possible for earthworms to bring up the spores of the disease to the surface, even twelve months after burial, but this method of propagation is doubted by some.

Other methods of propagation are direct inoculation from one animal to another by flies and insects, and by eating contaminated food and by the flesh of infected animals. The disease has not been proved to be capable of being conveyed from one animal to another except by direct ingestion of germ or spore, and the volatile emanations from a sick animal have not spread the disease, although the dried blood and powdered dry tissues of a dead animal are highly contagious. The incubatory period of the disease varies from a few hours to one, two or even four days, depending upon the malignancy of the germ and the susceptibility of the animal.

## SYMPTOMS.

The symptoms vary considerably according to the virulence of the attack, the method of the invasion of the germ, and the condition and susceptibility of the animal. In very acute attacks nothing is usually noticed but the bare fact that an animal is seen perfectly well overnight and found dead in the morning, generally with some effusions of black blood from the nostrils or anus. If seen during the attack it will be in convulsions and lead one to suppose that some active poison has been administered. There will be slight bloating before death, and rapid decomposition with extensive bloat after death. The

visible mucous membranes of the mouth, anus, etc., will be of a blue color. Death in these very acute cases will occur in from three to six hours after first symptoms, and they will not be confined to age, size or sex, but generally to the best conditioned animals of the herd. A great majority of the supposed deaths from poison weeds are in reality due to this form of acute anthrax, and in mountain countries the disease is often contracted by eating luxuriant plant growths in gulches and sheltered spots where stagnant water or snow has previously lain, and which has formed a suitable place for the development of anthrax spores carried there by the wind or running water from an exposed dead carcass, or where an animal may have died from the disease. Such spots or localities in the mountains are very quickly fatal, and on account of the usually luxuriant vegetation in these spots, the deaths occurring thereon have been put down to poisonous herbs.

A second form is that contracted from herbage grown on a more open spot, or under less favorable conditions for the malignancy of the germ. This form of the disease begins with a temperature of 103 to 105 degrees, and a pulse of 80 to 100 per minute. Feeding and rumination are suspended. Chills and muscular tremors may appear, and the skin shows uneven temperature. The ears and base of horns are cold and the coat staring and back arched. The animals move around with difficulty and manifest great weakness. The dullness is succeeded by great uneasiness, frequent lying down and getting up, kicking and pawing the ground, difficulty of breathing comes on with straining of the muscles of the chest. The discharge, at first soft, becomes covered with serum, mucus and blood. As the disease advances the weakness increases and the animal leans for support against any object, or it lies most or all the time. Blood vessels may rupture and cause characteristic blood spots under the membranes of the mouth, eyelids, rectum and vagina. Death occurs in one to two days.

A third type is that characterized by more or less similar symptoms to those of the second type, but of less intensity, and accompanied with local swellings, which may appear in any part of the body, but usually in hind or fore leg above the knee or hock, or in the neck and head. Sometimes the swelling will occur in the tongue which will protrude, turn first very red, then blue and finally black, with or without numerous pustules discharging a yellow serous fluid. In these cases an animal will often live five to seven days or until the local swelling mortifies. No doubt the disease is contracted in this form by direct inoculation from the soil into an open wound or sore, or by some spicula or vegetable growth injuring the tongue or mouth or by gradual absorption of the mild form of the germ through the stomach. Such swellings due to anthrax proper can be distinguished from black leg by the absence in the former of the crackling sound when swellings are handled.

The symptoms of black leg, black quarter and other anthracoid diseases are invariably local, and confined to the swelling, which first appears as a hard, tense effusion in the muscles of the hind or fore quarters, or in the neck or head, of young cattle between the ages of five months and three years, but usually under two years of age. The animals sud-

denly become lame and stiff and move with difficulty, the swelling crackles when handled, owing to the escape of gas from the decomposition of the blood, gradually get weaker and die in from twelve hours to three days after attacked. The swellings rarely, if ever, appear below the knee or hock joint, and are therein distinguishable from swellings due to injuries.

