Hog Cholera

BY C. N. McBRYDE

IN ITS EFFECTS on swine, hog cholera can be compared only with some of the diseases that used to wipe out whole communities of human beings before the days of modern medicine. The discovery of a serum that would produce immunity against this disease was an event of major importance to the livestock industry. Here a pioneer in the fight against hog cholera tells what it is and what can be done about it.

**HOG CHOLERA** is a devastating livestock disease that has caused enormous economic losses in the United States for over a century. It recurs from year to year but during certain periods has been unusually prevalent. The first such period on record reached its climax in 1887, the second in 1896, and a third in 1913. During these periods hog producers suffered enormous losses, and in some localities the swine population was almost wiped out. In the fall of 1926 the disease again became unusually prevalent in parts of the Middle West. The supply of preventive serum on hand at that time was inadequate to meet the unusual demand, and losses in some sections were very heavy.

The direct monetary value of hogs destroyed by cholera in the United States has amounted to as much as 65 million dollars in a single year, and the average annual loss during any 10-year period prior to 1914 was probably not less than 20 million dollars. If the indirect losses could be computed, the totals would be greatly increased.

The estimated number of hogs dying from cholera in the United States from 1884 to 1940 inclusive are shown in figure 1. According to data available, the disease killed more than 13 percent of the swine in the country in 1896. Again in 1913 more than 10 percent

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of the hogs in the United States died of cholera. Since 1914, except for 1926, as noted previously, the general trend of losses from hog cholera has been downward as a result of the increasing use of anti-hog-cholera serum.

It does not appear to be definitely established whether hog cholera originated in America or in Europe. According to some authorities the disease existed in Europe long before it was recognized in this country, and it seems not unlikely that the contagion may have been imported from there, as was pleuropneumonia of cattle. It was first reported in the United States in southern Ohio in 1833 and soon spread throughout the country. By 1853 no less than 90 separate areas of infection were known to exist, and the malady was becoming much dreaded by swine breeders. Hog cholera now occurs in every State in the Union and in practically all parts of the world where hogs are raised. In Canada and Australia, however, the losses from the disease are said to be comparatively small in proportion to the number of pigs raised.

**THE CAUSE OF HOG CHOLERA**

Hog cholera has been under investigation by the United States Department of Agriculture since 1878. Because of its very great importance to the livestock industry it was one of the first diseases to be studied experimentally by the Bureau of Animal Industry after its establishment in 1884.

As a result of early studies carried out in the laboratories of the Bureau of Animal Industry of the United States Department of Agriculture, it seemed to be definitely established in 1885 that a bacterium, or bacillus, resembling the germ that causes typhoid fever in man, was the cause of hog cholera. For nearly 20 years this germ, which came to be called the hog cholera bacillus, was quite generally accepted by research workers in the field of animal diseases as the cause of hog cholera. Later studies by the Bureau of Animal Industry, however, proved that this germ is not the true cause of the disease and established the fact that it is caused by a virus.

The virus of hog cholera cannot be seen with the most powerful microscopes in use today, and it passes readily through the pores
of very fine filters which hold back all visible bacteria. It is therefore called an ultramicroscopic virus and a filtrable virus. Attempts to grow the virus outside of the animal body generally have been unsuccessful. However, Carl Tenbroeck, director of the Department of Animal Pathology of the Rockefeller Institute, has recently reported that he has been able to grow the virus by methods similar to those previously described by Hecke, a German investigator.

The discovery that hog cholera is caused by a filtrable, ultramicroscopic virus was very important in the study of this disease. It upset all previous concepts regarding the nature of the disease and served to explain earlier failures to obtain an effective vaccine or serum. It also paved the way for subsequent studies that finally led to the discovery of a successful preventive serum.

**SYMPTOMS AND DIAGNOSIS**

**Hog cholera** is a highly infectious and contagious disease. It affects swine of all ages and is usually acute, although it sometimes pursues a subacute or chronic course. It is characterized by a sudden onset, loss of appetite, fever, and weakness. The mortality rate of the acute form is usually high, and entire herds have been wiped out by it within a short time. Pigs affected with the disease in the subacute or chronic form may linger for some time before they succumb. Spontaneous recovery is rare.

