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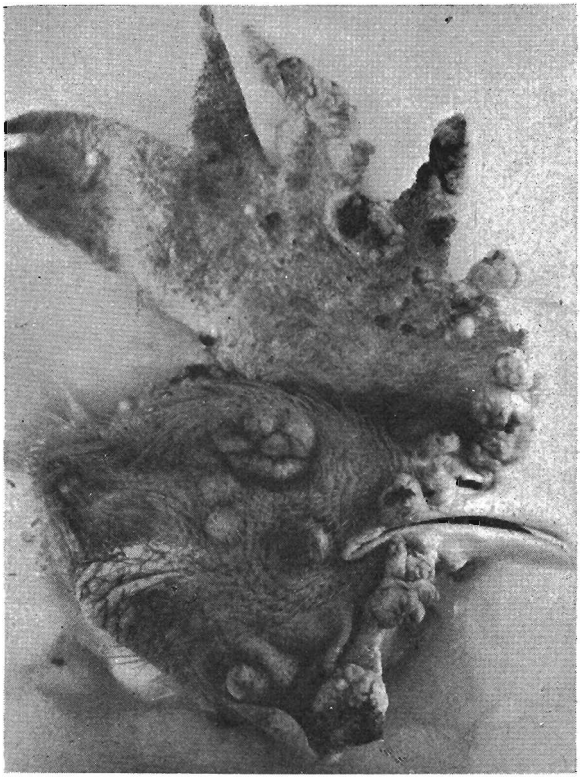
Fowl-pox in Domestic Poultry

by

E. M. DICKINSON



Oregon State System of Higher Education
Agricultural Experiment Station
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TABLE OF CONTENTS

Illustration on Cover—

Wart-like fowl-pox lesions on comb of chicken.

FOREWORD

Fowl-pox still causes unnecessary economic losses for many poultrymen despite the ready availability, for several years, of a successful preventive program. This bulletin provides information that will assist poultry producers to a better understanding of the fowl-pox problem.

The Oregon Agricultural Experiment Station has been instrumental in developing and encouraging the use of the fowl-pox vaccination program under proper circumstances. Minor investigations concerning fowl-pox are constantly in progress to develop new information and to establish a sound basis for improving the already successful fowl-pox vaccination program.

In this connection it is believed that poultrymen who have had trouble with their vaccination program on older birds may benefit by the studies on baby chick vaccination. During this critical period when the shortage of labor is acute, poultrymen may find baby chick vaccination a distinct advantage in this respect.

WM. A. SCHOENFELD
Dean and Director

SUMMARY

Fowl-pox is the name to be preferred over the more common name of chicken-pox, which may be confused with the disease of human beings that is called chicken-pox. The economic loss from fowl-pox in chickens and turkeys may be considerable through decreased egg production, loss of body weight, and lowered breeding efficiency. An annual preventive vaccination program is an effective and economical means of protecting the birds from fowl-pox. In localities where outbreaks of fowl-pox have occurred an annual vaccination program is advisable for flocks of chickens and turkeys.

Fowl-pox is caused by a filtrable virus that develops only in scratches, cuts, or other injured areas on the skin and mucous membrane. Vaccination of infected birds is not advisable. Lesions that involve the eye or the opening to the windpipe should be treated to prevent permanent injury or death of the bird. Chickens are usually vaccinated when they are moved from the brooder house to the range (8-12 weeks of age) or at about a month before egg production is expected ($3\frac{1}{2}$-$4\frac{1}{2}$ months of age). Turkeys are usually vaccinated when they are moved from the brooder to range at about 8 to 12 weeks of age. Turkeys to be kept for breeders should be revaccinated.

Experimental field trials with baby chick vaccination on 28 different poultry farms have been highly successful. Only fowl-pox vaccine and methods of application that have proved successful should be used. Baby chick vaccination is not recommended to replace successful programs of vaccination of older chickens. It may be helpful on poultry farms where trouble is encountered when the birds are vaccinated at an older age. Five to eight hundred baby chicks can be vaccinated in an hour with a crew of 2 or 3 persons including the vaccinator. Annually, more than a million chickens and turkeys are vaccinated against fowl-pox in Oregon.

Fowl-pox in Domestic Poultry

by

E. M. Dickinson

FOWL-POX is a disease that is often referred to as sore-head, canker, avian diphtheria, contagious epithelioma, or perhaps most commonly as chicken-pox. Since the disease is characterized by typical pox lesions, the term fowl-pox is preferred so that confusion with the disease of human beings referred to as chicken-pox may be avoided.

Investigations on the prevention of fowl-pox in domestic poultry have been given major consideration at Oregon Agricultural Experiment Station for many years. These investigations led to the general use of the cutaneous application of an unattenuated vaccine for the prevention of fowl-pox. The objects of this publication are to offer general information that will promote a better understanding of fowl-pox, its control, and to report results of field trials with baby chick vaccination.

ECONOMIC IMPORTANCE

Mortality from fowl-pox is seldom of economic importance. A marked difference is apparent, however, in the depressant effect that various outbreaks of fowl-pox have on different flocks of birds. The most critical loss from an outbreak of fowl-pox is usually the loss of egg production in chickens, and the loss of body weight and breeding efficiency in turkeys. Most natural outbreaks occur during the season when egg prices are usually highest and turkeys are being finished for market. The loss in egg production may vary widely during an outbreak in different flocks of chickens. The average loss in egg production is probably about 20 to 25 per cent extended over a period of about two months. The markets will not accept turkeys until all evidence of fowl-pox lesions are gone. Further, fowl-pox in a flock of breeder turkeys may cause a marked drop in fertility.

Fowl-pox is still an important disease to be considered by poultrymen in spite of the fact that a successful vaccination program has been available for a number of years. Some poultrymen believe they can stand the loss in egg production from an occasional outbreak of fowl-pox rather than the cost of an annual vaccination program. Others vaccinate the pullets for two or three years and then decide to try to get by without vaccinating. In general, however, most

poultrymen find annual vaccination of the young stock good insurance for economic poultry production.

An annual vaccination program is advisable on poultry farms and in localities where fowl-pox already has made its appearance. The advisability of a general state-wide vaccination program might be questioned because there are isolated localities in which fowl-pox has never occurred. To expose the birds in such isolated localities to infection by using fowl-pox vaccine would necessitate an annual vaccination program that might otherwise be unnecessary.

OCCURRENCE OF THE DISEASE

Fowl-pox is a disease that is common in flocks of chickens and turkeys in Oregon. It has been reported from all sections of the United States, Canada, and practically all other countries where domestic poultry is raised. The widespread distribution of the disease indicates its highly contagious nature.

