OBSERVATIONS ON A SEVERE OUTBREAK OF MYCOSIS IN CHICKS

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INTRODUCTION

During the summer of 1931 the writer was called upon to investigate losses of chicks in a Connecticut hatchery that amounted to approximately 10,000 out of 50,000 hatched during the season, or about 20 per cent. This hatchery specialized in Single Comb White Leghorn pedigreed stock, and was in the process of eradicating pullorum disease according to the Connecticut official plan.

At first an unusual outbreak of bacillary white diarrhea was suspected, but detailed bacteriological examination of 45 chicks failed to reveal infection from this source. On further study the condition was found to be characterized by whitish lesions in the crop and by the presence of yeastlike fungi in the digestive tract. The disease was finally determined to be thrush, muguet (French), or Soorkrankheit (German).

LITERATURE

According to Kaupp, chickens and turkeys affected with thrush, aphtha, or sore mouth appear dull and emaciated and often die in convulsions. The mucous lining of the mouth and esophagus shows whitish or brownish-yellow adherent deposits consisting of microscopic hyphae and oval spores of Oidium (Saccharomyces) albicans. Van Heelsbergen calls the disease oidiomycosis, and describes it as an affection of the mucous membrane of the mouth, fauces, esophagus, crop, stomach, and small intestine of birds, mammals, and man. Young chickens, pigeons, geese, and turkeys appear to be especially susceptible. However, according to Lahaye, as quoted by Van Heelsbergen, thrushlike affections in pigeons are often caused by fowl-pox virus. In the description of stomatitis oidica of birds, Hutyr and Marek quote Schlegel who observed cases in which the mouth cavity showed only discoloration, while the glandular stomach and gizzard revealed true thrush mycosis or ulcerlike foci.

On the whole, a study of the available literature leaves the impression that the disease is of epidemiological importance in pigeons but not in chickens.

The disease reported here appears to be different from the mycosis of birds described by Staub and Truche, for in the writer's cases the

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1 Received for publication Apr. 11, 1932, issued February, 1933.
3 HEELSBERGEN, T. VAN. HANDBUCH DER GEFLÜGELKRANKHEITEN UND DER GEFLÜGELZUCHT. 608 p., illus. Stuttgart. 1929.

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heart, liver, and peritoneum did not show the typical whitish films. It likewise differed from mycosis of turkeys, said by some to be identical with oidiomycosis of chickens. The writer has found the former disease to be characterized by yellow, conical, slightly curved processes with a hemorrhagic areola. These young lesions may become confluent and form extensive ulcers in the crop, esophagus, and glandular stomach. Such pathological manifestations, aside from the unknown etiology of mycosis in turkeys, constitute, in the writer's opinion, a distinction between thrushlike affections of turkeys and chickens.

**EPIDEMOLOGY**

The plant in which the present observations were carried out was situated on a well-drained hilly plateau and spread out over considerable territory. Brooding was carried on in 9 by 12 foot colony houses which were kept rather warm during the summer. The disease first appeared in the second or third hatch of the season, during the middle of April, increased in intensity during June and July, and disappeared at the end of August.

Clinical symptoms appeared from six to seven days after hatching and consisted of dullness, listlessness, huddling together, and marked roughness of the feathers. Gaping and diarrhea were not noticed as flock symptoms. Mortality started almost simultaneously with the appearance of clinical evidence, and reached a peak about the tenth day and again about the thirty-first day after hatching. Chicks that reached the age of 60 days had apparently recovered from the disease and developed into normal birds.

Daily records were kept of the mortality in 10 colony houses having a population of 4,919 chicks. From these records the total daily mortality was computed in terms of percentage and the data plotted as shown in Figure 1. For comparison, a corresponding line was plotted, based on a normally expected mortality of 15 per cent during the first 60 days after hatching. This latter figure was taken as the high average of a 3-year chick-mortality survey carried out in Connecticut.

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The mortality in the 10 colony houses under observation varied considerably, as is shown in Figure 2. The thin lines represent individual colony houses, the numbers indicating the population. The heavily stocked colony houses appear to have suffered most, and overcrowding may therefore be considered a factor in the spread of the disease. The thick line represents a total average mortality of 63 per cent.

