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Blackhead In Turkeys ---Surgical Control by Cecal Abligation

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Blackhead In Turkeys---Surgical Control by Cecal Abligation

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The veterinary department of the Missouri Experiment Station began a series of investigations on the control of entero-hepatitis in turkeys, in June, 1926. At the present time such portions of the results will be reported as appear complete. Other questions are still under investigation and the results will be reported at a later date. The data included at this time concern two major points: (1) Surgical features or cecal abligation and (2) the results of the application of cecal abligation to the control of entero-hepatitis.

Systems of turkey raising, in which new grounds for isolation against infection are used, are now successfully carried on. These systems, however, are for professional turkey raisers only, and cannot be used by the ordinary farmer who desires to raise turkeys as a side issue on his farm in conjunction with other poultry. Moreover, under ordinary farm conditions the turkeys must be raised with the other farm poultry, and this practice endangers the turkeys because chickens, though seldom affected with blackhead, are carriers of the parasite that causes the disease. Turkeys feeding on the same grounds with chickens are sure to develop blackhead and practically all of them die with the disease. A few turkeys appear to be naturally immune or have a mild form of the disease which confers immunity upon them. It is probable that the few survivors in a flock on the ordinary farm are birds of this nature. It is estimated that 90 per cent of poults or young turkeys and 20 per cent of adult turkeys die from the disease when running on infected grounds.

If a simple effective means of control could be discovered, the ordinary farmer could materially add to his poultry profits without the extra time and expense of an independent or separate project.

LITERATURE CITED

Smith[1] was the first investigator to make a detailed study of blackhead. The disease was first noted by Mr. Cushman of the Rhode Island Experiment Station in 1893. The disease attacks the young by preference and runs no regular course, but varies from bird to bird in severity, duration, and termination. It begins in the ceca and thence invades the liver through the blood. Though restricted to these organs, its action is severe enough to prove fatal to many affected turkeys.

Smith saw that the disease is always associated with a protozoan parasite of minute size whose destructive action is due in the main to

its power of multiplication within the tissues. It is probably discharged with the droppings of the diseased birds. From his investigation it was thought that the parasite was transmitted from bird to bird without passing through an intermediary host. The micro-parasite, discharged perhaps in the encysted stage from the sick bird, is taken up with the food and water by other birds and sets up the disease directly.

This investigator believed that certain flocks only were infected and that the disease was diffused among neighboring flocks by transmission from one to another. The older turkeys which had recovered from the disease became carriers of the parasite, similar to typhoid carriers in humans. If the disease was transmitted more or less directly from old to young, the remedy would appear to lie in two directions. (1) the disease might be allowed to go on with the hope of finding some remedy which would check it and lead to a cure, (2), the diseased flock might be entirely destroyed and new birds obtained elsewhere after a thorough cleansing and disinfection of the territory formerly occupied by the flocks. Smith recognized that effective treatment is difficult. Though turkeys may appear droopy, are unable to keep up with the movement of the flock, and even have diarrhea, the precise nature of the disease is not made clear by these symptoms. Among fifty turkeys examined many were regarded as suspicious cases, but when killed the protozoan disease was not found. He suggested quinine as a treatment. Smith's report contains an appendix with a post mortem description of fifty turkeys in which the various forms of entero-hepatitis are accurately described. There is also a description of the parasite, and of staining methods for its demonstration.

The microorganism was designated as Amoeba meleagridis, 1895, (Smith), and Histomonas meleagridis, 1919, (Tyzzer).

Chester and Robin[2] present studies based upon three cases in chickens stating that they were of some interest because the existence of entero-hepatitis in fowls had not before been demonstrated with certainty. They state that the pathological findings correspond with those of Smith, differing, however, in a very few important details, chief of which was the fact that they claim to have found the parasites within a large necrotic area in the spleen.

Salmon[3] states "that the ameba leaves the bodies of the sick birds with the excrement and infects other birds by entering the digestive organs with the food and drink. It passes along the alimentary canal until it arrives at the two blind pouches or lateral extensions called the ceca where it begins its growth and produces the first signs of disease. The microbes are then carried by the blood from the diseased ceca to the liver."

He further states "that the treatment of diseased birds has not given satisfactory results, and that the only hope of success at present is in preventing their infection."

"The measures of prevention which have been suggested are (1) obtaining eggs from birds believed to be healthy; (2) wiping the eggs with a cloth wet with alcohol (80 to 90 per cent) before they are placed in the incubator or under the hen for hatching, to remove any contagion that might be on the shell; (3) hatching in an incubator, or at least removing the eggs from under the hen a day or two before hatching would occur, wiping with alcohol and finishing in an incubator, in order to avoid exposing the poults to the hen; (4) placing the young poults on ground at a distance from all other domesticated fowls and which has not recently been occupied by other fowls; (5) excluding so far as possible pigeons, other wild birds, and rats and mice from the houses and runs occupied by the turkeys; (6) the frequent disinfection of the houses, feed troughs, drinking fountains, etc.; (7) the immediate killing of diseased birds and the destruction of their bodies by fire."

"These radical measures are necessary, and in sections of the country which are not too intensely infected they will make it possible to carry on the turkey industry successfully. However, it must be admitted that up to the present blackhead has proved to be the most difficult of all diseases to prevent or eradicate".

Higgins[4] gives a plan in the prevention of blackhead in which the poults are raised in one acre plots. He states in the article which is entitled "The Prevention of Blackhead by the Biological Laboratory Method of Artificial Incubation and Isolation" "that partial success has attended the procedures outlined on the laboratory premises, and he is not prepared to state that blackhead will not occur where this system is used, and that it is only after the method has been tried by others throughout the country that a final opinion can be expressed."

Pernot[5] is of the opinion "that after the disease is established in the ceca the parasites are probably carried by the blood to the liver, where they again find a suitable medium to grow in, causing the diseased areas already described."

"At the same time they are no doubt carried by the circulatory system to all parts of the body, but as we have found no other lesions except in the caeca and liver, it is to be inferred that these are the principal seats of disease, yet the blackening of the head which occurs at times is probably due to growths of the parasites causing thrombosis, a damming of the blood, which would indicate that they do grow elsewhere than in the liver and ceca, although we have never found this to be positively the case."

He also states "that treatment by injection through the rectum has been suggested, but it will be seen that an injector thus introduced would follow the intestine and not enter the caeca. Even were this possible, the liver might be diseased and could not be reached."

"Where the disease exists he recommends the suspension of turkey raising for one year."

"Upon restocking, eggs from healthy fowls which are not too closely in-bred should be secured, and the young raised on a part of the premises least frequented by the old flock."

Theobald[6] states that no satisfactory treatment has been devised and that rational prevention must depend largely on sanitary measures.

Welch[7] suggests that perhaps the surest method of avoiding blackhead is to hatch the turkey eggs in an incubator, rear the poults in a brooder on clean ground, apart from all turkeys or chickens, provide them with an abundance of range or pasture, and simply keep away from all possibility of infection. Blackhead must come from either infected ground or infected turkeys. With clean range and no mature turkeys to carry infection, the disease need not be feared. Since we have no method of control that can be relied upon after the flock becomes infected, this method of avoiding blackhead, though it involves the daily care of the young turkeys, is likely to be the one that will insure the largest number of turkeys at marketing time.

Steiner[8] has the following to say in regard to preventing blackhead: "The only means of preventing the disease is by eliminating the possible sources of infection, which is practically impossible with the general methods used in raising turkeys. The disease, however, has been prevented, or at least controlled, on infected premises, by sanitation and hygiene; but to adapt such measures to turkeys necessitates at least partial or strict confinement. Contrary to general belief turkeys can be raised successfully without free range, as many of the largest breeders are now raising them in comparatively small pens or runs. They should be on high, well-drained land, that can be cleaned and occasionally plowed and replanted."

"The drinking vessels should be protected against contamination from the feet or droppings of the turkeys, and only clean water, preferably from a well or cistern, should be supplied. Water holes should not be allowed to form. Feed should be given in protected troughs, in which the turkeys cannot stand, or on a floor which can readily be cleaned; but never on the ground. Houses, together with feeding and watering utensils, should be disinfected frequently with a 5 per cent solution of creosote or any other strong disinfectant."