Though fowl-pox is commonly found in chickens and turkeys, the disease has been reported as occurring on other birds such as pigeons, guinea fowl, quail, and pheasant. The author has observed pox lesions on blue grouse (*Dendragapus obscurus obscurus*) taken from natural field conditions that were readily transmitted to susceptible chickens. Further, the chickens infected with the grouse virus showed immunity 6 months later when inoculated with fowl-pox virus. European investigators have reported pox in ducks and geese. It is doubtful, however, whether this pox infection was due to the same type of virus as that which produces pox in chickens and turkeys.

Under natural conditions, fowl-pox infection is observed principally on exposed skin (comb, face, and wattles) and mucous membranes (mouth cavity) of birds. Parts of the body protected with feathers or tough horny covering are seldom infected. It is significant that most natural cases of fowl-pox in Oregon occur in flocks of chickens that are in egg production or turkeys that have reached sexual maturity. The increase in the size of the combs and wattles and increased fighting among mature birds in a productive flock are factors that contribute to the more rapid spread of the infection after it is introduced.

The disease is most commonly encountered in the fall and winter months although cases may occur during all seasons of the year. It has been quite generally noted that outbreaks of fowl-pox during the spring and summer months seem to be less severe than the outbreaks during the fall and winter.

CAUSE AND TRANSMISSION

The cause. A filtrable virus is the cause of fowl-pox. Although it is not possible to see this disease-producing agent with the aid of the highest magnification of a compound microscope, studies have been conducted with suspensions containing the virus. The virus in a scab lesion will withstand drying over an extended period of time. It has been observed that the virus will remain alive much longer in dry scabs left intact than in dry scabs that are ground to a fine powder. Fowl-pox virus has remained alive in dry intact scabs for over two years when held under refrigeration in tightly-stoppered bottles. On the other hand, the virus dies rather rapidly when the fowl-pox scabs are exposed to moisture, bacterial decomposition, and the disintegration of organic material. Thus, the possibilities of fowl-pox surviving in poultry houses and yards may vary greatly. Under average conditions, it is not likely that fowl-pox virus would remain viable in the poultry house or yard from one year to the next.

Other pox viruses. Fowl-pox virus refers to the disease-causing agent commonly found producing fowl-pox on chickens. It should be understood that other bird-pox viruses are recognized that appear to be closely related to the fowl-pox virus, but they possess definite biological differences. Pigeon and canary pox viruses are examples of variants of bird pox viruses. The fact that turkeys, when vaccinated with fowl-pox virus, begin to lose their protection 5 to 6 months after vaccination, indicates a biological difference that needs additional study. One should not assume, therefore, that all pox-like lesions observed on birds are necessarily caused by fowl-pox virus.

The transmission. The rate of spread of fowl-pox and the severity of lesions among chickens and turkeys in different flocks may vary. Probably the chief influence on this variation is the fact that fowl-pox virus will establish itself and produce lesions only where the cells of the skin or mucous membrane are damaged with scratches, cuts, bruises, or other injury.

Importance of injury for spread. In flocks of birds in which the spread of fowl-pox is very rapid, there are likely to be factors that promote injury and thus provide an avenue of invasion for the virus. Fighting among birds, cannibalism, and the use of feed and water utensils or other equipment that might scratch or injure the birds are factors that will assist in the spread of the infection. It has been definitely established that mosquitoes may also transmit

fowl-pox by feeding on the lesions of an infected bird and then feeding on a susceptible bird.

SYMPTOMS AND LESIONS

The symptoms. Birds show no specific characteristic symptoms, although the lesions of fowl-pox are typical and practically diagnostic of the disease. The most common symptoms are a depressed droopy attitude, decrease in food consumption, and a reduction or cessation of egg production. Early symptoms may include watery eyes, discharge from the nose with sneezing and cough. These symptoms are similar to those of other respiratory diseases and may cause confusion in making a diagnosis. When canker lesions form in the opening to the windpipe, the bird will exhibit symptoms of gasping. In some cases if this lesion is not promptly removed, it may develop in size until it fills the opening to the larynx (Figure 1) and causes suffocation of the bird. In an occasional case a canker lesion may develop on the mucous membrane around the eye. Eye lesions, if extensive, may destroy the eyeball and cause blindness. Lesions in the eye and in the opening to the windpipe are the ones most likely to cause death of the bird.

Two kinds of lesions. About 3 to 5 days after chickens and turkeys are infected with fowl-pox virus, pox lesions will begin to show definite formation. Lesions on thin skin protected by feathers develop more rapidly and subside more quickly than lesions that develop on the thick skin of the comb or wattles. Fowl-pox lesions develop more slowly on turkeys than they do on chickens. In a practical consideration two kinds of lesions (Figure 1) may be recognized; those developing on mucous membrane (cankers) and those on the skin (wart-like scabs). The latter type is the lesion most frequently seen and is most characteristic of the disease.

Skin lesions. The skin lesions begin as yellowish pustules that rupture after several days. The ruptured lesions exude serum that is often mixed with blood to build up a wart-like scab that is very firmly attached. These firmly-attached wart-like scabs may adhere to the skin of the face, comb, or wattles for from 2 to 3 weeks. Upon removal of such a lesion, it is noted that small caseous finger-like projections fit into small cavities in the underlying tissue. As healing begins to take place, the margin of the scab loosens and after several days the scabs will drop off. The entire elapsed time for the formation of the scabs and until they drop off varies with different birds. Most birds, however, will have dropped

their scabs within 4 to 5 weeks after they were infected. The size of the lesion and the depth of involvement depend to a great extent upon the type and extent of the injury into which the virus has been introduced and the thickness of the infected skin.