All breeds of swine are subject to the disease. At one time it was thought that the mulefoot, or single-toed, hog was immune, but this was proved to be a fallacy by experimental inoculation of these animals.

When the disease makes its appearance in a herd, the first symptoms noted are loss of appetite in one or more animals, which either refuse to come up to feed with the rest of the herd or come to the feed trough, nibble at their feed, and then turn away. In animals experimentally infected, fever usually develops a day or two before visible symptoms are noted.

The affected animals separate themselves from the rest of the herd and soon show signs of weakness, especially in the hind legs, which are frequently crossed, resulting in a peculiar wobbling, scissors-like gait. The fever rises rapidly in the acute cases, and the animals may become very thirsty. Frequently there is a conjunctivitis, characterized by a thick, gummy secretion, which at times may almost glue the eyelids shut. The sick pigs usually die within 7 to 10 days.

In diagnosing hog cholera, the temperature of the affected animals is of much importance. The normal temperature of swine under ordinary weather conditions, when the animals are at rest and not excited, ranges from 101° to 103° F. When cholera is present in a herd, it is not uncommon to find a large proportion of the hogs with temperatures of 104° to 107° F., or even higher. The body temperature usually falls in the later stages of the disease and frequently becomes subnormal shortly before death.

A pig sick with hog cholera has a rather characteristic appearance. The animal stands in a listless, dejected attitude with the head droop-
ing downward and the tail hanging straight and limp. As a field man of the Bureau of Animal Industry expressed it, the animal appears to be lost in thought (fig. 2).

In most cases it is not possible to know when the infection actually reaches a farm herd, but once the disease makes its appearance it spreads more or less rapidly throughout the herd if no treatment is given. A large part of the herd does not sicken suddenly, however, as is the case in an outbreak of swine influenza, or "hog flu."

In the course of virus production at the Bureau of Animal Industry station at Ames, Iowa, hog cholera virus was injected into the bodies of 100 susceptible shots. The shortest incubation period (the time between the entrance of the virus into the body of the animal and the appearance of visible symptoms) was 3 days and the longest 5 days, the average being about 4 days. When susceptible swine are exposed by contact, it is impossible to determine just when infection takes place, but visible symptoms are rarely observed within less than 5 or 6 days after such exposure.

**SEASONAL OCCURRENCE**

Hog cholera has a rather marked seasonal incidence. In the Middle West it is essentially a disease of the late summer and fall, as shown in figure 3. During the winter months outbreaks are sporadic, and the disease never becomes epidemic as in the summer and fall. In the South, where the winters are mild and the temperature more or less...
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uniform, severe outbreaks of hog cholera may occur at any season of the year.

Before the discovery of a preventive serum, the disease often swept through the countryside, causing devastating losses. During the fall months, looking across the prairies of the Middle West, one could often see smoke ascending from perhaps half a dozen farms where pigs dead of cholera were being burned. The writer recalls such sights in 1904 to 1906, the early years of his field work with cholera in Iowa and Nebraska.

POST MORTEM FINDINGS

The skin of the under surface of the body and behind the ears is frequently bright red at the height of the disease and later may become dark purplish.

The changes that take place in the lymph glands of hogs with cholera are usually quite striking and are of considerable diagnostic importance. These glands are normally gray, but in hog cholera they become enlarged and show marked reddening. When the glands are cut through, it is often found that the reddening is confined to the margin and does not extend throughout the body of the gland. The lymph glands are quite generally affected. The ones usually found on post mortem examination to be diseased are those in the neck near the angle of the jaw, those in the groin, and those in the mesentery, or thin membrane which supports the intestines.

The lungs show small hemorrhagic spots on the outer surface, varying in size from that of bird shot to that of a small pea and usually bright red in color. Another frequent lesion, or tissue injury, is caused by the collapse of lung lobules, giving rise to larger areas of a dark-red or purplish color.