Wegeforth[9] states that he has shown that in turkeys experimentally infected by the feeding of viscera taken from a turkey succumbing to

blackhead, the disease can be prevented by either the oral administration of the fluid extract of ipecac or by the ingestion of the powdered drug with the food. Further, it can be said that the disease failed to make its appearance among the turkeys on a ranch which for several years previous had been visited by epidemics of the disease in a virulent form, the prevention being attributed to the prophylactic administration of ipecac with the food.

Graybill[10] states that during the season of 1920 a flock of turkeys reared in incubators and brooders and on new soil, has provided additional evidence that this method is a successful means of rearing turkeys. The ground on which the flock was reared was in a large, well fenced horse paddock which had not been used for turkeys or chickens for a period of more than three years. The soil was plowed and sown in the spring. The old turkeys and poultry were confined in enclosures at a distance from the paddock and precautions were taken to prevent attendants carrying infection from these to the flock in the paddock. As in previous field experiments no attempt was made to exclude wild birds.

Tyzzer[11] states that the presence of the protozoan in the egg of Heterakis is indicated by experimental evidence of various sorts.

"No. 1. Heterakis eggs kept in 1.5 per cent nitric acid until embryonated produce blackhead when fed to young birds isolated from other sources of infection, although this treatment renders the material bacteriologically sterile."

"No. 2. That there occurs no resistant phase of the blackhead protozoan apart from the worm egg, capable of resisting the 1.5 per cent acid, is shown by the invariably negative results obtained by the repeated feeding of susceptible birds with the discharges of blackhead carriers, after treatment in 1.5 per cent acid. Furthermore, no resistant form has been demonstrated microscopically."

"No. 3. Heterakis material will only produce blackhead after the ova have become embryonated and capable of hatching. Samples of the same material fed before the eggs are ripe invariably furnish negative results."

"No. 4. The feeding of male Heterakis also furnish only negative results although ova-containing females of the same lot produce blackhead."

"The disease usually follows the feeding of large numbers of Heterakis, especially when the latter are pooled from several different birds. However, it is occasionally possible to feed large numbers from a single bird without producing blackhead. H. vesicularis obtained from pheasants has also furnished only negative results, as well as that obtained from the goose."

"Morphological evidence of the presence of the blackhead flagellate in the ovum of Heterakis has not yet been obtained, although large numbers of eggs have been examined. However, the invasion of the tissue of the worm by the protozoan has been demonstrated in a number of instances, thus far in half-grown worms from cases of blackhead. It is not yet known whether the acute disease or the carrier state is the most favorable for the infection of the worm."

The preceding evidence is given because of the close relationship of blackhead, the cecal worms and the operation of cecal abligation for the prevention of blackhead.

Tyzzer[12] in an attempt to prevent blackhead infection in turkeys by the addition of an amebicide, Chaparro amargosa, to their daily ration, found that this procedure resulted in an almost complete disappearance of Entamoeba gallinarium, a nonpathogenic ameba commonly found in the ceca of the turkey. It failed, however, to prevent blackhead infection.

Tyzzer[13] used tartar emetic as a treatment and preventive, but found that it failed to prevent the development of the disease or its fatal termination. Large doses of quinine hydrochloride injected either into the veins or deep in the breast muscle also failed to check the course of the inoculated disease. Emetin hydrochloride given subcutaneously in large doses failed to prevent the development of the inoculated disease.

Tyzzer[14] found that powdered ipecac appears to have no deleterious effect on the blackhead organism in the tissues for it does not prevent the development of blackhead resulting from inoculation nor does it prevent the fatal termination of this form of the disease. One would not therefore expect it to have curative properties when used in natural blackhead. When administered prophylactically it had a definite effect in delaying the onset of the disease. Ipecac served only to temporarily prevent blackhead infection, for the treated turkeys eventually became infected and only one of ten recovered. Tyzzer states that the claims of Wegeforth with respect to both the prophylatic and curative properties of ipecac are thus disproved by his investigation. Sulphur in large doses appeared to retard infection although the number of turkeys employed was not sufficiently large to furnish conclusive results. Sulphur may be slightly unfavorable to Heterakis for in general the sulphur-treated turkeys showed fewer of these worms than the control birds. He suggests that the most helpful mode of attacking blackhead appears to be through measures tending to eliminate Heterakis. Such measures may be directed towards the isolation of the turkey or towards the destruction of the worm. It is possible that vermifuges administered at short intervals may prevent blackhead infection. Whether the administration of vermifuges

at intervals will either prevent or lessen the incidence of blackhead in young turkeys must be determined by further experimentation. For the present it appears to be the safer course to rely on isolation for the prevention of the introduction of Heterakis to young turkeys.

Tyzzer states that he has again shown that newly hatched turkeys do well in close confinement, and notwithstanding the sterilization of the food they may develop normally for at least a month.

Graybill[15] does not confirm the finding of Wegeforth in regard to ipecac as a preventive or cure for blackhead, though he states that the treatment may have some favorable effect in lowering the mortality.

Curtis[16] suggests that poults may be successfully reared to maturity on comparatively small areas; while doing so they pass with little or no loss through two marketable stages; the broiler and small roaster. The experiments show that turkeys should be reared away from the house, and that they should be kept from all fields where ordinary fowls are likely to forage.

Rettger's[17] report is based upon investigations commenced in the spring of 1915 and conducted each year since during the breeding and rearing season. His work shows that turkeys can be reared in successive years without serious losses from blackhead by the use of the rotation system. "This saving from blackhead may be due to a break in the cycle of development of a protozoan organism which may be the cause of this disease, or, what is more probable, to a partial cleansing of the ground during the intervals of rest, and restoration of grass and clover to the yards, and hence an ample supply of this growing green food. Whether the same results may be obtained by the use of only two rotation yards and a system of biweekly rotation, instead of weekly, has not been determined. Such a modification would be in the direction of added simplicity, but numerous experiments are necessary before it can be adopted without material risk."

"There can be little doubt that chickens and other barnyard fowl transmit blackhead disease, and that ground that has been and is occupied by them constitutes an immediate source of infection."

Tyzzer[18] in summarizing previous tests on various drugs for the purpose of preventing or curing blackhead has the following to say: "We have tested experimentally ipecac, tobacco dust, sulphur, and Mexican bitter bush for the prevention, and Bayer 205, emetin, tartar emetic, quinine and turpentine for the cure of blackhead, but have not found that they exert any marked effect on the infection. Large sublethal doses of some of the newer arsenical preparations have a definite beneficial action on turkeys afflicted with blackhead. Tryparsamide was found to be the least toxic and the most effective of these drugs, but owing

to the necessity of intravenous administration in carefully graded doses at the first appearance of symptoms and its high cost, its general employment is probably not feasible and is not recommended. This treatment has, however, been followed by recovery in about 66 per cent of the birds treated for blackhead between 2 and 4 months of age, but it is often necessary to repeat the injections at short intervals in order to accomplish a cure. Carriers, on the other hand, are readily freed of the blackhead parasite, a single large dose of tryparsamide, Bayer 205, or even turpentine, accomplishing this result."

Tyzzer further states that the control of blackhead is necessarily based upon the recognition of the chief sources of infection, i. e., common poultry and also land that has been ranged over or that has been fertilized with poultry manure. It is not known to what extent older turkeys carry the ameba of blackhead, but it is probably to a much less extent than is the case with common fowls, and caecal worms are much less prevalent in the former. Turkeys having blackhead may transmit the disease directly to others independently of the caecal worm, and should thus be removed from the flock. There are distinct advantages in incubator-hatching and artificial brooding of young turkeys. They may be reared in this way not only free from blackhead but also from vermin and most of the internal parasites. If the brooder quarters and outdoor runs are so constructed that the attendant cannot enter them, and clean food, sand, water, etc. be furnished, no blackhead should appear. It is important under these conditions to furnish an ample supply of finely cut green fodder, otherwise leg-weakness may appear. When the poults are from 8 to 10 weeks old, or when their quarters become unduly crowded, they may be moved to the cleanest available pasture to complete their growth. By this system, the poults require more care but one is repaid for this by freedom from early losses. In case one has uncontaminated land and no common poultry, these rigid requirements are unnecessary, although it is well never to let old stock upon ground to be utilized in rearing young turkeys. While there is no available evidence that any form of diet will either prevent or produce blackhead, unless through contamination it serves to introduce the blackhead organism, care should be taken both to supply only food of good quality and to avoid radical changes in the ration, otherwise serious digestive disturbances may appear that are readily mistaken for blackhead.