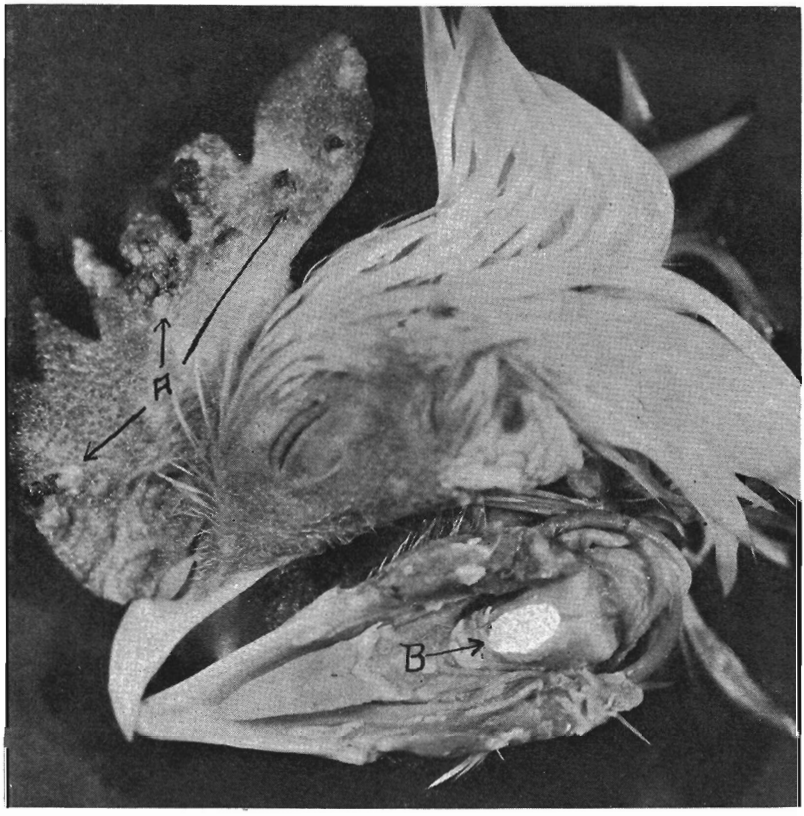

Figure 1. Fowl-pox lesions on chicken. (A) Wart-like scabs on comb. (B) Canker filling opening to windpipe.

Mucous membrane lesions. The canker lesions on the mucous membrane have a beginning quite similar to skin lesions. The pustular stage does not last long, however, and the ruptured pustule promptly forms a diphtheritic or fibrinous exudate that becomes firmly attached over the infected area. It is cheese-like in consistency and yellowish-white in color. The exposure to food passing over the lesions on the mucous membrane of the mouth has a tendency to cause these lesions to be shed sooner than the skin lesions.

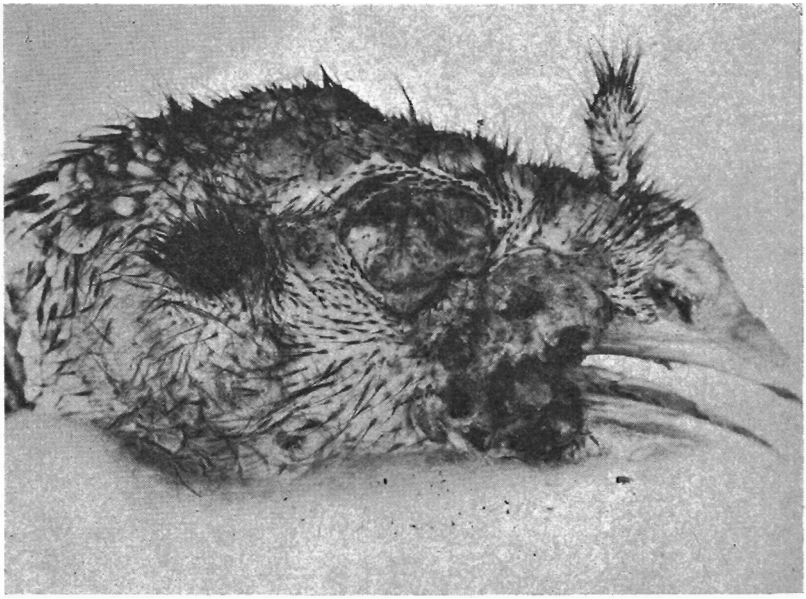

Figure 2. Fowl-pox lesions on the head of a turkey. Note large pox scab in the corner of the mouth.

TREATMENTS

Individual treatment of all lesions on infected birds is not worthwhile. For the average case of fowl-pox it is usually advisable to let the disease run its course without treatment. Most lesions on the comb, face, and wattles do not leave any permanent injury, and in due course of time, the scabs will become dry and drop off.

Treatment for eye lesions. In some cases lesions occur on the margin of the eyelid or on the mucous membrane lining the inside of the eyelid. A severe lesion in this location may destroy the eyeball and produce blindness. Promptly removing the scab-part of the lesion and applying freshly prepared 15 per cent argyrol solution to the infected area may save the eyeball. If the eyelids have a tendency to stick together, it is advisable to pull them apart and drop 2 or 3 drops of the argyrol solution on the eyeball. The treatment should be repeated as often as necessary to prevent the eyelids from sticking together.

Treatment for lesions in windpipe. Fowl-pox cankers on the mucous membrane of the mouth are not likely to prove serious

or fatal unless they develop in the opening to the windpipe. Gasping symptoms warn of such a developing lesion, and it should be removed promptly. A pair of thumb forceps are most effective for this purpose since care must be taken so that the canker will not be dislodged and then be dropped down the windpipe. It is usually advisable to swab the area from which the canker has been removed with some antiseptic such as tincture of iodine or freshly prepared 15 per cent argyrol solution.

Vaccination not a treatment for sick birds. Fowl-pox vaccination has no value as a treatment for infected birds. With a natural outbreak of fowl-pox in the flock the question arises whether or not to vaccinate the uninfected birds. Whatever procedure is followed, it should be accepted as a plan to make the best of an already bad situation. Experience with such cases indicates that on the average vaccination is not desirable. In most cases by the time the presence of the disease is determined a fairly high percentage of the birds either show lesions or are in the incubative stage. Under some circumstances and when only a few birds (less than 5 per cent) are affected with fowl-pox, vaccination might be justified. It should be understood that a drop in egg production following the use of fowl-pox vaccine may be expected. The loss in egg production, however, usually will be less and of shorter duration than when the disease runs its natural course.

FOWL-POX VACCINE A PREVENTIVE

Vaccination prevents fowl-pox. Fowl-pox vaccination, when properly carried out, has proved highly successful in protecting chickens and turkeys from this disease. It should be understood that vaccination is of no value as a treatment for a bird on which fowl-pox lesions have started to develop. Neither is fowl-pox vaccination of any value as a preventive for diseases other than fowl-pox. It is important that poultrymen appreciate the difference between treatment of infected birds and preventive measures employed to protect healthy susceptible ones. The success of a vaccination program depends on the use of a suitable fowl-pox vaccine, properly applied so that the birds will develop a fowl-pox "take," which will result in the development of a high degree of immunity or protection.

Two kinds of vaccines. There are two kinds of pox vaccines that are available for poultry—pigeon-pox vaccine and fowl-pox vaccine. Fowl-pox vaccine is the type that is almost universally used.