![Figure 3.—Seasonal occurrence of hog cholera in Iowa, based on a 5-year record, 1928–32.](image-url)
The spleen, or milt, is usually engorged with blood, darker than normal, and often soft and easily torn. Not infrequently dark, raised, ovoid areas a quarter of an inch or more long are seen along the border of the spleen.

The kidneys usually show characteristic lesions in the form of small, more or less circular hemorrhages, varying from pin-point to pin-head size. These are perhaps the most characteristic of all lesions of hog cholera. They are shown in figure 4. They are best observed after the thin capsule surrounding the kidney has been stripped away. The hemorrhages may be few in number, but at other times the surface may be thickly studded with them, giving rise to the so-called turkey-egg kidney. The bladder usually shows small hemorrhages on the inner lining like those seen on the kidneys.

![Figure 4](image)

**Figure 4.**—Hog kidney showing lesions characteristic of acute hog cholera.

The intestines sometimes show small red hemorrhages on the outer surfaces and also on the inner lining. The lining of the upper part of the large intestine often shows a diffused reddening. In the subacute or chronic cases the lining of the large intestine often becomes ulcerated, and this is especially noticeable where the small intestine joins the large intestine. Distinct, raised ulcers may occur in the large intestine. When well-defined, these are called button ulcers.

Marked variation in the extent of the lesions is a peculiarity of the disease. At times they may be so slight as to be scarcely noticeable; again, they may be very extensive and very striking. Since tissues and organs of hogs dying from other causes may present an appearance very similar to that described for hogs dead of cholera, it is not advisable for a farmer to attempt to determine the cause of death by cutting open a dead hog. A veterinarian should always be called in when disease appears in a herd.
MODES OF INFECTION

That the sick pig is a potent factor in the spread of hog cholera has long been known, but the manner in which the virus is thrown off from the animal body has not been so well understood. Experiments conducted at the Bureau field station at Ames, Iowa, have demonstrated that the virus is present in the circulating blood of the sick animal and also in the various secretions and excretions. It was found in the circulating blood of a sick pig as early as the first day after experimental infection. The virus was found in the eye and nose secretions and the fecal matter by the third day and in the urine by the fourth day. It is apparent that the cholera-infected pig may be a source of danger during the period of incubation, that is, before the development of visible symptoms of the disease. In purchasing new stock, therefore, the farmer should segregate such animals and keep them under observation for at least 2 weeks before adding them to his herd.

At one time it was thought that birds, especially pigeons, might be an important factor in spreading the disease. Farmers were accordingly advised to destroy their flocks of these birds. That belief was purely theoretical, however, and was proved false by carefully conducted experiments in which susceptible pigs were exposed for long periods to pigeons which passed back and forth from a pen only 10 feet away that contained pigs sick and dying of hog cholera. Although pigeons were shown not to be concerned in the dissemination of hog cholera, it is not unlikely that crows and buzzards may act as carriers of the disease, for these birds may carry away and later drop portions of cholera-diseased carcasses upon which they have fed.

The virus has been found to remain active throughout the winter in the carcasses of cholera-infected pigs buried late in the fall in Iowa. Unburied carcasses of infected pigs were found to remain infectious for 11 weeks during cold weather. In earlier times such carcasses were undoubtedly a potential menace, but nowadays dead animals on farms are usually picked up promptly by trucks operated by rendering plants. If such service is not available, all carcasses of hogs should be burned or else buried deeply and covered with quicklime. During the warm summer months, both buried and unburied carcasses undergo rapid putrefaction, and the virus is soon destroyed. In warm weather, after the virus leaves the animal body in the secretions and excretions, it is quickly inactivated, but in cold weather it may survive for a much longer time. Contaminated pens were found to harbor the infection for as long as 4 weeks during the winter season, whereas in summer they were sometimes no longer infectious after 24 hours. The rapid disappearance of the virus from contaminated pens in hot weather is probably a result of putrefactive and fermentative changes taking place in the litter. Sunlight is also potent in the destruction of disease organisms.

