of carbolic acid destroyed their virulence, but a 1 per cent. solution acting for the same length of time had no effect in this direction.

It is evident, therefore, that the virus of fowl-pox is of a very highly resistant nature.

DESCRIPTION OF ILLUSTRATIONS.

FIGS. 1 and 2.

Heads of two chickens naturally infected with *epithelioma contagiosum*. Sketch (life size).

FIG. 3.

Photograph of the head of a fowl experimentally infected. The comb of this fowl, after having been lightly scarified with a lancet, was rubbed with material obtained from the natural case of the disease shown in fig. 1. Some of the comb lesions of this bird were pounded in a mortar, then mixed with a small quantity of boiled water, and the liquid was utilised for the purpose of inoculation. In the case of the fowl shown in fig. 3, the lesions made their appearance after an incubation period of five days. The photograph was taken the eighth day after inoculation.

FIGS. 4 and 5.

Fig 4 shows the right, and fig. 5 the left, side of the head of the same fowl shown in fig. 3, but these two photographs were taken the eighteenth day after inoculation.

CONTROL OF HOG-CHOLERA (SWINE-FEVER) BY SERUM IMMUNISATION.¹

By A. D. MELVIN, D.V.S., Chief Bureau of Animal Industry,
U.S. Department of Agriculture.

IT is probable that most of those present are familiar in a general way with the experimental work conducted by the Bureau of Animal Industry during the last three or four years, concerning the cause and prevention of hog-cholera. It will be remembered that as a result of experiments recorded in Circular 43 and in Bulletin 72 of this Bureau, the conclusion was reached that the so-called hog-cholera bacillus is not the true cause of hog-cholera, but that this organism plays the part of a secondary invader, the true cause of the disease being a virus which is present in the blood of hogs affected with hog-cholera, and which, under certain conditions of filtration, is capable of passing through the finest porcelain filters. Up to the present time this filtrable virus has resisted all attempts at artificial cultivation, and we know of its presence only through the effect upon hogs when fluids from sick animals, free of all known bacteria, are injected into susceptible animals.

The methods of immunisation described herein have been arrived at by the Biochemic Division of this Bureau, and the investigations for the past four years have been under the direct supervision of Dr M. Dorset, the Chief of that Division, and through whom the Department has had the process patented in such manner as to insure to all the people in the United States the right to its free use.

It is a well-known fact that hogs which have recovered from an attack of hog-cholera are completely immune when subsequently exposed to the same disease.

¹ Read before American Veterinary Medical Association, Philadelphia, Pa., 10th September 1908. Reprinted from the American Veterinary Review, October 1908.

These two facts—the presence of the filtrable virus in the blood of hogs sick of hog-cholera, and the immunity in hogs which have recovered from an attack of that disease—form the basis for the preparation of the serum which we have used successfully in immunising hogs against hog-cholera.

Method of Securing Immune Serum.

Without attempting to go into the method of producing this serum in detail, it will be sufficient to say that the protective serum is produced by a process of hyperimmunisation, carried out as follows:—

An immune hog is injected with large amounts of blood from hogs sick of hog-cholera. These injections will not produce more than a transitory effect upon the health of the immune, although they would prove certainly fatal to a susceptible hog. This treatment of immune hogs with large amounts of disease-producing blood is known as hyperimmunisation, and gives to the blood of the immune the power to protect susceptible hogs from hog-cholera. After a week or so, when the immune has recovered from the effects of this treatment, blood is drawn from the immune by cutting off the tail. The blood-drawing is repeated three or four times at intervals of a week between the drawings, after which the immune is usually bled to death from the carotid. After each drawing from the immune the blood obtained is defibrinated and mixed with a suitable antiseptic. If preserved in sterile bottles this defibrinated blood, or serum, as it is called, will retain its potency for years.

The protective serum having been obtained from an immune hog in the manner indicated, the potency of this serum is determined by injecting susceptible pigs with varying amounts of the serum and at the same time exposing them to hog-cholera along with untreated control animals. In practice it will, of course, be found best to first collect large quantities of serum and to mix this before testing. A standard serum will thus be secured at a minimum cost.

Method of Protecting Susceptible Pigs.

A standard serum of known potency having been secured, either of two methods may be used for protecting susceptible pigs. These are known as (a) the serum-simultaneous method and (b) the serum-alone method.

The first of these, which is to be recommended for use, especially in herds which have not been exposed to hog-cholera, consists in injecting subcutaneously on one side of the body of the pig to be vaccinated a suitable quantity of serum, and simultaneously on the other side of the body a small quantity of virulent blood taken from a hog sick of hog-cholera. Experiments have shown that by this method pigs are given a firm immunity lasting at least six months and probably much longer.