The length of immunity following the use of pigeon-pox vaccine on chickens and turkeys is so short that this type of vaccine is not recommended. The virus for fowl-pox vaccine is produced in two different ways. The virus may be propagated on the chorio-allantoic membranes of a growing chick embryo or on the skin of healthy susceptible chickens. Vaccines prepared with virus produced by either method have given suitable protection against natural fowl-pox.

Methods of applying vaccine to chickens or turkeys. Fowl-pox vaccine is commonly introduced into the skin by either "feather follicle" or "stick" application. "Feather follicle" application consists of plucking 2 or 3 feathers from the skin and introducing the vaccine into the follicles with a brush. A brush for applying the vaccine is usually included with vaccine that is to be applied in this manner. "Stick" application consists of dipping a suitable sticking needle into the vaccine and then puncturing the skin. The depth of the puncture should be completely through the skin, yet not so deep that underlying tissues are damaged. A needle for applying the vaccine is usually included with vaccine to be applied in this manner. The preferred site for puncturing the skin ("stick" application) is on the outside of the right leg in the area free of feathers just back of and below the stifle or knee joint. (Figure 3.) Vaccine for application by the "feather follicle" method should not be applied by the "stick" method and vice versa. Regardless of where fowl-pox vaccine is obtained the instructions on the care and application of the vaccine that are included with each shipment should be carefully followed.

Examine for "takes." The success of a fowl-pox vaccination program depends on a vaccine that will produce "takes." It is highly desirable, therefore, that 10 to 15 per cent of the birds be examined about 7 to 10 days after vaccination for fowl-pox "takes." (Figure 4.) Under average conditions, one should expect to obtain 98 to 100 per cent "takes." It is usually advisable to revaccinate the birds immediately when 20 per cent or more of the birds show no evidence of "takes." To make certain that "takes" are not being overlooked, it is important that all the birds be vaccinated in the same area on the body and on the same (right) side.

When breeder turkeys are revaccinated following vaccination 6 months or more previously, many of the birds will show a lack of "takes" which indicates that such birds are still immune from the previous vaccination. Therefore, lack of "takes" in flocks of turkeys

Figure 3. x marks the preferred site for vaccination of young range and mature fowls.

Figure 4. Typical stick "take" 7 days after vaccination.

that are being revaccinated does not bear the same significance that it would in a flock being vaccinated for the first time.

Length of immunity. Following vaccination it requires 2 to 3 weeks for chickens and 3 to 4 weeks for turkeys to develop immunity. There is usually sufficient immunity produced following vaccination with fowl-pox vaccine to provide protection for the life of the average chicken. Turkeys vaccinated with fowl-pox vaccine are usually protected for at least 5 to 6 months following vaccination. This protection covers the average growing period when poults are vaccinated at 8 to 12 weeks of age. Turkeys that are to be held over for breeding purposes should be revaccinated when the final selection of breeders is made or about 6 weeks before hatching eggs are desired.

Age to vaccinate chickens. Chickens are usually vaccinated either at the time they are moved from the brooder house and placed on range (8 to 12 weeks old) or at about one month before the birds are expected to come into egg production ($3\frac{1}{2}$ to $4\frac{1}{2}$ months old). Danger of coccidial outbreaks or other diseases occurring soon after the birds are put on range, may make this former period for vaccination undesirable for some poultrymen. For many poultrymen vaccinating birds at an older age has helped to avoid this problem. Regardless of the age at which birds are vaccinated, it is essential that they be in good health. In recent years field trials in which baby chicks a few days old were vaccinated have been quite successful. Results of some of these field trials are discussed later in this bulletin. Poultrymen should determine for themselves the age for vaccination that best meets the problems on their particular poultry farms.

It is not uncommon for chickens to show a depressant effect about 2 to 3 weeks after vaccination. A drop in food consumption and a tendency for the birds to be slightly droopy may be noted for a few days. This depressant effect might be somewhat relieved if about 10 days after vaccination the birds were given, each day for a week or more, a small amount of moist mash or some other highly palatable food that would be consumed in 20 to 30 minutes.

Age to vaccinate turkeys. Turkey poults are commonly vaccinated at about 8 to 12 weeks of age. A convenient time for this is when the poults are moved from the brooder house onto the range. Due to the short period of immunity in turkeys, it seems inadvisable to vaccinate baby poults only a few days old. There seems to be no obvious depressant effect on turkeys following fowl-pox vaccination.

It is important, however, that the poults be in good health when they are vaccinated.

FIELD TRIALS ON BABY CHICK VACCINATION*

Materials and methods. Field trials on baby chick vaccination have been conducted on twenty-eight different commercial poultry farms with a high degree of success. Some chicks were vaccinated at about one day of age, when they were removed from the chick boxes and placed under the brooder. Others were vaccinated at various ages varying from 2 to 18 days. The methods of handling and types of brooding equipment were as varied as the number of poultry farms on which trials were conducted.

The vaccine used and the instrument for applying it were the same as that distributed by the Oregon Agricultural Experiment Station, Department of Veterinary Medicine, for use in vaccinating chickens and turkeys of any age.

The method of holding baby chicks and the site for vaccination varied slightly from that recommended for older chickens. Baby chicks were held by grasping the wings between the left thumb and forefinger and the right leg between the right thumb and forefinger. The other fingers of both hands were placed under the chick's body for support. The preferred site for vaccination was the fold of the skin in the flank between the stifle or knee joint and the body. The margin of the skin, in the fold of the flank, was grasped between the thumb and forefinger of the left hand and the skin was stretched taut in this manner. By lightly blowing a current of air from the breath on the down of the stretched skin a small area of skin was exposed into which the vaccine was introduced by puncturing the skin with a needle (Figure 5). The needle was made of a No. 1 cotton darning needle with the eye cut across to leave two sides, about 2/16 to 3/16 inches long, that were sharpened to a point at the ends. The needle was stuck into the skin to the depth of the two sides. The vaccine was applied on the right flank in approximately the same location on all chicks to facilitate later checking for "takes" (Figure 6) and to insure that the administration was done in an area that would not be harmful to the chicks.

The skin of day-old chicks is very tender. Careful administration of the vaccine was essential to be certain, first, that the sticking needle punctured the skin to introduce the vaccine so as to insure a

* The author wishes to express his appreciation for the cooperation of the poultrymen who assisted with the field trials by submitting their baby chicks for vaccination and by keeping records.

Figure 5. x marks the preferred site for vaccination of baby chicks.

Figure 6. Typical stick "take" on baby chick.

"take," and, second, that the stick was done properly so as to prevent excessive damage to the skin that might result in an extensive pox lesion. It was observed that the skin of baby chicks toughens after a few days under the brooder. For this reason chicks between 3 and 7 days of age were considered most desirable for vaccination.