Cured meats are unquestionably a source of danger when fed as scraps in garbage, since the virus has been found to survive in hams taken from cholera-infected hogs cured by both the dry-salt and brine methods.

A study of insects as possible carriers of hog cholera was made
some years ago at the field station at Ames. The species studied included the common hog louse, the housefly, the biting stablefly, the buffalo gnat, and several species of mosquitoes. Extensive experiments demonstrated quite conclusively that both the housefly and the stablefly were capable of transferring the virus of hog cholera from sick to well pigs. The results for the other insects were negative.

The housefly commonly feeds on the highly virulent eye secretions of hogs suffering from cholera as well as on the infectious blood from wounds or cuts. Since experiments by the United States Bureau of Entomology and Plant Quarantine have demonstrated that houseflies can travel as far as 12 miles in 48 hours, it is plain that these flies may contribute to the rapid spread of hog cholera from farm to farm.

It was demonstrated that the virus of hog cholera may be transmitted from sick to well pigs through the bite of the stablefly. Not much is known as to the flight habits of stableflies except that they will follow a team of horses for a considerable distance along a highway. After engorging themselves with blood, they have a habit of resting for a while on the vegetation along the roadside and then following another team of horses. In such relays they may travel a considerable distance. In the late fall, too, the flies may enter the open windows of automobiles and thus be transported long distances. Weekly counts of flies trapped on dairy farms near Ames were made during the summer and early fall for several years. Curves or graphs plotted to show the prevalence of the biting flies were found to correspond very closely to those showing the incidence of hog cholera during the several years in which the fly counts were made. Insect transmission provides the most satisfactory explanation of the rapid spread of hog cholera during an outbreak and the fact that it frequently seems to jump from one farm to another, often skipping over intervening farms.

**IMPORTANCE OF SANITATION AND CARE IN THE PREVENTION OF DISEASE**

Sanitation, proper feeding, and good care are of the greatest importance in successful swine raising.

A recent survey by an authority on swine diseases has revealed, however, that only about one-third of the farmers of this country follow good practices in feeding and housing their swine.

Poor feeding undoubtedly tends to lower the resistance of livestock to many infectious diseases. Recent experimental work indicates, for example, that a ration lacking in certain vitamins may be a hitherto unsuspected factor in certain intestinal troubles of swine. Poor housing is a predisposing factor in pneumonia, influenza, and other respiratory disturbances.

Sanitation is probably the most neglected factor in swine raising, and its lack undoubtedly contributes to the occurrence of filth-borne intestinal diseases. The practice of using old hog lots year after year should be discontinued. When pigs are allowed to run in such lots they are almost certain to pick up the eggs of intestinal parasites.
and the germs of disease, and as a result the farmer will have a lot of unthrifty, unprofitable pigs on his hands.

Among the ailments of swine the intestinal diseases are next in importance to hog cholera. They not only cause an enormous direct loss but are also responsible for a large indirect loss. The simultaneous vaccination of such infected herds with serum and virus for immunization against hog cholera is likely to be followed by bad results.

In 1927 the Bureau of Animal Industry, through carefully conducted experiments carried out in McLean County, Ill., developed what has become known as the McLean County system of swine sanitation. While the system was developed primarily for the protection of swine against infestation with the ascaris, or common roundworm, it has also served to protect them against the filth-borne bacterial diseases. In this way it has proved a valuable adjunct in the successful immunization of swine against hog cholera.

Considering the great importance of sanitation and care in the prevention of swine diseases and their bearing on hog cholera, interested farmers should refer to the article in this volume in which the McLean County system is described (p. 774).

**PREVENTION OF HOG CHOLERA**

Many preparations composed of various drugs and chemicals have been exploited from time to time as preventives of or remedies for hog cholera, but all such products tested by Federal and State institutions have been found worthless. Farmers are therefore warned against investing their money in such preparations.