Eriksen[19], from experiments he conducted, was unable to show that neoarsphenamine is of decided value in the treatment of these protozoan diseases in poultry, either as a curative or prophylactic agent. The difficulty attending intravenous administration and the expense of the drug prohibits its practical use.

Billings[20] advocates and has used in Minnesota and other states for several years a plan of raising turkeys that successfully prevents blackhead and mentioned that it has been used many years in a small way by other investigators (Salmon[3], Higgins[4], Graybill[10], Curtis[16], Rettger[17], Tyzzer[12,24] etc.) This appears to be the most complete and successful plan for the professional turkey raiser that has yet been devised for the control of blackhead.

Van Es[21] recommends three things for the control of blackhead as follows: (1) the use of carefully cleansed turkey eggs for hatching in the incubator and keeping the poults for the necessary period in clean brooders; (2) avoiding contact between the poults and older turkeys, common fowls, and any other kind of poultry flock; and (3) keeping the poults in more or less spacious confinement on ground which for a period of not less than one or two years has not been used by poultry, and especially not by turkeys and chickens.

In reviewing the literature on the subject, the work bearing most directly on the investigation is described in preliminary reports and papers which have been published from time to time during the progress of this investigation. In the first of these[22] a surgical operation is described which apparently prevents blackhead. In the others[23, 24, 25] an account is given of the observed results.

CAUSE AND NATURE OF THE DISEASE

The protozoan parasite, Ameba meleagridis, is now generally regarded by poultry pathologists as being the cause of "Blackhead" or entero-hepatitis in turkeys. Under natural conditions the lesions characteristic of the disease are found in the cecal pouches and in the liver. In the studies carried on in the present investigation the pathological evidence indicates that the primary invasion of the ameba occurs in the cecal pouches where the fecal matters, which may be infested with the specific pathogenic protozoa, are held for a longer period than in other parts of the alimentary tract, thus favoring their migration through the mucosa into the mesenteric and portal blood streams and thence into the liver. Another factor favorable to the invasion of these amebae into the cecal circulation is the presence in the cecal pouches of an irritant parasitic worm (Heterakis papillosa) which produces wounds and inflammation of some extent in the mucous coat, and thus produces conditions that favor the local attack and the passage of the ameba. Practically all investigators are agreed that the primary invasion of the ameba occurs in the cecal pouches.

These considerations led to the opinion that if the cecal pouches could be removed or separated from the main gut by surgical operation,

with safety to the bird, the principal access of the ameba would thus be removed, and that a bird so treated would not contract the disease.

DEFINITION AND USE OF THE WORD ABLIGATION

The word abligation[22] has been selected as the most appropriate surgical term to describe the separation of the ceca from the main gut. It is not found in the medical dictionaries for the good reason perhaps that in both human and veterinary surgery such an operation on the alimentary viscera has never been attempted, or at least so rarely that a special name has not been applied. The word is not a newly coined word but a very old and almost obsolete English word of Latin origin which is here revived for appropriate use. The exact definition of the word abligate as given in the dictionary is "To tie up so as to hinder from." Abligation therefore will be used to indicate that the ceca have been separated in some manner from the main digestive tract, regardless of just how this may have been accomplished. More extended investigation and experimentation may show that other methods of operating are more feasible and are less hazardous than the present methods described, and a more appropriate term may be applied to the operation.

SITE OF OPERATION

Attempts to carry out the surgical features of the experiment were undertaken and entrance into the peritoneal cavity through various regions was tried. After the sacrifice of numbers of chickens and turkeys it was found that the most convenient site for the operation was on the left side between the last two ribs, the exact location for caponizing on that side. The point of junction of the two ceca with the large intestine is located opposite this site, and the parts to be operated upon are easily drawn upward through the incision in a convenient position for the operation. If this is done carefully but little hemorrhage will occur, as only a few small blood vessels will be ruptured.

METHOD OF OPERATING

It has been found possible to separate or disconnect the ceca from the main gut by three distinctly different operations. The first consists simply in ligating the two ceca near the point where they branch from the main intestine (true abligation). Ligature materials tried in this operation consisted of plain No. 4 catgut, chromatized catgut, silk ligatures, silk bands, linen ligatures, and narrow aluminum bands or clamps. The most suitable of these was found to be plain No. 4 catgut, using two ligations, 4 m.m. apart on each cecum; although one ligation of each cecum has been successfully accomplished, the two ligations more nearly assures one that the separation of the ceca from the main gut is accomplished.

In the second method each cecum is severed near the point where it branches from the main intestine. The stumps are then turned inward and the lumen closed by drawing the serous surfaces together with silk ligatures, using Lembert sutures.

In the third operation the ceca are extirpated and the lumen of each of the two intestinal stumps is closed as described in operation No. 2. It is necessary to make two incisions, one in the regular site for abligation between the last two ribs, and the other in the abdominal wall posterior to the left leg. This is a difficult and time-consuming operation since it is necessary to ligate the mesenteric blood vessels that supply the circulation to the ceca. The first incision is made between the last two ribs in the regular manner. The two ceca are severed near their divergence from the main gut, and the intestinal stumps turned inward and closed with Lembert sutures. A second entrance several inches long is then made in the abdominal wall posterior to the left leg. The two detached ceca are then removed through this incision. Each group of mesenteric blood vessels supplying the ceca is taken up and carefully ligated as they are encountered in removing the organs. Unless this is done fatal hemorrhage is likely to occur.

AGE AND PREPARATION OF BIRDS FOR OPERATION

Birds to be operated upon should have reached the age of 8 weeks. Depending on the age, all birds should be fasted from 24 hours to 2½ days before the operation, to have the digestive tract, including the ceca as free from food and fecal contents as possible.

It is considered best after operating to put the birds on a milk diet for four days, though our data do not show any particular advantage as far as outcome is concerned.

TECHNIC OF OPERATION

Instruments.—The instruments commonly used in the operation are shown in Fig. 2. They should be sterilized and proper asepsis observed, though complications seldom arise unless leakage from ligature wounds of the organs occurs.

Operation.—For the operation the bird is placed on its right side, the wings drawn forward and the feet drawn backward and fastened with cords. A few feathers are removed over the site for the operation. An incision an inch or longer is then made between the last two ribs and a caponizing spreader placed in the wound as in caponizing. With a caponizing hook the anterior wall of the left abdominal air sac is torn open, exposing the intestines. A curved probe is then passed under the main intestine at the point where the ceca branch from the former. The parts to be operated upon are easily drawn upward through the

wound to a convenient position for operating as already described. By means of a curved thread-carrier two ligatures 4 m.m. apart are then passed between the main intestine and one of the ceca where it branches. The cecum is tied off firmly with these two ligatures. Care should be taken to draw the ligature tight enough to effectually close the passage into the main gut and at the same time not tight enough to cut through the outer cecal coat. The same procedure is carried out upon the other cecum. The size of the suture will depend somewhat on the size of the bird to be operated upon. For adult birds, size No. 4 is most suitable.

After the operation is complete the organs are then gently replaced in the body cavity and the wound closed by one ligature. To accomplish this it is necessary to pass the ligature around the two adjacent ribs, since the intercostal muscle is not sufficiently strong to hold the ligature when this is passed through it. Drawing this ligature tight effectually closes the wound and practically eliminates the possibility of wind puffs, which under ordinary conditions occur as frequently as in caponizing One suture is put in to partially close the skin wound.

MORTALITY RATE FROM OPERATION

In none of these methods of operating as yet has it been possible to perfect a technic that reduces the mortality to a practical degree. The present data show that the mortality rate varies from 13.6 per cent to 60.3 per cent. The average mortality including the three methods of operating is approximately 47 per cent.