The day-old chicks were vaccinated when they were removed from the chick boxes to be placed under the brooder. When vaccinating chicks 2 to 5 days of age, they were caught and put in the chick boxes or other suitable boxes. The chicks were then conveniently vaccinated as each chick was put back under the brooder. Care was taken not to put more than 15 to 20 chicks to a compartment that would normally hold 25 day-old chicks. In some cases, especially with older chicks, it was more convenient to use panels of boards one foot wide and confine the chicks to a small space beside the brooder stove. Chicks over a week old were not so easily confined in large numbers and there was greater danger from piling and suffocation.

Two or three persons, including the vaccinator, were sufficient to vaccinate 500 to 800 chicks an hour. Two boxes about the size of egg cases were placed end to end near the brooder stove for the vaccinator and the person holding the chicks to sit on, facing each other. The vaccinator put the vaccine container on the box between his legs. The person holding the chicks had the boxes containing the chicks setting so they could be easily reached. When a third person was available, he hastened the vaccination program by getting the chicks out of the boxes and handing them to the person holding them for vaccination. After each chick was vaccinated, it was placed under the brooder.

Five to ten days after vaccination from 20 to 100 per cent of the chicks in each brood were examined for fowl-pox "takes" (Figure 6). None of the broods vaccinated showed less than 98 per cent and most of the lots developed 100 per cent "takes" on the chicks examined.

Results of field trials. Poultrymen who cooperated in the field trials on baby chick vaccination kept daily records of deaths from all causes for 6 to 10 weeks after vaccination. These mortality records are presented in Tables I and II and show the variations in different broods. Table III is a summary of the mortality records for 6 weeks after vaccination. These records indicate that, in spite of the occasional high mortality in a brood of chicks, the average mortality of all broods was no more than one might expect during an average brooding period.

One experience in which baby chicks were vaccinated and then placed back in the boxes for several hours resulted in about 5 per cent of the chicks developing pox lesions on the margins of the eyelids and in the corners of the mouth. Most of the infected chicks died. In no other instance was there a report of accidental infection following vaccination. This evidence indicates clearly that vaccinated day-old chicks should not be immediately replaced in shipping boxes and sold as fowl-pox vaccinated day-old chicks.

DISCUSSION OF BABY CHICK VACCINATION

In view of the results obtained in these field trials, baby chick vaccination has a definite place as part of the disease prevention program on many poultry farms. It is not recommended that baby chick vaccination replace vaccination of older birds when the latter program has been successful. Baby chick vaccination has proved of definite value on several farms where complicating trouble has arisen in the older chickens following vaccination.

Poor results may occur following vaccination at any age in a limited number of cases. Investigations of several such cases in older birds has revealed that the birds were vaccinated when they had coccidiosis, roundworms, or other complicating diseases. Under such circumstances, condemnation of the fowl-pox vaccination program is not justified. The fault in such cases lies in the judgment of the person concerned with the vaccination. In some sections poultrymen relieve themselves of this responsibility by having the local veterinarian do the vaccinating when he considers it advisable. The question concerning the proper age to vaccinate chickens still remains a problem that the individual must solve for himself.

Baby chick vaccination has certain advantages that are important under our present circumstances. A crew of 2 or 3 persons can vaccinate as many baby chicks in a given period of time as a crew of 4 to 6 can vaccinate pullets on range. Further, the ease with which baby chicks are caught and held compared with pullets on range offers another labor-saving advantage.

The question of length of immunity following baby chick vaccination has been checked. Chickens vaccinated as baby chicks 2, 3, 4, and 5 years previously have proved to have protection against artificial inoculation with fowl-pox virus. Further, no case of natural fowl-pox has been reported in flocks of mature chickens that have been protected by vaccination when they were baby chicks.

SUGGESTIONS FOR BABY CHICK VACCINATION

1. Use only fowl-pox vaccine and methods for administration that have proved successful on baby chicks.

2. The preferred age for vaccinating baby chicks is between 3 and 7 days, inclusive.

3. The skin of baby chicks can be torn easily. Make sure the needle punctures the skin, but avoid deep punctures or excessive skin injury.

4. Put each baby chick under the brooder immediately after vaccination. Under no circumstances should baby chicks be put in chick boxes immediately after vaccination.

5. Fowl-pox vaccination is for the purpose of protecting the poultry investment. Maintain better-than-average brooding conditions to protect that investment still further.

Table Ia. WEEKLY MORTALITY FROM ALL CAUSES. 1940 SEASON.
(Chicks one day old when vaccinated)

Farm	Number chicks	Sex	Days of age	Mortality during weeks after vaccination										Total	Per cent	Remarks
				1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th			
C	600	♀♀	1	7	1	7	1	6	3	6	2	....	....	33	5.5	
H	328	♀♀	1	1	2	1	1	1	1	0	0	0	0	7	2.1	
	336	♀♀	1	2	1	1	1	2	0	1	0	1	0	9	2.6	
	327	♀♀	1	2	3	1	0	1	0	1	0	2	0	10	3.0	
N	300	♀♀	1	5	0	0	0	1	0	2	0	2	....	10	3.3	
	300	♀♀	1	1	0	1	1	0	1	5	3	2	....	14	4.6	
	326	♀♀	1	2	2	0	1	1	0	1	3	7	....	17	5.2	
	344	♀♀	1	6	2	1	1	0	1	2	1	2	....	16	4.6	
	341	♀♀	1	8	3	1	0	0	0	0	4	3	....	19	5.5	
Total	3,202			34	14	13	6	12	6	18	13	19	0	....	....	
Accumulative per cent mortality				1.06	1.49	1.90	2.09	2.46	2.65	3.13	3.54	4.27	4.27	....	....	