## POST MORTEM APPEARANCES.

In the very acute cases lasting but a few hours, the post mortem appearances are usually confined to the spleen and heart. The former will be broken down and partially disintegrated, increased in size, and containing a tarry liquid composed of broken down pulp, blood cells and bacilli. Blood spots will be seen in the structure of the heart and immediately under the lining membrane. The blood itself will be black in color and not easily clotted; will be deficient in fibrin and may be exuded in any part of the body.

In the second type of the disease the blood extravasations in various parts of the body are more marked, the spleen is larger and more broken down and blood spots are found under the lining of the lungs and the large intestines, and the faeces in the small bowels are stained with blood.

In the third type there is the addition of numerous carbuncles or external swellings, which when cut into are found to consist of a peculiar jelly-like mass of a yellowish color, more or less stained by blood. In all cases the "bacillus anthracis" is present in the blood, local swellings and extravasations; and its presence is the only sure method of determining the disease. In all cases the blood cells cohere in masses and are shrunken, and have lost their fullness and roundness. Carcasses soon lose rigidity and decompose rapidly.

The post mortem appearances of black leg and the anthracoid diseases are mostly confined to the local portion affected, and in addition to the more blackened condition of the carbuncles or external swellings, and their crackling when handled during the life of the animal, they can be distinguished from anthrax proper by the blood rapidly coagulating, its retention of its fibrine and the microscopic characters of its special germ. The spleen also in black leg is unchanged, though the heart and lungs may be affected with black spots.

## TREATMENT.

Except in very rare instances, treatment is ineffectual and useless. In a few cases of direct inoculation into an open wound, it is said recovery has taken place by the adoption of free incisions and frequent washings with solutions of iodine and carbolic acid, in the proportion of three ounces of tincture iodine, one ounce pure carbolic acid, to one pint of alcohol, and and giving internally every six hours of four ounces alcohol and one ounce aromatic spirits of ammonia and five drops creosote. Preventive treatment, however, is very important, and may be divided into two heads; measures necessary to minimize the soil infection, and those to immunize the animal, or render it proof against attack. As the life history of the germ peculiar to anthrax proper and anthracoid diseases is so similar, and the susceptibility of animals to both affections is so similar, the same measures are applicable in all cases.

As the primary source of soil infection is the multiplication of the spore-producing bacilli contained in an infected animal, it is of the greatest importance that carcases should be thoroughly disposed of. This, of course, can best be done by burning, but when this is impracticable, they should be buried deeply where they cannot be exposed by dogs or wild animals, and where they will not contaminate any water course. The effectual disposition of carcasses should be insisted upon by county authorities, as the history of this disease unmistakably proves that when this precaution has been neglected in the older cattle countries where anthrax is prevalent, the death rate has gradually and surely increased, even in some places to as high as 60 per cent. per annum. It must also be remembered that the ground and all objects which have come in contact with the blood or refuse of an infected animal should be disinfected, and this is best done with a 5 per cent. solution of chloride of lime. The removal of carcasses to rendering establishments and the skinning of them is fraught with so much danger that such methods should be prohibited.

We have seen that it requires a certain degree of moisture and heat to develop the spores, and that this is most liable to occur outside the animal body during wet weather in summer and after inundations and during the partial drying up of stagnant pools of water. Therefore, to lessen the chances of attacks, all such places where the disease has previously prevailed should be avoided, during favorable weather for the activity of the germ, and the most important measure of all is to instantly remove a herd from a locality where one has died, and to keep the herd away for such time as the favorable condition of weather remains. Instant removal from an active source of contagion has a two-fold effect. It is, on the one hand, rarely the case that two localities are equally affected at the same time, and on the other hand, the susceptibility of animals is lessened by change of conditions altering those constituents of the blood favorable to the germ.