During the ravages of the disease various changes in management were made in an attempt to check the losses. The results are shown in Table 1.

Table 1.—Comparison of loss of chicks reared under different conditions

<table>
<thead>
<tr>
<th>Point of comparison</th>
<th>Condition of rearing</th>
<th>Number of chicks</th>
<th>Number died</th>
<th>Per cent of loss during first 60 days of life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eggs and incubators</td>
<td>Native eggs hatched in native incubators</td>
<td>3,858</td>
<td>2,606</td>
<td>67.5</td>
</tr>
<tr>
<td></td>
<td>Native eggs hatched in foreign incubators</td>
<td>790</td>
<td>424</td>
<td>55.8</td>
</tr>
<tr>
<td></td>
<td>Foreign eggs hatched in foreign incubators</td>
<td>302</td>
<td>96</td>
<td>32.8</td>
</tr>
<tr>
<td>Sanitation in colony house</td>
<td>Chicks in colony house cleaned once a week</td>
<td>559</td>
<td>514</td>
<td>91.8</td>
</tr>
<tr>
<td></td>
<td>Chicks in colony house cleaned once a day</td>
<td>588</td>
<td>243</td>
<td>41.3</td>
</tr>
<tr>
<td></td>
<td>Chicks in colony house on wire floors</td>
<td>482</td>
<td>202</td>
<td>41.9</td>
</tr>
</tbody>
</table>

*Native = on the original hatchery plant; foreign = away from the original hatchery plant.

It will be seen that a change in incubators brought about a slight decrease in mortality, but certainly not enough for all the losses to be attributed to incubation. Even chicks from an entirely different
source became affected by the disease when brought to the premises, suffered a loss of 32.8 per cent. Neither a daily cleaning of the colony houses nor the use of wire floors was very effective in controlling the disease, for the losses under strictly sanitary conditions amounted to 41.9 per cent.

The total actual mortality in this outbreak can only be estimated, since about 90 per cent of the total output of 50,000 was sold as day-old chicks. According to the original owner, the purchasers reported losses aggregating 6,000, under circumstances very closely resembling those observed on the home plant. While there is no direct evidence that all of these 6,000 chicks died from the same cause, the writer found the characteristic lesions of thrush in the organs of five abnormal chicks selected at random from a group that had been purchased from the home plant. The losses were reported principally by buyers of large lots; the buyers of small lots, or rather those who brooded the chicks in small flocks or batteries, apparently had better luck. The widespread reports of losses would indicate that feeding methods, which were known to be quite varied among the owners, could not be considered an important factor in the trouble.

**PATHOLOGY**

In a study of the disease it was surprising to find that gross lesions in chicks from 2 to 3 weeks old were often so small as not to be easily distinguishable. In older chicks gross lesions tend to become localized in the crop and are readily recognized. In 120 field cases recorded, 84 showed lesions in the crop, 29 in the proventriculus, 53 in the gizzard, 6 in the liver, and 44 in the gall bladder; in 12 field cases no macroscopic lesions were observed.

In very young chicks the gross lesions in the crop consisted of pinhead-sized whitish nodules, and in older chicks of circular whitish ulcerlike patches (fig. 3, A) ranging in diameter from 1 to 5 mm., or of grayish-white pseudomembranes often forming a ridge along the folds (fig. 3, B). Very often only loose necrotic material with no apparent injury to the underlying tissue was found. As a rule, the unopened crop appeared tympanitic on palpation.

A microscopic examination of the crop showed extensive destruction of the stratified epithelium deep in the Malpighian layer (fig. 3, C), and quite often walled-off ulcers (fig. 3, D) or extensive diphtheroid to diphtheritic membranes. The lesions were characterized by the absence of inflammatory reaction.

The proventricular wall appeared at times diffusely swollen, or exhibited whitish, opaque, circular areas on the serous surface. The mucous surface was covered with brownish or mucoid exudate. Under the microscope necrotic lesions were seen in the epithelium of the superficial glands and in the centers of small lymph nodes. (Fig. 4, A and B.)