Many so-called tonics also are advertised as able to do wonders for hogs. Some of them may have some value as conditioners, but none are of any value in the prevention or cure of hog cholera.

**ANTI-HOG-CHOLERA SERUM**

After the discovery that hog cholera is caused by a filtrable, or ultramicroscopic, virus, a few preliminary experiments looking toward production of a protective serum were carried out in 1903 at the Bureau of Animal Industry experiment station at Bethesda, Md. Results were not satisfactory, and the experiments were laid aside on account of other work. In 1905 the experiments were resumed at the Bureau field station at Ames, Iowa. A successful preventive serum was finally developed there and was given a practical trial on farms in the vicinity of Ames in 1907.

The method of preparing the serum was patented, and all rights were dedicated to the public. Notice of the successful results was sent to every State, with an invitation to send representatives to the Bureau station at Ames to observe the methods of preparing and administering the serum. Twenty-five States accepted this invitation in 1908. During the years immediately following these demonstrations, a number of States began production and distribution of the new serum to farmers within their borders. At the same time or shortly after the preparation and sale of the serum were under-
taken by commercial concerns, and when these firms became well established serum production by the States was discontinued.

The serum is prepared by injecting large immune hogs with virulent blood obtained from pigs sick of cholera. A very minute quantity of such blood would cause the death of a susceptible hog, but even large doses are harmless to an immune hog. After the immune hogs are injected with virulent blood they are called hyperimmunes, since their immunity is increased by this procedure. After a suitable interval, the hyperimmune hog is bled by cutting off a portion of its tail. Several bleedings are made in this manner. This blood contains large quantities of protective substances termed antibodies. Anti-hog-cholera serum is prepared by removing the fibrin and cells from the blood and adding a small amount of preservative to the clear serum.

The efficacy of anti-hog-cholera serum in the prevention of hog cholera is now universally recognized, and the serum is used in all parts of the world where hogs are raised. It is not a cure for hog cholera and should be used only as a preventive, although it seems to have some curative value if administered in the very early stages of the disease.

When given alone, the serum produces only a temporary immunity, which may be lost within a few weeks. When the serum is given in conjunction with a small amount of virus or virulent blood, however, a solid, or lasting, immunity is produced which usually persists throughout the lifetime of the animal. Because of the permanence of the immunity, this method of administering the serum, known as simultaneous inoculation, or serum-virus immunization, is generally employed in the immunization of herds of swine. The serum may be injected under the skin of the flank or in the axillary space between the foreleg and body. In small pigs some practitioners favor injecting the serum into the abdominal cavity of small pigs, while it may be injected behind the ear in large animals. The two methods most commonly employed in giving the serum and virus are shown in figure 5, A and B.

The dose of serum varies with the weight of the animal. The minimum doses prescribed by the Bureau of Animal Industry are shown on all commercial labels. If cholera has appeared in a herd before treatment is given, the amount of serum should be increased by half. Because the dose increases with the weight of the animal, it is more economical to immunize swine against cholera when they are small. When pigs are left unvaccinated there is also additional risk of loss. Many farmers therefore make it a routine practice to have each year's crop of pigs immunized while young. Immunization at about weaning time is recommended.

Since an active virus is used in simultaneous, or serum-virus, immunization—commonly termed vaccination—it is of the utmost importance that the animals receiving this treatment be perfectly healthy and free from disease. After treatment, there is a period of lowered resistance in the animals, owing to the fact that the virus circulates in the blood for 2 or 3 weeks after vaccination. If the animals are perfectly healthy at the time of treatment, are not harboring any infection and are not exposed to infection shortly after treatment,
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Figure 5.—A. Injecting a pig with anti-hog-cholera serum beneath the skin in the flank. B, Injecting virus in the axillary space between the foreleg and the body.
there is no danger connected with this method of immunization. If, however, the pigs happen to be harboring a masked or unsuspected infection at the time of treatment or become exposed to infection shortly thereafter, trouble may develop, and so-called breaks may occur. Such unfortunate occurrences are really not breaks in immunity but result from the combined action of the virus and some other infective agent. The period of lowered resistance which accompanies serum-virus treatment results from a decrease in the number of white blood cells, which are known to be one of the main defenses of the animal body against infection. The decrease in white cells has been found to be less when large doses of serum are given, and therefore it is advisable to give ample doses of serum in carrying out the simultaneous, or serum-virus, treatment.