It may be taken as almost a proved fact, especially in black leg, that the conditions of weather and soil which are favorable to the development of the germ, are likewise productive of a highly nutritious and increased natural food supply, and this latter undoubtedly causes that peculiar fibrinous condition of blood favorable to the invasion and sustenance of the black leg germ. So much is this the case, that practically it has been found out that enforced exercise which reduces the fibrin of the blood will often stop the death rate in a herd of young cattle attacked. It must also be noted though, that the removal from an infected spot during this enforced exercise, even if only for a few days, has a great deal to do with the arrest of mortality. In anthrax proper, however, removal is the most important element, as in this case the presence of the germ in an active condition is more important than the susceptibility of the animal.

Where anthrax is known to exist in special localities and where it is practicable to do so, drainage of the infected pasture will prevent further outbreaks, if no fresh carcasses of infected animals are allowed to remain unburied thereon. Pools of stagnant water should be fenced off and also any

other known infected spots. Efforts should likewise be made by the state or nation to prevent frequent inundations of the lands used for cattle grazing. In some cases it is necessary to withdraw cattle entirely from infected and dangerous pastures at certain seasons of the year.

Considering, however, the great difficulties attendant upon the attempts to annihilate or curtail the spread of the anthrax germ, and the total impracticability of effectually preventing all loss in this direction, in many countries, all efforts lately have been directed towards rendering the animal proof against attacks. This has successfully been accomplished by the eminent scientist M. Pasteur, and as it appeared that animals would not natually become immune against anthrax, as they will against so many other diseases, notably Texas fever and cattle plague, recourse has been had to artificial methods. Pasteur discovered, in 1882, a vaccine which at first was partially successful, but which during the last few years he has so improved that at the present time it is almost universally accepted as a safe preventive in Europe and Australia. In France over 4,000,000 animals have been vaccinated and the death rate has been reduced from 10 per cent. per annum in sheep to less than 3-4 of one per cent., and in cattle from 5 per cent. to 1-5 of 1 per cent.

In Austro-Hungary a still better result has been obtained from about the same number of inoculations.

In Germany, a commission appointed by the Minister of Agriculture reported that vaccination was economical and advantageous and a laboratory was established for this purpose at Stuttgart in 1894.

In Italy the annual loss among cattle was considerably over 10 per cent., and a laboratory was established at Rome in 1894.

In Belgium it has been used with success since 1882.

In Spain the mortality has been reduced from 20 per cent. per annum to 1 per cent.

In Russia, by an imperial decree issued in 1894, a laboratory was established at Nijni Novgorod and vaccination is actively prosecuted.

In Great Britain the disease has increased of late years, but it is kept in check to a great extent by the universal system of sub-soil drainage, yet vaccination is recommended for animals pastured on the few permanently infected localities.

In Australasia, in some portions, the death rate was 200,000 animals per year, representing 30 per cent. of the stock of such infected localities. In 1890 the lymph was prepared at Rodd Island, N. S. W., and in 1893, 119,000 head of stock were successfully vaccinated in New South Wales alone.

In Turkey vaccination was introduced in 1894.

In the United States the Pasteur Anthrax Vaccine Company has been established in New York, and has already made considerable progress in the introduction of this method of protection in several states, namely North Dakota, Illinois, Delaware, New Jersey, Texas, California, Florida, New York and Louisiana.

Pasteur's method consists in the injection of about four drops of the attenuated virus of anthrax under the skin and repeating the operation in twelve days with a stronger lymph.

The operation for the prevention of black leg consists in injecting into the tail of the animal the specially attenuated virus of this disease.

The principle of the inoculations is to confer immunity against natural infection by submitting the animal to the disease in a mild and non-fatal form. The strength of the virus is carefully graduated and tested before being sent out. There is as yet no laboratory in the United States for its manufacture, and that provided by the Pasteur Anthrax Company comes from Paris.