In the ligature method seventy-three birds were operated on, using one ligation on each cecum. Twenty-nine birds survived and forty-four died from the operation, a mortality rate of 61.3 per cent.

Where two ligations were used on each cecum, in a group of thirty-seven birds, thirty-two survived and five died from the operation, giving a mortality rate of only 13.6 per cent. Since a large per cent of the birds in this group were adults it is thought that this may account for the low mortality rate as compared to other methods.

Fourteen birds were abligated, using narrow aluminum bands or clamps. Six birds survived and eight succumbed to the operation, showing a mortality rate by this method of 57.2 per cent.

In the second method of operating, where the cecal neck is cut, twenty birds were operated on; eight survived and twelve died as a result of the operation, showing a mortality rate of 60 per cent. Again, the number of birds is small and the figures on mortality rate for that reason may be misleading.

Only five birds had their ceca extirpated. Four of the five survived the operation, showing a mortality rate of 20 per cent.

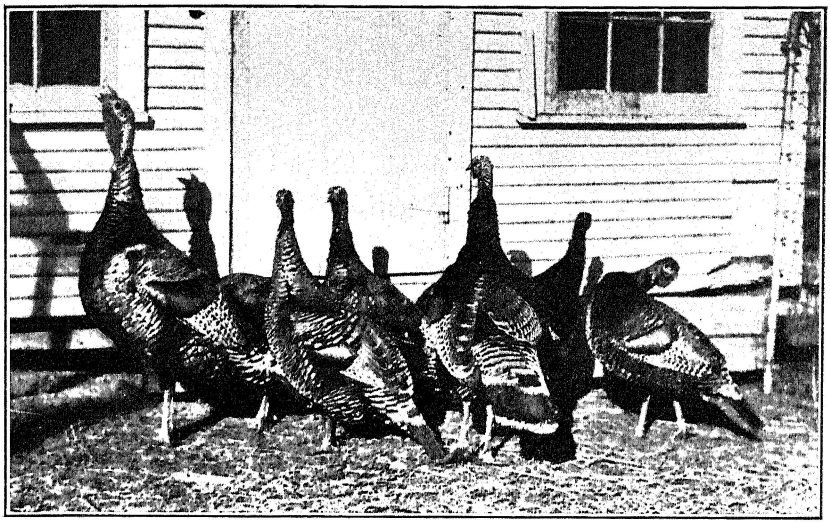

Fig. 1.—A breeding flock of purebred bronze turkeys that have been abligated 17 months.

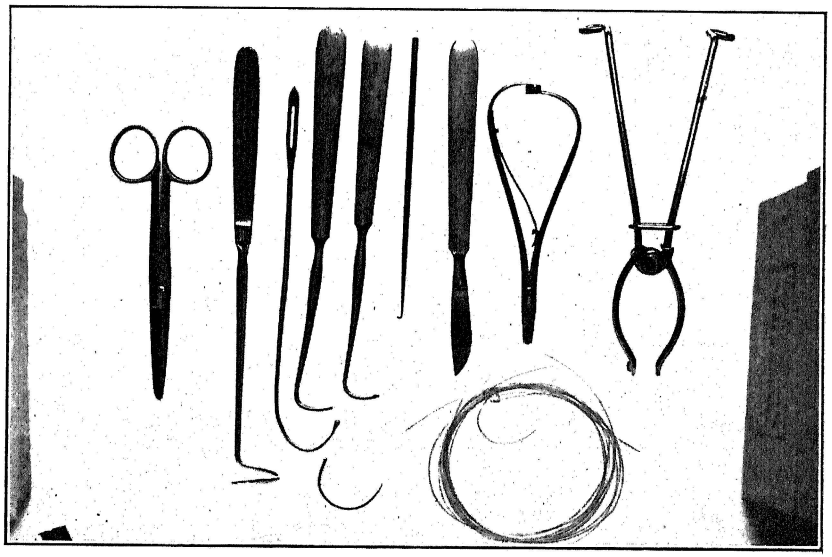

Fig. 2.—The instruments commonly used in the operation of cecal abligation.

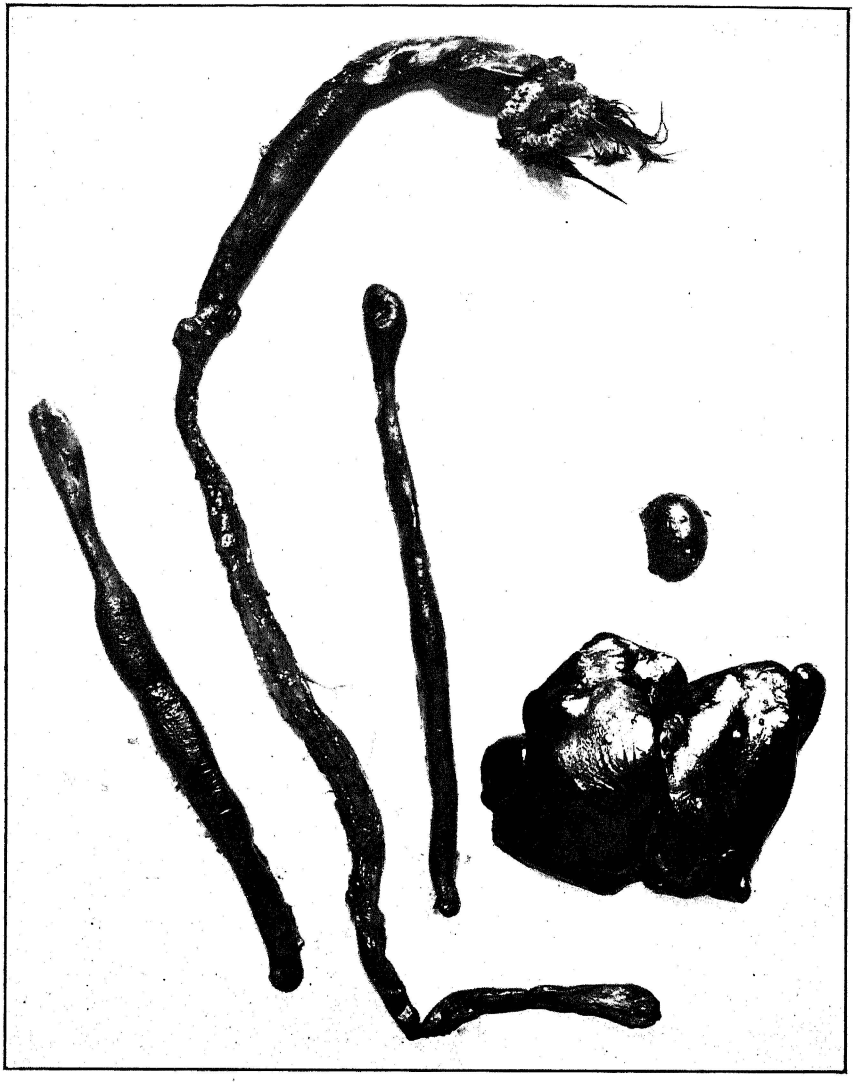

Fig. 3.—The organs of an abligated turkey, No. 1259, in which the ceca have made a proportionate growth with the rest of the intestine. (This bird died of generalized tuberculosis. Visible lesions are present in the liver and spleen.)