Table Ib. WEEKLY MORTALITY FROM ALL CAUSES. 1940 SEASON.
(Chicks 2 to 8 days old when vaccinated)

Farm	Number chicks	Sex	Days of age	Mortality during weeks after vaccination										Total	Per cent	Remarks
				1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th			
B	265	♀♂	7	1	0	1	2	1	2	1	1	0	....	9	3.39	
	365	♀♂	7	2	4	1	6	14	4	6	8	6	....	51	13.97	
	313	♀♀	2	2	0	0	0	0	0	1	....	....	....	3	0.95	
	291	♀♀	2	13	0	0	0	0	0	0	....	....	....	13	4.46	
	570	♀♂	7	25	1	2	0	1	3	1	....	....	....	33	5.77	
	611	♀♂	7	2	1	2	2	1	5	0	....	....	....	13	2.12	
C	521	♀♀	3	23	7	8	1	0	9	7	3	2	2	62	11.90	
	499	♀♀	3	29	10	6	0	4	10	3	2	3	2	69	13.82	
	475	♀♀	8	7	0	3	6	3	2	3	....	....	....	24	5.05	
D	545	♀♀	8	1	1	1	0	1	1	2	0	....	....	7	1.28	
	545	♀♂	8	1	1	1	1	1	1	3	0	....	....	9	1.65	
	506	♀♂	8	1	0	1	1	1	1	2	1	....	....	8	1.58	
	500	♀♀	8	2	0	2	1	0	0	1	1	....	....	7	1.40	
	480	♀♂	8	2	1	0	1	0	1	1	1	....	....	7	1.45	
	450	♀♂	8	3	0	0	1	0	1	2	1	....	....	8	1.77	
	500	♀♀	8	0	1	0	0	2	3	1	0	....	....	7	1.40	
	520	♀♂	8	2	0	0	1	2	0	1	1	0	....	7	1.34	
	512	♀♀	8	3	0	0	0	0	1	0	0	....	....	4	0.77	
	504	♀♀	8	2	0	0	0	0	1	1	0	....	....	4	0.79	
	518	♀♂	8	2	0	0	0	0	1	2	0	1	....	6	1.15	
H	319	♀♀	7	3	2	2	0	1	0	1	1	0	0	10	3.13	
	309	♀♀	7	1	0	2	2	0	0	1	1	0	0	7	2.26	
	309	♀♀	7	1	1	1	1	0	2	0	0	1	0	7	2.26	
J	364	♀♀	7	1	2	2	3	0	0	0	0	0	0	8	2.19	
	329	♀♀	7	2	1	0	2	0	0	0	0	0	0	5	1.51	
L	406	♀♀	4	9	3	2	7	4	4	0	0	0	0	29	7.14	
	302	♀♀	2	3	0	3	6	0	0	1	0	3	0	16	5.29	
M	573	♀♂	5	4	2	2	0	1	6	4	2	1	....	22	3.83	
N	301	♀♀	3	1	0	0	3	3	0	3	1	1	0	12	3.96	
	306	♀♀	3	6	1	2	1	0	0	0	0	1	0	11	3.59	
	309	♀♀	3	10	0	1	1	0	1	2	0	1	0	16	4.99	
	300	♀♀	8	0	0	0	0	2	1	0	2	....	....	5	1.66	
P	414	♀♀	3	9	7	4	0	0	3	7	10	9	0	49	11.83	
	414	♀♀	3	10	4	0	0	0	0	4	6	8	4	36	8.69	
V	460	♀♀	6	3	0	0	0	1	1	1	0	0	....	6	1.30	
	489	♀♂	6	3	1	1	0	1	0	0	0	0	0	6	1.22	
	300	♀♀	6	1	0	0	1	2	0	1	0	0	0	5	1.66	
	354	♀♂	8	9	12	16	10	6	10	7	....	....	....	70	19.77	
Total	16,048	.....		199	63	66	60	57	72	68	41	36	8	....	.....	
Accumulative per cent mortality				1.24	1.63	2.04	2.41	2.77	3.22	3.64	3.94	4.36	4.49	....	.....	

Table Ic. WEEKLY MORTALITY FROM ALL CAUSES. 1940 SEASON.
(Chicks 9 to 18 days old when vaccinated)

Farm	Number chicks	Sex	Days of age	Mortality during weeks after vaccination										Total	Per cent	Remarks
				1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th			
BB	366	♀♀	16	2	4	5	12	7	10	2	....	....	....	42	11.47	
	366	♀♀	16	0	0	2	3	2	2	....	....	....	....	9	2.45	
	367	♀♂	16	1	1	1	5	5	2	....	....	....	....	15	4.08	
	520	♀♂	9	0	1	6	5	5	3	2	....	....	....	22	4.23	
	470	♀♂	9	2	7	10	4	4	6	4	....	....	....	37	7.87	
C	605	♀♀	9	3	4	13	1	1	3	1	....	....	....	26	4.29	
L	320	♀♀	18	4	0	6	3	0	0	1	0	....	....	14	4.37	
M	500	♀♀	12	1	0	1	0	0	8	1	....	....	....	11	2.20	
	505	♀♀	10	8	1	3	2	1	4	3	9	1	....	32	6.33	
Total	4,019	.....		21	18	47	35	35	38	14	9	1	....	....	.....	
Accumulative per cent mortality				0.52	0.96	2.13	3.00	3.63	4.57	5.00	6.09	6.28	....	....	.....	

Table IIa. WEEKLY MORTALITY FROM ALL CAUSES. 1941 SEASON.
(Chicks one day old when vaccinated)

Farm	Number chicks	Sex	Days of age	Mortality during weeks after vaccination										Total	Per cent	Remarks
				1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th			
C	512	♀♀	1	7	0	1	1	1	0	2	4	6	5	27	5.2	
F	599	♀♀	1	9	1	5	0	4	2	0	16	6	0	43	7.3	
H	330	♀♀	1	5	1	0	0	0	1	0	0	0	0	7	2.1	
	330	♀♀	1	4	0	1	0	1	0	0	0	1	0	7	2.1	
	327	♀♀	1	2	1	1	0	0	0	2	0	0	1	7	2.1	
L	370	♀♀	1	8	2	2	0	0	1	7	4	1	....	25	6.7	
	370	♀♀	1	8	2	0	0	1	0	3	7	2	....	23	6.2	
	418	♀♂	1	11	0	0	0	2	4	0	3	....	....	20	4.7	
N	285	♀♀	1	5	0	0	0	1	1	2	8	0	....	17	5.9	
	325	♀♀	1	5	1	0	0	1	2	1	1	2	....	13	4.0	
	318	♀♀	1	3	0	0	0	0	8	3	2	0	....	16	5.0	
Q	1,022	♀♀	1	14	2	2	0	0	0	5	3	5	2	33	3.2	
R	450	♀♀	1	4	4	2	0	0	0	2	0	1	....	13	2.8	
	440	♀♀	1	6	3	3	1	2	1	0	1	1	....	18	4.0	
	341	♀♀	1	2	2	0	2	3	0	1	1	0	0	11	3.2	
	350	♀♀	1	2	0	1	1	1	2	1	0	1	0	9	2.5	
	350	♀♀	1	3	1	0	1	0	0	0	0	1	0	6	1.7	
S	700	♀♀	1	17	10	1	1	8	21	15	20	48	22	163	23.2	Chilled 1-2. Cocci. 5-10
T	204	♀♀	1	1	1	0	1	0	2	3	6	6	8	28	13.2	
	306	♀♀	1	2	2	0	0	0	3	4	1	8	12	32	10.4	
Z	375	♀♀	1	6	1	2	1	1	4	8	20	11	8	62	16.5	Coccidiosis 7-10th wks.
AA	357	♀♀	1	3	0	0	0	1	2	....	....	....	....	6	1.6	
	359	♀♀	1	3	2	0	2	1	2	....	....	....	....	10	2.7	
Total	9,438			130	36	21	11	28	56	59	97	100	58	....	.....	
Accumulative per cent mortality				1.37	1.75	1.98	2.09	2.39	2.98	4.33	5.44	6.65	7.66	....	.....	