The corneous lining of the gizzard frequently revealed ulcers (fig. 4, C), especially in the cardiac region (fig. 4, D), or old hemorrhages which were visible by transmitted light (fig. 4, E). The true mucous membrane of the gizzard had usually lost its normal glossiness and appeared opaque and grayish white, or it showed whitish shallow ulcers. On microscopic examination, the ulcers in the lining were found to consist mostly of craters in the tissue, with little cellular reaction around them.
In the majority of cases the liver was normal, although occasionally whitish pinhead-sized nodules or small hemorrhagic infarcts were seen. Sections of some livers which appeared normal to the naked eye showed, under the microscope, periportal focal necrosis. (Fig. 5, A.) The gall bladder was often enlarged and the bile thickened. The duodenum appeared congested and hemorrhagic, and the caecal contents foamy. In some instances the caeca contained large numbers of a protozoan which morphologically resembled *Trichomonas*.
Figure 4.—A, Section of proventriculus No. 1732, showing necrosis of epithelium of superficial glands, X 70; B, section of proventriculus No. 1721, showing focal necrosis of lymph nodule, X 70; C, Inverted gizzard No. 1598, showing superficial ulcer in corneous lining, X 2; D, Inverted gizzard No. 1673, showing circular ulcers at cardia, X 2; E, Corneous lining of gizzard No. 1772, photographed by transmitted light, and showing old hemorrhages and whitish, shallow ulcers, X 1.5.
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etberthi; occasionally they contained hemorrhagic cores which were probably due to an intercurrent infection with Eimeria tennella. The kidneys often appeared pale and slightly tumefied. The ureters were distended.

ETIOLOGY

In the literature the statement is frequently made that hyphae can be demonstrated readily in scrapings of lesions. In the present study mycelial threads were found infrequently, but spores could be seen, although recognition of them as such was attended with some difficulty.

Since cultural studies on routine laboratory media were inconclusive, the use of Sabouraud agar was resorted to. From 64 field cases that were cultured yeastlike fungi were isolated in 54 instances from various organs, such as the crop, proventriculus, gizzard lining, true mucous membrane of the gizzard, the liver, gall bladder, and intestine. As a rule, only one type of organism was isolated from any one organ.

The types of yeastlike fungi isolated fall into three main groups, according to their growth characteristics on Sabouraud agar. The first type, which was isolated 38 times, produced a dry, whitish, high convex colony, consisting of spherical conidia with little or no mycelial structures in young cultures. This organism produced general infection in rabbits, on intravenous injection, and according to Benham resembled Monilia albicans. The second type, which was isolated 16 times, developed a rough, feathery, adherent colony, consisting of thick mycelium and spores. It was not pathogenic to rabbits and resembled Oidium lactis. The third type, isolated fifteen times, produced a smooth, grayish, flat colony, consisting of small elliptical conidia. It was not pathogenic to rabbits and resembled Monilia krusei.

In an effort to reproduce the disease by artificial infection, tests were made with 52 chicks ranging in age from 3 to 22 days. Five chicks were fed with a composite fecal specimen from field cases. Four of the chicks succumbed to the infection. (Table 2.) All showed typical lesions in the crop (fig. 5, B) and one of them in the mouth, also. This was the only mouth lesion seen during the outbreak. Monilia albicans was isolated from the principal lesions. This experiment proved rather conclusively that droppings from diseased birds are infectious and that M. albicans must be considered the principal cause of the disorder. To test the pathogenicity of pure cultures, 47 of the 52 chicks were injected in different ways. M. albicans was found to be highly pathogenic, Oidium lactis much less so, and M. krusei was apparently not harmful under experimental conditions. (Table 2.)

The method of administration, whether oral, subcutaneous, intravenous, or intraperitoneal, did not seem to be of particular importance in the demonstration of pathogenicity, but the age of the chick appeared to be a definite factor, chicks from 1 to 2 weeks old being most susceptible.