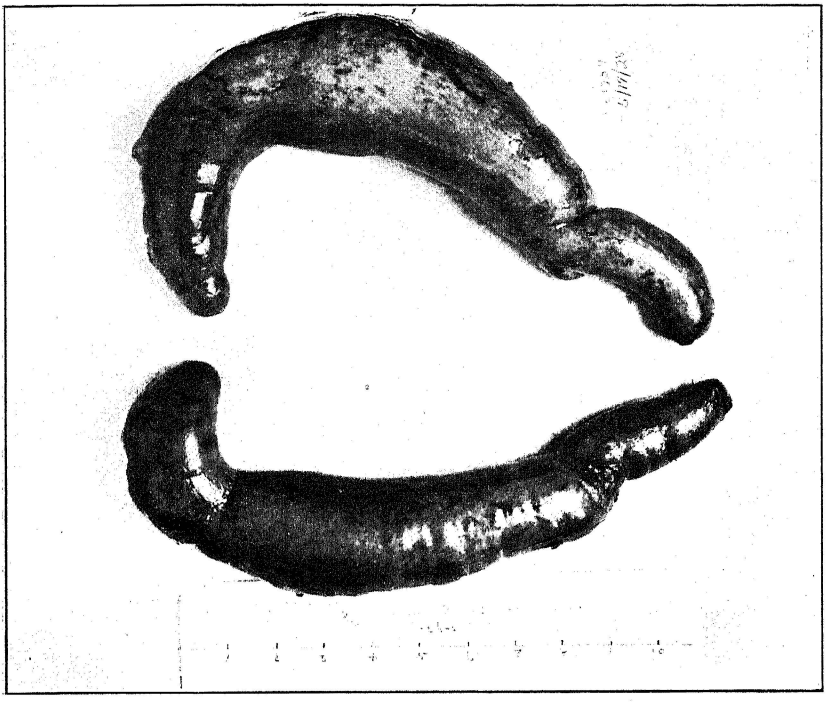

Fig. 4.—The two ceca of an abligated turkey showing typical enlargement as the result of the operation. The scale of inches above will show the extent of the abnormal growth.

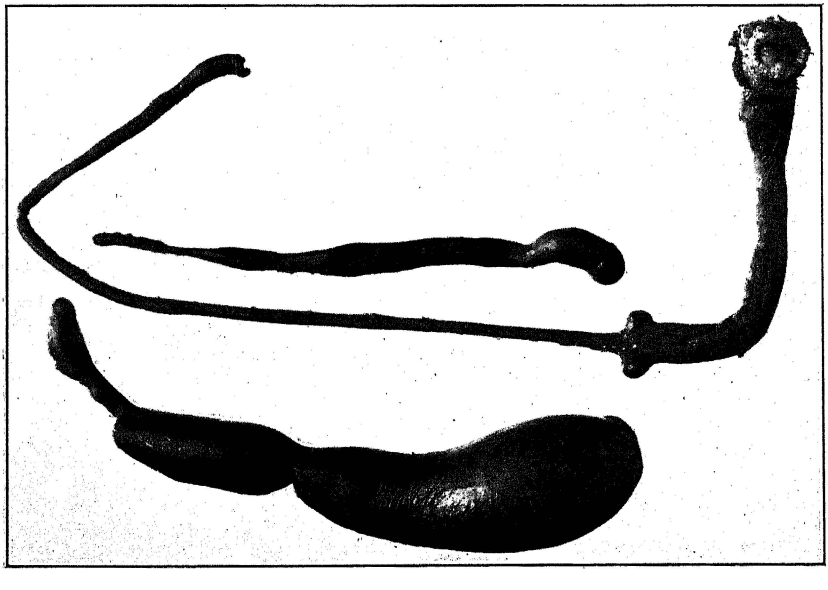

Fig. 5.—The organs of an abligated turkey in which there is enlargement only of one cecum. The other organ being normal in size.

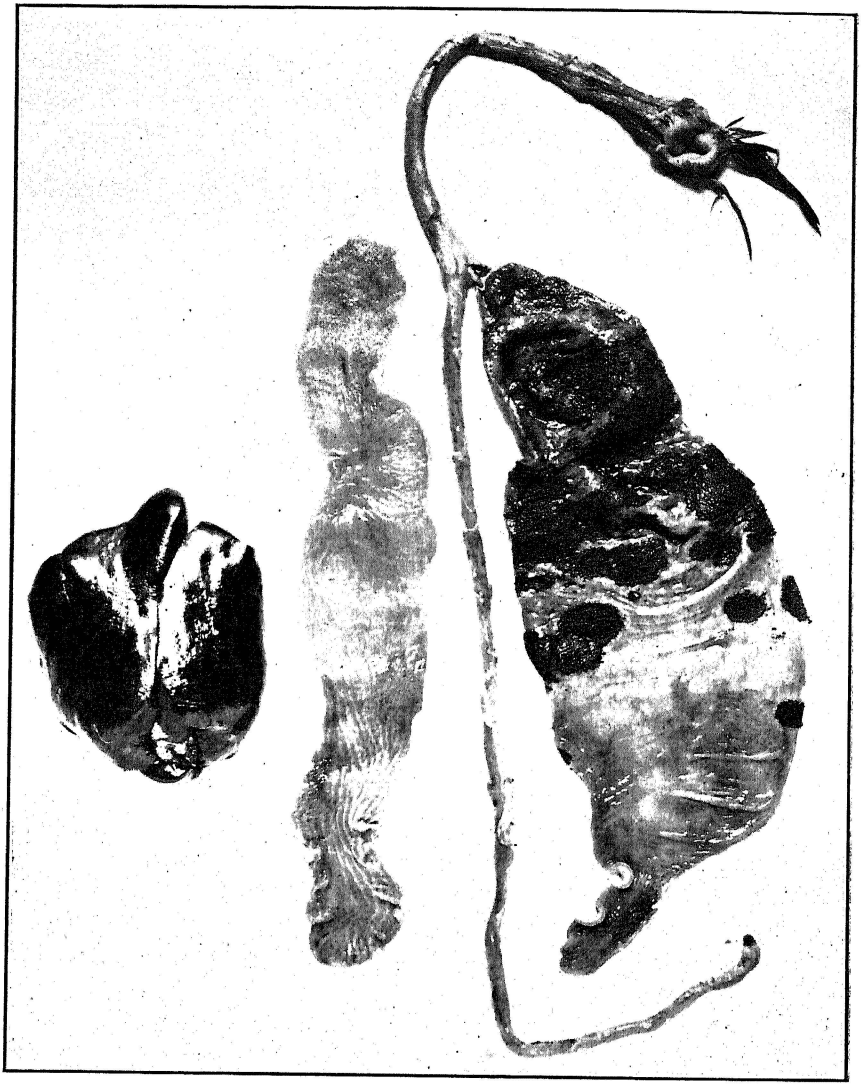

Fig. 6.—The organs of a partially abligated bird. One cecum is entirely abligated and healthy. The other cecum, which still communicates with the main gut through a very small opening, shows the characteristic ulcers of entero-hepatitis. The liver is also visibly affected with the disease.

CAUSE OF MORTALITY

The immediate cause of the high mortality from the operation is almost entirely due to the fact that the stumps at the point of the operation sometimes fail to seal over. This results in a "leak" from the main intestinal stumps or from the cecal stumps. The contents of the organs pour out into the peritoneal cavity, causing peritonitis and death in 5 to 10 days. If a "leak" does not occur the birds show very little evidence of sickness and are normal in appearance six days after the operation.

CHANGES PRODUCED IN THE CECA BY THE OPERATION

When the ceca are either ligated or cut off, as described, they do not become necrotic, since the blood supply, coming as it does through the mesentery, is not cut off. But the ligation ultimately effects a complete severance of the ceca from the main gut and the stumps produced by the ligature wounds heal over in most cases so perfectly as to prevent any leakage from the functional gut or from the detached ceca. They usually continue to live and grow in proportion to the other alimentary viscera and remain in the body cavity as free hanging sealed tubes, suspended by their mesenteric ligaments and slight cicatricial bands adhering to the surgical stumps. Fig. 3 shows the organs of an abligated turkey, No. 1259, in which the ceca have made a proportionate growth with the adjacent parts of the intestine. The mesentery and cicatricial bands have been dissected away in order to show more clearly the comparison. Turkey No. 1259 had been abligated for 18 months prior to the time when these organs were removed and photographed. Just why it is that some ceca remain normal in size after abligation and others become greatly enlarged (See Table No. 1.) is yet to be determined.

In case the ceca are not removed from the abdominal cavity, complications sometimes occur in 7 to 32 months after the operation. One or both ceca may become greatly enlarged and thickened. The organs may attain a length of 55 cm and a circumference of 17 cm and the walls will be 2 mm thick. The contents consist of a pasty mass resembling putty and considerable gas. The cause of these changes in the organs has not yet been determined. Fig. 4 shows two typically enlarged ceca.