Table IIb. WEEKLY MORTALITY FROM ALL CAUSES. 1941 SEASON.
(Chicks 2 to 8 days old when vaccinated)

Farm	Number chicks	Sex	Days of age	Mortality during weeks after vaccination										Total	Per cent	Remarks
				1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th			
A	602	♀♂	7	0	1	2	0	0	7	8	12	23	....	53	8.8	Cocci. 7-9th weeks
B	410	♀♂	3	4	2	2	3	9	1	4	3	1	....	29	7.0	
	429	♀♂	2	4	1	4	17	5	4	4	3	....	....	42	9.7	13 smothered 4th week
	544	♀♂	6	4	0	8	5	11	6	....	....	....	....	34	6.4	
	350	♀♂	2	4	1	1	1	2	2	....	....	....	....	11	3.1	
	85	♀♂	8	1	1	4	0	0	0	....	....	....	....	6	7.0	
C	610	♀♂	6	6	1	0	2	5	2	0	1	0	0	17	2.7	
	593	♀♂	7	3	2	1	0	3	2	8	5	3	....	27	4.7	
D	500	♀♂	8	2	1	0	0	0	1	....	....	....	....	4	0.8	
	470	♀♂	8	0	0	0	1	2	1	....	....	....	....	4	0.8	
	475	♀♂	8	2	1	0	1	0	2	....	....	....	....	6	1.2	
	475	♀♂	8	3	0	1	1	2	1	....	....	....	....	8	1.6	
	540	♀♂	7	1	0	1	2	0	0	....	....	....	....	4	0.7	
	545	♀♂	7	1	0	1	1	2	0	....	....	....	....	5	0.9	
	450	? ?	7	1	1	1	2	2	0	....	....	....	....	7	1.5	
	450	? ?	7	2	1	2	2	1	0	....	....	....	....	8	1.7	
	450	? ?	7	1	2	1	1	0	0	....	....	....	....	5	1.1	
	450	? ?	7	1	0	3	2	0	0	....	....	....	....	6	1.3	
	450	? ?	7	2	0	0	1	0	0	....	....	....	....	3	0.6	
E	406	♀♀	2	6	3	10	27	8	0	....	....	....	....	54	13.3	Cocci. 3-5 weeks
	494	♀♀	2	3	3	11	27	4	0	....	....	....	....	48	9.7	Cocci. 3-5 weeks
F	685	♀♀	8	0	5	5	27	9	5	8	10	10	....	79	11.5	26 smothered 4th week
	566	♀♀	5	4	6	5	4	2	3	0	0	10	9	43	7.5	
	502	♀♀	6	3	1	4	3	6	1	0	4	0	....	22	4.9	
	500	♀♀	4	7	6	2	3	6	0	8	5	0	....	37	7.4	
G	788	♀♀	7	1	6	0	2	1	1	6	3	0	2	22	2.7	

Table IIb. (*Continued*)

Farm	Number chicks	Sex	Days of age	Mortality during weeks after vaccination										Total	Per cent	Remarks
				1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th			
I	307	♀♀	4	3	1	2	3	3	1	5	....	....	....	18	5.8	
	310	♀♀	4	7	0	1	3	8	2	2	....	....	....	23	7.4	
J	257	♀♀	5	1	1	1	0	0	2	3	2	3	0	13	5.0	Blackhead 6-9th weeks
K	292	♀♀	2	9	2	0	2	1	10	....	....	....	....	24	8.2	Pullorum disease 1-2 wks.
	292	♀♀	2	14	14	4	0	2	0	....	....	....	....	34	11.6	Pullorum disease 1-3 wks.
L	350	♀♀	7	2	1	0	0	1	0	7	4	8	....	23	6.5	
M	614	♀♀	2	2	4	5	8	4	4	7	4	2	....	40	6.5	Cannibalism 3-9 wks.
	407	♀♀	5	3	0	2	3	1	6	6	5	7	....	33	8.1	
	411	♀♀	5	6	0	3	0	1	3	7	4	5	....	29	7.0	
N	298	♀♀	7	1	0	1	0	1	0	0	1	0	....	4	1.3	
	298	♀♀	7	0	0	1	1	1	2	1	0	0	....	6	2.0	
	290	♀♀	7	1	0	0	1	1	1	0	0	0	....	4	1.3	
P	525	♀♀	6	3	0	4	3	6	8	4	4	5	....	37	7.0	
	552	♀♀	6	1	0	1	3	6	7	5	6	3	....	32	5.7	
	114	♂♂	6	0	0	0	0	0	0	2	0	0	....	2	1.7	
R	365	♀♀	5	3	4	1	2	0	0	0	0	0	....	10	2.7	
	365	♀♀	5	1	1	1	1	1	0	1	0	1	....	7	1.9	
	364	♀♀	5	4	0	1	3	1	1	0	0	0	....	10	2.7	
	364	♀♀	5	1	3	2	1	1	1	1	0	0	....	10	2.7	
	489	♀♂	5	1	1	0	0	0	1	0	2	0	....	5	1.0	
	515	♀♂	5	3	0	0	0	0	1	1	0	3	....	8	1.5	
	365	♀♂	5	2	1	2	3	2	0	0	0	2	....	12	3.2	
	400	♀♂	5	1	4	1	0	1	0	0	0	0	0	7	1.7	
	355	♂♂	5	1	1	0	4	7	5	1	2	1	....	22	6.1	
S	419	♀♀	4	7	3	2	3	0	0	0	0	0	0	15	3.5	
V	496	♀♀	6	4	2	1	0	2	1	2	0	0	....	12	2.4	
	458	♀♀	6	2	1	0	3	0	3	1	2	0	....	12	2.6	
Total	23,091			149	89	105	182	131	98	102	82	87	11	....	....	
Accumulative per cent mortality				0.64	1.03	1.48	2.27	2.83	3.25	3.91	4.47	5.07	5.44	....	....	