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In these experiments the time from artificial infection to death ranged from 10 to 45 days, the average being 31 days. It should be kept in mind, however, that these experiments took into account only actual mortality and not morbidity, which is known from field observations to be always considerably higher.

In a further study of the mode of transmission of the disease 100 eggs were hatched in sterilized incubators and the chicks reared in
sterilized battery brooders. In the crops of four of these chicks characteristic lesions of thrush were found and *Monilia albicans* isolated from them. Some of the hens from the poultry plant suffered from an extremely moist type of vent gleet, and a mycological examination of lesions from these birds yielded fungi of the *M. albicans* type.

**Table 2.—Results of experimental feedings of or injections with infectious material**

<table>
<thead>
<tr>
<th>Infectious material</th>
<th>Number of chicks infected</th>
<th>Fatal cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feces</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Pure cultures resembling—</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Monilia albicans</em></td>
<td>16</td>
<td>11</td>
</tr>
<tr>
<td><em>Oidium lactis</em></td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td><em>Monilia krusei</em></td>
<td>15</td>
<td>0</td>
</tr>
</tbody>
</table>

As a final link in the evidence of the etiological relationship of yeastlike fungi to the disease outbreak, mycelial structures (figs. 3, C, and 5, C), or clusters of spores (fig. 5, D), were often demonstrated in microscopic sections of the organs.

**DISCUSSION AND SUMMARY**

Losses totaling 10,000 chicks were observed in a commercial hatchery of 50,000 chicks that were less than 60 days old. The average loss in the home plant was 63 per cent, and in the chicks that were sold as day old, 13 per cent. The morbidity was much higher, according to the clinical appearance of the flocks. The chicks that survived made good recovery, and 60 days after hatching had developed into normal birds. Losses were smaller when brooding was carried out in small lots or batteries; change in feed and rigid sanitary precautions were not very effective as control measures.

The diseased condition was characterized by whitish ulcers or pseudomembranes in the crop, brownish or mucoid deposits in the proventriculus, and ulcers in the gizzard. The lesions in small chicks were often so small as to be easily overlooked.

On mycological examination yeastlike fungi were isolated from the crop, proventriculus, gizzard, gall bladder, and intestine. The predominating organism was a yeastlike fungus resembling *Monilia albicans*; the other observed types resembled *Oidium lactis* and *M. krusei*.

The diseased condition was reproduced by feeding fecal material from diseased chicks and by injecting fungus cultures of the *Monilia albicans* type. In two instances artificially infected chicks succumbed with the *Oidium lactis* type. Infection experiments conducted on small lots of chicks were not uniformly successful, a point readily understood when field observations of small-lot brooding are considered. The average period of incubation under experimental conditions was 31 days, a period that closely coincided with the second mortality peak under field conditions. The second mortality peak may, therefore, have been due to postnatal infection.

The disease may appear in septicaemic form, as was indicated by the isolation of virulent fungi from the liver and gall bladder; how-
ever, the extreme virulence of the infection in very young chicks, together with the slight pathological changes that occurred and the occasional presence of focal necrosis in the liver, suggests a toxemic action of the fungi.

Day-old chicks from the hatchery developed the disease after they had been removed from the original premises. Chicks raised on wire floors in a new, isolated colony house suffered 41.9 per cent losses. The first and highest mortality peak occurred about the tenth day after hatching; the average incubation period under experimental conditions was 31 days. The cloaca of laying hens affected with a moist type of vent gleet was shown to carry yeastlike fungi. When eggs from the plant were hatched in a sterilized incubator and the chicks reared in sterilized battery brooders, the disease appeared in only a few instances. These data furnish circumstantial evidence that the disease can be transmitted through the agency of the egg, presumably on the egg.

The fact that the owner found that brooding in batteries was safer than in colony houses, and the writer’s observation that only relatively small numbers of chicks succumbed to experimental infection, suggest that management may play a part in the postnatal spread of the disease.

According to available information, this report of a severe outbreak of thrush or mycosis in chicks is the first in which the disease has been shown to be of major epidemiological importance.