In a group of twenty-six abligated birds on which complete data are available, it was found that eleven, or 42.3 per cent developed enlarged ceca. Two of the eleven birds had enlargement of only one cecum, the other organ being normal in size. Fig .5 illustrates this condition. Bacteriological examination by stained smears and cultures of the contents of these enlarged organs shows enormous numbers of B. coli communior in pure culture and it is the opinion that the activity of this organism

may be responsible for the enlargement and the formation of gas in the organs.

This is a problem for more extended research. If the activity of bacteria are responsible for the enlargement, some method of sterilization of the sealed organs at the time of operating may prevent this abnormal growth.

TABLE 1.—A GROUP OF ABLIGATED TURKEYS THAT DEVELOPED ENLARGEMENT OF THE CECA

No. of Bird	Abligated	Enlarged Ceca	Growth Period of Ceca
18 and 19	7-25-28	3-26-29	8 months
45	10- 5-27	3-26-29	17 months
58	11-25-27	5-24-29	17 months
77	12-31-27	5-28-29	16 months
1225	6- 9-26	2-11-29	32 months
1239	6-27-27	9- 7-29	26 months
1252	10- 7-26	10- 8-28	24 months
1254	6-25-27	10- 8-28	15 months
1256	9-23-26	4-22-29	28 months
1267	6-24-27	2-16-28	7 months
1273	6-24-27	10- 8-28	15 months

Table No. 1 shows a group of abligated birds which developed enlarged ceca. This group of 11, typical of birds developing enlargement of the ceca, shows a minimum period for the enlargement of seven months and a maximum of 32 months, the average being 18.6 months for the 11 birds. These birds either died as a result of the enlargement or were visibly distressed by the pressure produced by the enlarged organs at the end of the periods shown. Just when the enlargement begins has not been determined. One significant point in regard to the development of the enlarged ceca is that the majority of the birds shown in Table No. 1 did not develop enlargement of the ceca under one year so that as far as turkeys being raised for the Thanksgiving and Christmas markets are concerned the enlargement of the ceca would not be a problem. Only in two cases, No. 18 and 19, and No. 1267 did the birds develop enlarged ceca within a year. The average period of 18.6 months would carry them through the second year's market. The enlarged ceca would be a problem affecting abligated breeding birds which were to be retained for two years or more.

It has been demonstrated repeatedly that these enlarged organs may be successfully removed from the body cavity with a comparatively low mortality. Until the problem of enlargement is overcome it may be necessary to rely on this expedient in valuable breeding flocks which have been abligated for a year or more, if enlargement of the ceca occurs. This is a time-consuming operation, similar to the one described under

methods of operating where the ceca are extirpated, except that one incision is required instead of two. Since the organs are already separated from the main intestine, it is necessary only to make one incision posterior to the left leg. The operation, however, should be performed early enough so as to prevent post operative shock resulting from the removal of such large organs from the body cavity. Some valuable experimental birds used in these investigations have had their lives prolonged by this emergency operation.

UTILIZATION OF FOOD BY TURKEYS WITH ABLIGATED CECA

Since the ceca of turkeys are comparatively large double diverticula of the main digestive tract and would therefore appear to have an important nutritive function, it seemed desirable to ascertain whether the operation of cecal abligation has any effect on the coefficients of digestibility. If the ceca were found to be essential organs of digestion and absorption it can be readily seen that the progress of this investigation would be seriously hindered, since cecal abligation might retard proper body growth and functional activities of the abligated bird. Observations of birds subsequent to the operation have not shown any visible differences from non-abligated birds. Quoting from the aut hor's article in Veterinary Medicine[22] it is stated "As judged by the egg-laying capacity of the birds subsequent to the operation, the ceca do not appear to be essential organs of digestion or of absorption."

Two digestion trials were carried out in co-operation with the Animal Nutrition Department on abligated birds, and carefully selected controls. The technic of Halnan[26], with slight modifications, was used, and the calculations were made by Katayama's[27] method. The data indicate that the coefficients of digestibility are unaffected by abligation. The full results of these digestion trials will appear in a separate paper.

THE RESULTS OF THE APPLICATION OF CECAL ABLIGATION TO THE CONTROL OF ENTERO-HEPATITIS

The following discussion and tables relate to the control of entero-hepatitis by the use of cecal abligation. Other incidental data are included. As far as is possible the tables and data are arranged to show the comparative resistance of abligated and non-abligated turkeys of various ages.

Data on the comparison of the resistance to entero-hepatitis on abligated and non-abligated two year old turkeys are shown in table 2. These birds were part of a flock of 150 adults in which infection was present, as shown by an occasional case of entero-hepatitis developing. Fifteen of the birds were abligated and fifteen unabligated birds were used as controls. Both of these groups were exposed to infected grounds

TABLE 2.—A COMPARISON OF THE RESISTANCE TO ENTERO-HEPATITIS OF ABLIGATED AND NON-ABLIGATED TWO YEAR OLD TURKEYS

Group 1 Abligated

No. of Bird	Date Exposed	Results	Alive	No. Days Exposed
825	7-27-27	Healthy	2- 1-28	184
1288	7-28-27	Healthy	2- 1-28	183
861	8- 1-27	Healthy	2- 1-28	180
977	8- 1-27	Healthy	2- 1-28	180
885	8- 4-27	Healthy	2- 1-28	177
791	4-30-27	Healthy	2-26-29	596
901	4-30-27	Healthy	3-14-29	584
1204	4-30-27	Healthy	9-10-27	130
2833	4-20-27	Healthy	2-22-29	292
1218	7- 2-27	Healthy	10-27-27	115
838	5-14-27	Healthy	9-11-27	117
1282	6- 6-27	Healthy	2- 1-28	235
1213	4-30-27	Healthy	2- 1-28	210
2333	4-30-27	Healthy	2-22-29	652
819	4-30-27	Healthy	10-27-27	83
Average number of days exposed				261.2

Group 2 Not Abligated

No. of Bird	Date Exposed	Results	Alive	No. of Days Exposed
571	3- 3-27	Healthy	3-14-29	731
667	3-15-27	Healthy	10-25-28	560
874	3-15-27	Healthy	12-21-27	276
918	3-15-27	Healthy	2-20-28	335
665	3- 3-27	Healthy	5-23-27	80
851	3-15-27	Ent.-hep. 4-11-27		26
932	3- 3-27	Ent.-hep. 4-28-27		55
575	3-15-27	Ent.-hep. 4-28-27		43
1206	3-15-27	Ent.-hep. 5- 2-27		47
580	6- 1-26	Ent.-hep. 10-18-26		137
757	3-15-27	Ent.-hep. 10-27-27		222
560	3- 3-27	Ent.-hep. 4-18-27		45
997	4-28-27	Ent.-hep. 6-14-27		46
1227	1-12-27	Ent.-hep. 5-19-27		127
1207	3- 3-27	Ent.-hep. 4-26-27		53
Average number of days exposed				184.8

at approximately the same periods and the average periods of exposure of the two groups are approximately the same. The abligated group was exposed for a slightly longer average period (261.2 days) than the unabligated group (184.8 days).

A study of the abligated group shows that none of these birds developed evidence of entero-hepatitis during periods ranging from 83 to 652 days, while it will be seen that ten of the unabligated or control group contracted or died with entero-hepatitis during exposure periods varying from 26 to 222 days.

In this connection it should perhaps be pointed out that seven of the ten birds that contracted or died of entero-hepatitis all developed the disease within a period of from 26 to 55 days. This is a much shorter period of exposure than the shortest period shown in the abligated group. Five of the control group did not show visible signs of the disease during a period ranging from 80 to 731 days.

In a group of birds which have survived the disease for a period of two years a certain per cent is not likely to contract symptoms of entero-hepatitis, due to a natural immunity or to the fact that a very slight attack of the disease has rendered these impervious to infection.

It has been generally stated that twenty per cent of adults contract entero-hepatitis when exposed to infected grounds. The data shown in Table 2, Group 2, do not confirm this statement as sixty-six per cent of the fifteen control birds contracted entero-hepatitis.