Table IIc. WEEKLY MORTALITY FROM ALL CAUSES. 1941 SEASON.
(Chicks 9 to 17 days old when vaccinated)

Farm	Number chicks	Sex	Days of age	Mortality during weeks after vaccination										Total	Per cent	Remarks
				1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th			
B	465	♀♂	17	1	0	0	6	3	3	2	0	1	0	16	3.4	
O	1,007	♀♀	14	0	2	0	4	0	10	7	1	....	....	24	2.3	
U	799	♀♀	16	0	0	0	1	2	0	0	0	....	....	3	0.3	
X	1,022	♀♀	15	2	1	3	5	2	7	3	0	....	....	23	2.2	
	1,002	♀♀	10	1	0	2	1	4	5	4	1	0	....	18	1.7	
Y	367	♀♀	9	6	0	2	2	5	1	0	....	....	....	16	4.3	
	389	♀♀	9	3	2	0	3	0	1	0	....	....	....	9	2.3	
	386	♀♀	9	0	3	1	5	5	1	0	....	....	....	15	3.8	
	350	♀♀	10	2	1	2	15	10	15	9	2	2	....	58	16.5	Coccidiosis 4-7th wks.
Total	5,787			15	9	10	42	31	43	25	4	3	0	....	.....	
Accumulative per cent mortality				0.25	0.41	0.58	1.31	1.84	2.58	3.02	3.10	3.27	3.27	....	.....	

Table III. Summary of Mortality from All Causes After Vaccination During 1940 and 1941

Number of broods	Total chicks vaccinated	Age when vaccinated	Accumulative per cent of total mortality					
			1st week	2nd week	3rd week	4th week	5th week	6th week
1940								
9	3,202	1	1.06	1.49	1.90	2.09	2.46	2.65
38	16,048	2-8	1.24	1.63	2.04	2.41	2.77	3.22
9	4,019	9-18	0.52	0.96	2.13	3.00	3.63	4.57
1941								
23	9,438	1	1.37	1.75	1.98	2.09	2.39	2.98
53	23,091	2-8	0.64	1.03	1.48	2.27	2.83	3.25
9	5,787	9-17	0.25	0.41	0.58	1.31	1.84	2.58

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W. B. Bollen, Ph.D.....Associate Bacteriologist

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† On leave for duration for military service.
‡ On leave of absence.

STATION STAFF—(*Continued*)

Entomology

D. C. Mote, Ph.D.—Entomologist in Charge
B. G. Thompson, Ph.D.—Associate Entomologist
S. C. Jones, M.S.—Associate Entomologist
K. W. Gray, M.S.—Associate Entomologist
Joe Schuh, M.S.—Assistant Entomologist
H. E. Morrison, M.S.—Assistant in Entomology

Home Economics

Maud M. Wilson, A.M.—Home Economist
M. Fincke, Ph.D.—Associate Home Economist
Gertrude N. Hoppe, M.S.—Research Assistant in Home Economics

Plant Pathology

C. E. Owens, Ph.D.—Plant Pathologist in Charge
S. M. Zeller, Ph.D.—Plant Pathologist
F. P. McWhorter, Ph.D.—Plant Pathologist*
B. F. Dana, M.S.—Plant Pathologist (Division of Fruit and Vegetable Crops and Diseases)*
F. D. Bailey, M.S.—Associate Plant Pathologist (Agricultural Marketing Administration)*
P. W. Miller, Ph.D.—Associate Pathologist (Division of Fruit and Vegetable Crops and Diseases)*
G. R. Hoerner, M.S.—Agent (Division of Drug and Related Plants)*
John A. Milbrath, Ph.D.—Assistant Plant Pathologist

Publications and News Service

C. D. Byrne, Ed.D.—Director of Information
E. T. Reed, B.S., A.B.—Editor of Publications
F. L. Ballard, B.S.—Editor of Agricultural Publications
D. M. Goode, M.A.—Editor of Publications
J. C. Burtner, B.S.—In Charge of News Service

Branch Stations and Experimental Areas

L. Childs, A.B.—Superintendent, Hood River Branch Experiment Station, Hood River
F. C. Reimer, M.S.—Superintendent, Southern Oregon Branch Experiment Station, Talent
D. E. Richards, B.S.—Superintendent, Eastern Oregon Livestock Branch Experiment Station, Union
H. K. Dean, B.S.—Superintendent, Umatilla Branch Experiment Station (Division of Western Irrigation Agriculture), Hermiston*
H. B. Howell, B.S.—Superintendent, John Jacob Astor Branch Experiment Station and Northrup Creek Cut-over Land Grazing Experimental Area, Astoria
G. A. Mitchell, B.S.—Superintendent, Pendleton Branch Station; Assistant Agronomist (Dry Land Agriculture), Pendleton*
M. M. Oveson, M.S.—Superintendent, Sherman Branch Experiment Station (Division of Cereal Crops and Diseases and Division of Dry Land Agriculture), Moro*
E. S. Degman, Ph.D.—Superintendent and Associate Pomologist, (Division of Fruit and Vegetable Crops and Diseases), Medford*
Obil Shattuck, M.S.—Assistant Superintendent, Squaw Butte-Harney Cooperative Range and Livestock Station, Burns
Arch Work. B.S.—Associate Irrigation Engineer (Division of Irrigation), Medford*
Kenneth C. Ikeler, M.S.—Superintendent, Squaw Butte-Harney Cooperative Range and Livestock Station (U. S. Grazing Service), Burns*
G. G. Brown, A.B., B.S.—Horticulturist, Hood River Branch Experiment Station, Hood River
L. G. Gentner, M.S.—Assistant Superintendent, Associate Entomologist, Southern Oregon Branch Experiment Station, Talent
J. F. Martin, M.S.—Junior Agronomist (Division of Cereal Crops and Diseases), Pendleton*
J. R. Kienholz, Ph.D.—Assistant Pathologist (Division of Fruit and Vegetable Crops and Diseases), Hood River*
Joseph Belanger, B.S.—Cooperative Research Agent, Conservation Experiment Station (Division of Soil Conservation), Pendleton*
A. E. Gross, M.S.—Superintendent, Klamath Experimental Area, Klamath Falls
Edwin Keltner, B.S.—Superintendent, Red Hill Soils, Experimental Area, Oregon City
E. M. Harvey, Ph.D.—Assistant Technologist, Project Leader, Sea Food Laboratory, Astoria
R. Sinnhuber, M.S.—Assistant Biochemist, Sea Foods Laboratory, Astoria
D. Sitton, B.S.—Assistant Superintendent, Malheur Experimental Area, Ontario
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