Anti-hog-cholera serum is now produced on a large scale in the United States by many commercial plants throughout the country, the majority of which, however, are located in the hog-raising States of the Middle West, where suitable animals are readily obtainable. In 1913 Congress passed an act placing these plants under the supervision of the United States Bureau of Animal Industry. A new division was accordingly established, designated as the Division of Virus-Serum Control, which maintains a rigid supervision, through its trained veterinary and lay inspectors, of all commercial plants engaged in the production of anti-hog-cholera serum and hog cholera virus, as well as of other biological products intended for veterinary use. Before any anti-hog-cholera serum leaves a commercial plant, samples are subjected to rigid tests for potency, carried out under the supervision of Federal veterinary inspectors. Samples of all virus used with anti-hog-cholera serum are likewise tested. The swine raiser who has his pigs immunized against hog cholera is, therefore, sure of having standardized and reliable products used on his herd, provided the veterinarian who does the work has handled the products in a proper manner after receiving them from the producer.

**CRYSTAL-VIOLET VACCINE**

Scientific workers in the Bureau of Animal Industry have sought for many years to develop a protective vaccine from which the disease-producing properties of the active virus would be completely eliminated.

Much time and work have been devoted to the preparation and testing of experimental vaccines at the station at Ames during the last 15 or 20 years. Various chemical agents have been used in the preparation of vaccines, and in some cases effective vaccines were obtained. The results were not uniform and consistent, however, until crystal violet, an aniline dye, was tried as an attenuating, or weakening, agent with a view to reducing virulence. It was found that the addition of this chemical to virus-infected blood entirely eliminated the disease-producing property of the virus without affecting its antigenic, or immunizing, property.

The new immunizing agent so developed was subjected to carefully controlled experimental tests at the Bureau field station and
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has been used successfully on more than 12,000 pigs in 236 farm herds in the vicinity of Ames. Pigs treated with this vaccine show no visible reaction, and there is no danger of introducing hog cholera on noninfected premises through its use. The absence of any reaction period following the administration of crystal-violet vaccine, with no apparent loss of appetite and no necessity for change of ration, provided a good one is being supplied, insures an uninterrupted gain in weight. In turn this should effect somewhat earlier marketing than is possible with pigs receiving serum-virus treatment, which usually necessitates a reduction in the feed for a time.

Although the duration of the immunity following treatment with crystal-violet vaccine has not been definitely established, it seems to protect swine against hog cholera satisfactorily through the fattening period or up to the usual market age, which is about 8 months in Iowa. Unfortunately there is an interval of 2 or 3 weeks between the administration of the vaccine and complete establishment of immunity, and this will naturally limit its use to some extent in veterinary practice, for it could not be used in a community where hog cholera is prevalent. For the same reason, the vaccine could not be used on garbage-feeding ranches where the pigs are farrowed on the ranch. It might be used, however, on garbage-feeding ranches which bring in pigs from the outside if the pigs receiving the vaccine are held in quarantine for 3 weeks and fed on grain before being put on the garbage ration. The vaccine cannot, therefore, entirely supplant the serum-virus method of immunization, but it may find a field of usefulness in the treatment of farm herds in the spring and early summer before hog cholera becomes prevalent. It should also afford a somewhat cheaper and safer means of protection than simultaneous immunization.

The new vaccine is now being distributed in considerable amounts to veterinary practitioners in Iowa, Illinois, and several Eastern States, and a better appraisal of its true value can be made when these extended field trials have been completed.

As in the case of anti-hog-cholera serum, the Government has obtained a patent on crystal-violet vaccine with all rights dedicated to the public.