Table 3 shows a flock of twenty-eight birds under six months of age which were raised in a brooder house until the beginning of this experiment. These birds were selected from Table 4, and are all approximately the same age. Thirteen were abligated and fifteen were used as controls. Both groups were exposed to the same infected grounds at approximately the same period.

None of the abligated group developed evidences of entero-hepatitis during a period ranging from 86 days to 912 days.

All but one (No. 1239) of the fifteen control birds contracted entero-hepatitis during a period ranging from 41 days to 242 days.

The average number of days of exposure of the abligated group is 556.5 days as compared to 144.8 days for the control group.

Moreover, six of the control group contracted the disease within a period ranging from 41 to 97 days, the average days of exposure for the six birds being 62.9. Six birds of the abligated group having the shortest period of exposure show an average of 305.6 days.

In Table 4 is shown all of the birds that have been completely abligated and those used as controls during the three-year period of this investigation, except the birds shown in Table 2 which are older. The data is arranged chronologically and a summary by years is shown in Table 5.

Forty-five birds were completely abligated and survived the operation during the three-year period, showing a minimum and maximum exposure period of 25 to 912 days respectively with an average exposure period of 327.4 days. All of these remained healthy, while 27 of 30 control birds contracted entero-hepatitis with an average exposure period of only 106.1 days during the same period.

It is of interest to note that of the 27 control birds contracting entero-hepatitis, 19 developed the disease within a period of less than 100

TABLE 3.—A COMPARISON OF THE RESISTANCE TO ENTERO-HEPATITIS OF ABLIGATED AND NON-ABLIGATED TURKEYS UNDER SIX MONTHS OF AGE

Group 1 Abligated

No. of Bird	Date Exposed	Results	Alive	No. Days Exposed
1255	9-23-26	Healthy	11-18-28	775
1268	9-23-26	Healthy	2- 0-28	487
1256	9-23-26	Healthy	4- 5-29	912
1249	10- 7-26	Healthy	4- 5-29	898
1252	10- 7-26	Healthy	10- 8-28	808
1257	10-22-26	Healthy	5-17-28	565
1270	1-27-27	Healthy	9-26-27	239
1272	2- 4-27	Healthy	4-30-27	86
1240	3- 3-27	Healthy	7- 8-27	125
1247	3- 3-27	Healthy	11- 5-28	602
1263	3-11-27	Healthy	4- 5-29	744
1269	3-11-27	Healthy	7-31-28	530
1254	6-25-27	Healthy	10- 9-28	464
Average Number Days Exposed				556.5

Group 2 Not Abligated

No. of Bird	Date Exposed	Results	Contracted Ent.-hep.	No. Days Exposed
1258	9-30-26	Ent.-hep.	5-27-27	237
1241	2-29-27	Ent.-hep.	5-19-27	50
1260	9-30-26	Ent.-hep.	4-30-27	210
1261	9-30-26	Ent.-hep.	2-27-27	147
1238	9-30-26	Ent.-hep.	2- 2-27	122
1246	9-30-26	Ent.-hep.	5-18-27	228
1248	9-30-26	Ent.-hep.	1-25-27	115
1271	9-30-26	Ent.-hep.	6- 2-27	242
1239	9-30-26	Healthy	Healthy	267
1267	2-20-27	Ent.-hep.	4-30-27	70
1273	2-20-27	Ent.-hep.	5-27-27	97
1245	2-20-27	Ent.-hep.	4-12-27	52
1250	2-20-27	Ent.-hep.	4- 1-27	41
1253	2-20-27	Ent.-hep.	6-13-27	73
1244	2-20-27	Ent.-hep.	9- 2-27	222
Average Number Days Exposed				144.8

days, while 35 of the 45 abligated birds were exposed without contracting the disease for over 100 days. Moreover, 5 of the abligated birds were exposed for periods ranging from 744 to 912 days without showing any evidences of entero-hepatitis.

From a study of Table 5 one might assume that cecal abligation is 100 per cent efficient in preventing entero-hepatitis in turkeys within the exposure periods represented. However, since it has been demonstrated repeatedly by Tyzzer and others that blackhead may be introduced artificially by other routes than the digestive tract it is possible

TABLE 4.—A COMPARISON OF THE RESISTANCE TO ENTERO-HEPATITIS OF ABLIGATED AND NON-ABLIGATED TURKEYS FOR THE THREE YEAR PERIOD

Group 1 Abligated

No. of Bird	Date Exposed	Results	Alive	No. of Days Exposed
D3406	6-21-26	Healthy	8- 1-26	40
1268	9-23-26	Healthy	2- 0-28	487
1255	9-23-26	Healthy	11-18-28	775
1256	9-23-26	Healthy	4- 5-29	912
1693	9-24-26	Healthy	11-15-26	51
1249	10- 7-26	Healthy	4- 5-29	898
1252	10- 7-26	Healthy	10- 8-28	808
D3487	10- 8-26	Healthy	11-17-26	39
1257	10-22-26	Healthy	5-17-28	565
1270	1-27-27	Healthy	9-26-27	239
1272	2- 4-27	Healthy	4-30-27	86
1240	3- 3-27	Healthy	7- 8-27	125
1247	3- 3-27	Healthy	11- 5-28	602
1263	3-11-27	Healthy	4- 5-29	744
1269	3-11-27	Healthy	7-31-28	530
1254	6-25-27	Healthy	10- 9-28	464
2217	7-14-27	Healthy	10-27-27	103
1042	8- 4-27	Healthy	10-27-27	83
36	9-22-27	Healthy	3-12-28	170
41	10- 3-27	Healthy	7-24-28	291
44	10- 5-27	Healthy	5-26-28	231
45	10- 5-27	Healthy	3-26-29	531
47	10- 5-27	Healthy	3-29-28	174
53	10-28-27	Healthy	2- 8-28	100
51	10-28-27	Healthy	1- 4-29	426
52	10-28-27	Healthy	9-13-28	315
54	10-28-27	Healthy	3-13-29	495
71	12-23-27	Healthy	3-13-29	380
58	11-25-27	Healthy	3-13-29	468
59	11-25-27	Healthy	3-13-29	468
x72	12-23-27	Healthy	1-18-28	25
75	12-30-27	Healthy	2- 6-29	369
77	12-31-27	Healthy	3- 9-29	428
89	1-27-28	Healthy	11-21-28	294
102	2- 3-28	Healthy	10- 5-28	242
101	3-30-28	Healthy	3-13-29	343
101	4- 7-28	Healthy	6- 3-28	56
109	5-16-28	Healthy	7-27-28	71
76	7- 4-28	Healthy	9- 4-28	60
80	7- 5-28	Healthy	3-12-29	247
78	7-10-28	Healthy	3-12-29	242
72	7-10-28	Healthy	3-12-29	242
73	7-12-28	Healthy	3-12-29	240
79	7-12-28	Healthy	8-18-28	36
18 & 19	7-25-28	Healthy	3-26-29	241
Average No. Days Exposed				327.4