The serum-alone method, which consists simply in the injection of the protective serum without the simultaneous use of disease-producing blood, appears to confer only a temporary immunity upon the treated pigs, unless they be exposed to hog-cholera a short time after receiving the serum, in which case they also acquire a lasting immunity. For these reasons the serum-alone method is admirably adapted to the treatment of hogs in a herd where hog-cholera has

already broken out, but which have not themselves shown visible symptoms of disease.

The experiments which are being carried out to determine the curative properties of the serum are not yet complete, but from the results thus far obtained we know that serum in the doses used for immunisation cannot be depended upon to cure hogs which already show visible symptoms of hog-cholera. Further work along this line is needed. It should be stated that neither the serum-simultaneous nor the serum-alone method, when properly applied, appears to injure the hog in any way.

Cost of the Serum.

In order to determine the cost of producing serum for practical use, every item of cost would, of course, have to be taken into account and allowance made for all sources of revenue. Owing to the conditions under which we have been working, that is, manufacturing serum for experimental use only, and utilising the same force for the production of the serum and for carrying on varied experiments, we are unable to give an exact cost price of the serum thus far produced. Sufficient work has been done, however, for an estimate to be made. With the dose of serum at 20 cc., and with the production carried out with strict economy, it seems likely that the cost per dose can be brought to 25 cents. This estimate is based upon the supposition that each hyperimmunised immune will furnish 150 to 200 doses of serum, and that the carcase of the immune after final bleeding will be utilised for food. There seems to be no objection to the use of such a carcase for food purposes, provided the *post-mortem* examination discloses no reason for rejecting it.

I have recently been informed by Dr C. E. Marshall, of the Michigan Agricultural College, who has begun the preparation of this serum for distribution to farmers of that state, that it is their purpose to charge at present two cents per cc. for the serum, though they hope to be able to reduce the price materially before another season. It will undoubtedly prove to be true that the cost of the serum will vary with the conditions of manufacture, and the proportionate cost should decrease as the amount of serum produced increases. In any case it seems certain that the serum can be produced cheaply enough for practical purposes.

Results of Practical Tests of the Serum.

The statements which have been made above concerning the protective power of serum from hyperimmunised immunes are based upon tests upon several thousand hogs. These tests were not carried out in small experiment pens only, but in great part upon farms under practical conditions. During the fall of 1907 approximately 2000 hogs were treated on fifty different farms, a considerable proportion of untreated hogs being left in all cases as a control on the action of the serum. Both methods of vaccination were used and the herd conditions varied widely. The herds can be roughly classified as (*a*) those in an infected district, but themselves free from disease, (*b*) those which were known to have been exposed by contact with sick hogs, but which had not developed disease at the time of treatment

and (c) herds in which hog-cholera was present and hogs sick and dying at the time of treatment.

In no cases were any of the ordinary methods of combating hog-cholera by disinfection and separation of the sick from the apparently healthy practised. Where disease was present at the time of treatment, the treated were allowed to run with the sick animals along with a number of untreated animals, which served as controls, and the success following vaccination can therefore be attributed to the action of the serum. In the herds where hog-cholera appeared subsequent to treatment, all of the vaccinated hogs remained well, while more than 65 per cent. of the checks died. In the herds which had been exposed, but were apparently well at the time of the treatment, 4 per cent. of the treated animals died, while approximately 90 per cent. of the checks succumbed. In the herds where disease existed at the time of treatment, and where we did not anticipate very great success, 13 per cent. of the treated animals were lost, whereas 75 per cent. of the checks died.

These successful field trials, confirming as they did numerous tests carried out under experimental conditions, have convinced us of the efficiency of this method of dealing with hog-cholera, and although improvements will undoubtedly be made in many of the details of producing the serum, the method is believed to be now in such condition as to make the practical use of it entirely feasible.

In order that the states most concerned in this question might be brought into closer touch with the work, and also for the purpose of discussing plans for effective co-ordination of the state and federal work in dealing with hog-cholera, twenty-five of the chief hog-raising states were requested to send representatives to Ames, Iowa, where the Bureau of Animal Industry maintains a farm devoted to experiments with hog-cholera. In response to this invitation, representatives from twenty different states visited Ames and were shown the details of the serum production.

A general discussion at these conferences developed the practically unanimous opinion on the part of state and federal representatives that the serum should be prepared by each of the states for distribution to the hog raisers, and all state representatives expressed their intention to undertake the work as soon as funds could be secured. At the present time a number of states have actually begun work. If the serum is prepared in sufficient quantities there seems to be no doubt that a great saving can be effected simply by treating animals in exposed herds or in herds in which the disease has just appeared.

If the greatest good is to be accomplished, however, we should not be content simply to reduce the losses from hog-cholera, but should undertake systematic efforts to eradicate the disease. We are all familiar with the course which hog-cholera usually takes when it appears in a neighbourhood. A herd develops the disease, which may not be recognised as hog-cholera for several weeks after it has made its appearance. Following this the neighbours' hogs will become infected, and from there rapid progress is made, the number of new foci increasing more rapidly as the infected area widens, until finally the losses in a single county may be enormous.