Where Pasteur's vaccination is impracticable, or where the death rate is too small to make it economical, it may be advisable to have recourse to other older methods of prevention, and foremost among these, attention must be drawn to the old fashioned custom of setoning the dewlap and dressing with an unguent which would have the tendency to keep the wound open for a few days.

This method frequently arrests the disease and it has especially been used as a preventive of black leg.

The operation consists in passing the seton needle transversely through the dewlap and leaving in the wound for a few weeks a piece of tape knotted at both ends and dressed with a mixture of eight ounces oil, one ounce turpentine and one drachm sulphuric acid. This operation has a two-fold effect, the first is a discharge of serum and pus from the wound which is supposed to act as a relief to blood surcharged with fibrin in susceptible animals; and secondly, it probably brings about an introduction from the soil direct of the disease germ into the open sore, sufficiently inflamed to reduce the virulence of the germ.

The latter may account for its efficiency, as it can readily be understood how a natural vaccination can roughly be obtained in that manner from a pasture infected, but the objections to this method lie in its inaccuracy, and to the danger to be derived from soil affected with anthrax in its most malignant form. A black leg inoculation in this manner, and probably in the case of the milder forms of anthrax, may probably be of service and in the absence of the accurate vaccination recommended by Pasteur may be better than nothing.

In all cases of outbreaks of these diseases it is also advisable after removal from the locality where an outbreak has occurred, to give to each animal with its salt a proportion of hyposulphite of soda, in the proportion of one part of soda to ten parts of salt.

## CONCLUSION.

If the following facts are carefully considered, other methods of preventing this dreadful malady will occur to the intelligent owner of stock, according to the special conditions existing at the time of an outbreak, and this bulletin will not have been issued in vain, if common sense and intelligence are combined toward a determined effort to prevent the introduction and propagation of this costly and dangerous disease in the herds of the state.

First—The anthrax germ multiplies rapidly in the blood of a living animal and causes its death in from three hours to seven days.

Second—Outside the body of an animal in the presence of oxygen, and a temperature of not lower that 65 degrees Fahrenheit, nor higher than 120 degrees Fahrenheit, the germs will form spores (or seeds) in their centers.

Third—The spores will resist the destructive action of extreme heat, cold and moisture, and the action of soil, for an indefinite period, and in the presence of organic matter with a warm moisture will develop into the active germ.

Fourth—The germ of anthrax proper will affect almost all animals, but especially the herbivora, and the age and condition of the animal but slightly modifies its action. The germ of the anthracoid diseases, such as "black leg," etc., affects only young cattle, and this especially when the blood is in a susceptible condition. Both germs are modified in virulence, according to the character of soil and the amount of organic matter and salts contained therein.

Fifth—The spores of both forms are contained in the dried blood and tissues of an infected carcass, and can be carried anywhere in the form of dust, or conveyed unharmed by flies, insects, birds and running water, and may exist in hay grown on infected lands.

Sixth—Saline germ destroyers, such as salt and the hyposulphites, will check the multiplication and prevent the spore-forming power of the active germ.

Seventh—Vaccination direct from the soil, or one artificially produced by an attenuated virus, especially the latter, will not be fatal, and will confer immunity against another attack for an indefinite period.

Eighth—Sub-soil drainage of spore-infected localities will to a very large extent, if not altogether, prevent the fructification of the germ spore.

Ninth—Diminution of excess of fibrin in the blood, such as may be produced by the administration of soda and potash salts, will render young cattle far less liable to the destructive action of the "black leg" germ.

Tenth—No qualities of soil or temperature or meteorological conditions will develop the anthrax or anthracoid germ without the existence thereon of a previous spore or germ.

Eleventh—Instant removal from a locality where a death occurs is the most important preventive, as it rarely happens that two adjacent localities are equally virulent at the same time.

Twelfth—The localities in Colorado affected at the present time are limited in extent, and will in the future be reduced or increased in area, in exactly the same proportion as the absolute destruction of infected carcasses is established.

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