TABLE 4 (CONTINUED)—A COMPANION OF THE RESISTANCE TO ENTERO-HEPATITIS OF NON-ABLIGATED TURKEYS FOR THE THREE YEAR PERIOD

Group 2 Not Abligated

No. of Bird	Date Exposed	Results	Alive	No. of Days Exposed
1258	9-30-26	Ent.-hep.	5-27-27	237
1260	9-30-26	Ent.-hep.	4-30-27	210
D3390	7-23-26	Healthy	9- 0-26	37
D3221	7-23-26	Ent.-hep.	5- 6-27	293
1261	9-30-26	Ent.-hep.	2-27-27	147
1238	9-30-26	Ent.-hep.	2- 2-27	122
1246	9-30-26	Ent.-hep.	5-18-27	228
1248	9-30-26	Ent.-hep.	1-25-27	115
1271	9-30-26	Ent.-hep.	6- 2-27	242
1239	9-30-26	Healthy	6-27-27	267
1267	2-20-27	Ent.-hep.	4-30-27	70
1273	2-20-27	Ent.-hep.	5-27-27	97
1244	2-20-27	Ent.-hep.	9- 2-27	222
1245	2-20-27	Ent.-hep.	4-12-27	52
1250	2-20-27	Ent.-hep.	4- 1-27	41
1253	2-20-27	Ent.-hep.	6-13-27	73
1241	2-29-27	Ent.-hep.	5-19-27	50
A96	6-30-28	Ent.-hep.	7-14-28	14
A97	6-30-28	Ent.-hep.	7-21-28	21
A98	6-30-28	Ent.-hep.	7-25-28	25
A99	6-30-28	Ent.-hep.	7-16-28	16
A103	6-30-28	Ent.-hep.	7-17-28	17
A105	6-30-28	Ent.-hep.	8- 1-28	31
A93	6-30-28	Ent.-hep.	10- 8-28	98
A94	6-30-28	Ent.-hep.	10- 8-28	98
A95	6-30-28	Ent.-hep.	9-10-28	70
16 & 17	7-31-28	Healthy	3-11-29	220
C	9- 8-28	Ent.-hep.	10-10-28	32
11	10-24-28	Ent.-hep.	11-19-28	25
68	10-24-28	Ent.-hep.	11-27-28	13
Average No. Days Exposed				106.1

that under severe conditions of exposure to a more virulent type of infection or by accidental infection parenterally, that an occasional case of entero-hepatitis may occur in abligated turkeys. It would appear from these data, however, that cases of this nature would be of rare occurrence. This opinion is further strengthened by the fact that during the entire three-year period of this investigation in no instance has a turkey that was completely abligated shown any evidence of blackhead. These observations extend not only to our experimental birds but to turkeys on farms where the poultrymen have attempted the practical application of the operation for the control of this disease.

In Table 6 is shown a group of twelve partially abligated and nine unabligated birds. The birds for this table were selected because their exposure dates are approximately the same. All of the birds in both

TABLE 5.—SUMMARY OF TABLE 4 BY YEARS SHOWING A COMPARISON OF THE RESISTANCE TO ENTERO-HEPATITIS OF ABLIGATED AND NON-ABLIGATED TURKEYS

Group 1 Abligated

Year	No. Birds	No. Days Exposed			Healthy	Ent.-hep.
		Min.	Max.	Average		
1926	9	39	912	508.3	9	0
1927	24	25	744	326.9	24	0
1928	12	36	343	192.8	12	0
Totals	45	Avr. 33.3	Avr. 666.3	342.6	45	0

Group 2 Not Abligated

Year	No. Birds	No. Days Exposed			Healthy	Ent.-hep.
		Min.	Max.	Average		
1926	10	37	293	189.8	2	8
1927	7	41	222	83.5	0	7
1928	13	14	220	52.3	1	12
Totals	30	Avr. 30	Avr. 245	108.5	3	27

groups developed entero-hepatitis at varying periods, as shown by the table.

The partially abligated birds contracted the disease within an average period of 290.4 days, whereas the unabligated group contracted the disease within an average period of only 141.1 days.

Assuming that the infection enters the tissues only through the portals of the two ceca, such results as obtained from Table 5 might be expected, since in a partially abligated bird, one in which only one cecum was communicating with the main gut or one in which both ceca were constricted but communicating, there would be less opportunity for the parasite to enter these susceptible organs.

It will be noted from the dates given in the table that all but one of the partially abligated group were operated on in 1926. Improvement of the operation since then has eliminated or prevented the occurrence of partially abligated birds. Fig. 6 shows a picture of the organs of a partially abligated bird. One cecum is entirely abligated and healthy, the other is greatly constricted but connected to the main gut by a very small lumen, and is badly affected with entero-hepatitis. The two ceca have been slit open in order to show the healthy and diseased mucous

TABLE 6.—A COMPARISON OF THE RESISTANCE TO ENTERO-HEPATITIS OF PARTIALLY ABLIGATED AND NON-ABLIGATED TURKEYS

Partially Abligated					Not Abligated				
No. of Bird	Sex	Date Exposed	Days Exposed	Contracted Ent.-hep.	No. of Bird	Sex	Date Exposed	Days Exposed	Contracted Ent.-hep.
1272	F.	3-11-27	49	4-30-27	1258	F.	9-30-26	237	5-27-27
1243	M.	9-24-26	262	5-16-27	1261	M.	9-30-26	147	2-27-27
1265	F.	3- 3-27	204	9-17-27	1267	F.	2-20-27	70	4-30-27
1275	F.	10-22-26	211	5-23-27	1238	M.	9-30-26	122	2- 2-27
557	F.	3-21-26	489	8- 0-27	1241	F.	2-29-27	50	5-19-27
636	M.	6-28-26	696	4-22-28	1260	M.	9-30-26	210	4-30-27
1259	M.	10- 0-26	554	6-24-27	851	F.	3-15-27	26	4-11-27
108	M.	5-12-28	313	3-25-29	1248	M.	9-30-26	115	1-25-27
D2656	M.	6-15-26	150	1-28-27	D3221	F.	7-23-26	293	5- 6-27
W654	F.	6-28-26	306	4-30-27	Av. No. Days Exposed			141.1	
781	F.	6-28-26	59	8-26-26					
1233	M.	7-23-26	192	2- 0-27					
Av. No. Days Exposed			290.4						

surfaces respectively of the two organs. Another point of interest in connection with this photograph is that it will be seen that the lesions in the communicating cecum are all located near the constricted outlet of the organ. Ulcers under natural conditions never or rarely affect the ceca in this location. It is probable that the abligation and resulting constriction so reduced the movement of the invading protozoa that the infection was not carried the usual distance into the susceptible organs before gaining access into the mucous surface and producing typical ulcers.

DISCUSSION

During the three year period of this investigation 340 birds have been operated upon. This includes not only the turkeys upon which the data of this paper are based but also field cases where farmers have attempted the practical application of cecal abligation to the control of blackhead or entero-hepatitis in turkeys. Approximately 146 of the 340 survived the operation.

The data presented in this bulletin seem to show conclusively that separating the ceca from the main digestive tract effectively prevents entero-hepatitis in turkeys even under severe conditions of natural exposure for comparatively long periods.

There are many problems in connection with these investigations yet to be solved, two of which at this time render the application of this discovery to the control of the disease somewhat impractical. The first of these is that the mortality rate from cecal abligation is too high. The second, that a large per cent of abligated birds develop enlarged ceca

within periods ranging from 7 to 32 months after the operation is performed. When these two difficulties have been overcome, it is believed that the use of this operation will become a general practice on farms where the poultryman desires to raise from 100 to 200 turkeys in conjunction with other farm poultry. What bearing the operation may have on other diseases of turkeys or on poultry in general is yet to be determined.

It is evident from comparative studies briefly described in this bulletin and to be published in detail elsewhere, that the separation of the two ceca from the main digestive tract does not impair the digestion and utilization of food by the abligated birds.

SUMMARY

1. The ceca may be separated from the main gut by three distinctly different operations.

(a) By ligating the two ceca near the point where they branch from the main intestine (true abligation).

(b) Each cecum is bisected near the point where it branches from the main intestine. The stumps are then turned inward and the lumen of each closed with Lembert sutures.

(c) The ceca are extirpated and the lumen of each of the two intestinal stumps are closed as described in (b).

2. Cecal abligation was designated as the most appropriate term for the operation described.

3. Mortality from the operation varies from 13.6 per cent to 60.3 per cent, the average being 47 per cent.

4. Immediate cause of the mortality is due to the fact that the stumps at the point of the operation fail to seal over and a "leak" results causing peritonitis.

5. The operation permanently separates the ceca from the main gut, but does not retard their growth and development. In approximately 42 per cent of cases the ceca become greatly enlarged in 7 to 32 months after they are separated from the main digestive tract. The cause of this has not been determined, though B. coli communior isolated in pure culture from the contents of the enlarged organs may have some etiological relation.

6. The utilization of food by abligated turkeys is the same as for unabligated birds.

7. During the three-year period 60 birds were completely abligated and exposed with 45 controls unabligated. The 60 abligated birds all remained healthy, while 37 of the 45 controls contracted the disease.

8. The partially abligated birds were more than twice as resistant to entero-hepatitis as unabligated birds.

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