It is evident that in order to control the disease there must be some means of confining it to the original centre of infection. This

has been attempted by the British Government through the quarantine of farms where hog-cholera exists and the slaughter of all infected animals. That such procedures alone will not yield the desired results is shown by the official reports of the prevalence of hog-cholera in England.

In this country such methods would not be suitable, for, aside from the enormous expense involved, it would, in my opinion, be entirely impracticable to thoroughly disinfect extensive farm premises and to carry out a quarantine which would be effective against such carriers of disease as dogs, crows, buzzards, and other animals.

Plan for Eradication of Hog-Cholera by Serum Immunisation.

I have already stated that the serum from hyperimmunised hogs can be used to protect hogs from hog-cholera, and that a large saving can be effected if the serum is applied promptly after the disease appears in a herd. Why, then, should not this serum be used as an agent for the eradication of hog-cholera? It seems reasonable to believe that it can be used successfully for this purpose, but complete success cannot be expected without proper organisation and the direction of the work by health authorities.

In order that the possibilities of well-directed work along these lines may be brought to the attention of those who may in the future have this work to perform, I desire to submit the following plan for combating hog-cholera through serum immunisation:—

(1) The serum should be prepared by the State Experiment Stations, or by State Live Stock Sanitary Boards which are properly equipped with laboratory facilities, the efficacy of all serum to be determined by such laboratories before distribution.

(2) The field application of the serum should be in the hands of the State Live Stock Sanitary Board or State Veterinarian.

(3) The states should be organised into districts, each in charge of a deputy State Veterinarian, or a deputy appointed by the Live Stock Sanitary Board. These districts should be small enough to permit the deputy to exercise close watch over them.

(4) The deputy State Veterinarians should keep a supply of serum on hand, so that prompt action may be taken when infection appears.

(5) Hog raisers generally throughout the state should be informed when the serum is available for distribution, and, if necessary, compulsory notification of the presence of disease in a herd should be imposed.

(6) Upon notification to the State Live Stock Sanitary Board or State Veterinarian that hog-cholera has appeared in a certain neighbourhood, the diseased herd or herds should be immediately quarantined, the premises disinfected as thoroughly as possible, and all hogs on the farm which have been exposed or which are not visibly ill should be treated with serum alone. All hogs on the farm which have not been exposed should be treated by the serum-simultaneous method, and of course the prompt removal of dead animals should be enforced. At the same time all hogs on surrounding farms should be treated by the serum-simultaneous method.

Prompt action of this kind should result in confining the disease to the first herd where disease appeared, though we must admit the possibility of infection being carried beyond the vaccinated belt by

birds. If this should occur the procedure should be the same as in the first case of disease, though the probability of dissemination by birds will not be great owing to the comparatively small size of the infected area.

With a well-organised live stock sanitary board and an efficient corps of deputies throughout the state there seems to be no reason why hog-cholera should not be kept well under control and possibly in time eradicated by proceeding along the lines just indicated. By starting the work in early spring or summer the task would probably be much simplified and the cost reduced to a minimum.

Aside from the eradication of hog-cholera, which is an end we should all strive for, it seems that an immense saving to swine breeders and to the hog industry in general can be accomplished through the protective inoculation of pure-bred hogs. Some of these hogs represent years of patient effort on the part of breeders, and their loss is a loss to the swine industry in general, which depends for its success in great measure upon the development and preservation of the superior characters possessed by these pure-bred animals.

There is no doubt that the hog raisers would gladly co-operate with the state authorities, and any outbreak of disease would be promptly reported, as the farmer would have everything to gain and nothing to lose by so doing.

THE SIGNIFICANCE OF LEUCOCYTES AND STREPTOCOCCI IN MILK.¹

By WILLIAM WHITFIELD MILLER, Assistant Surgeon, Public
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IN the search for better and simpler methods for detecting milk from diseased cows, especially when mixed with the milk from healthy cows, as may be the case in market milk, particular attention has been paid to the presence of leucocytes and streptococci. In America, and to some extent abroad, much work has been done by State and city health authorities in the examination of dairy milk, with a view to determining the significance of these elements, and fixing standards limiting their number in acceptable dairy milk. It was early observed that in the milk of cows with udder disease of an inflammatory nature pus cells and streptococci were almost invariably present in large numbers.

Following this observation, examinations were made to determine how often leucocytes and streptococci were present in market milk. The result showed that they were present in the majority of milks to a greater or lesser extent. They were not so numerous, however, as in the milk of diseased animals. The interpretation placed upon these findings, viz., that one or more of the cows of the dairy herd from which the milk was derived was affected with garget (an inflammation of the udder) is no longer regarded as strictly correct, since it is now well proven that the normal milk of healthy cows always contains leucocytes and usually streptococci. In the last two or three

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