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Bobwhite, *Colinus virginianus,* as Host for *Heterakis* and *Histomonas*

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Abstract

Bobwhites were experimentally infected with *Histomonas meleagridis* and *Heterakis gallinarum*. Chickens and turkeys were similarly infected for comparison. Although the bobwhites were nearly as susceptible to *Histomonas* infections as were New Hampshire chickens, and more susceptible to tissue invasion, clinical histomoniasis was much less severe than in young turkeys. The bobwhites were poor hosts for *Heterakis,* whether *Histomonas* was also present or not. Thus, it appears that bobwhites are relatively unimportant in contaminating soil with *Histomonas*-bearing *Heterakis* eggs.

Introduction

Histomoniasis, also called blackhead or infectious enterohepatitis, is an important protozoan disease in many species of gallinaceous birds. The causal agent, *Histomonas meleagridis,* is transmitted through the eggs of the common cecal worm, *Heterakis gallinarum.* The bird may ingest these directly from the soil. More commonly, however, the embryonated eggs are ingested by an earthworm, in which the eggs hatch and the emerging larvae enter the tissues or the coelomic cavity. They are then acquired by the bird that consumes the earthworm.

Some gallinaceous birds, exemplified by the turkey, are usually quite susceptible to histomoniasis. In turn, they develop severe ulceration of one or both ceca, secondary involvement of the liver, and quite frequently death. In other species, such as chickens of several breeds, the disease runs a milder course, with rapid repair of cecal damage. Liver involvement is uncommon and mortality infrequent or rare. However, such birds may produce histomonads in profusion, and void many mature *Heterakis gallinarum* that contain eggs carrying the protozoan.[7] In still other galliform birds, such as the Japanese quail, *Coturnix coturnix japonica,* the disease is unimportant. This quail neither succumbs nor voids sufficient numbers of infectious stages of the parasites to be significant in spreading histomoniasis to more susceptible birds.[10]

As early as 1919 Tyzzer[11] reported blackhead "in a number of quail, *Colinus virginianus.*" He later added that "they appear to be somewhat more resistant than grouse."[12] Cram *et al.,* in 1932, referring to birds 1-3 months old, stated: "In the quail, death often results before infection has spread to the liver," but

described an instance of liver involvement in a bird 9 months old.[3] In the decades that followed, there have been occasional reports of blackhead mortality in bobwhites, principally among birds reared in confinement.[1,4,5] Apparently, no one has determined to what extent this common inhabitant of our fields, woodlands, parks, and even our experiment stations may disseminate *Histomonas*-bearing eggs of *Heterakis gallinarum*. This determination was the major purpose of our present study as our earliest observations had convinced us that unconfined bobwhites were not being ravaged by histomoniasis.

Materials and Methods

Birds. The bobwhites used for these studies were incubator-hatched, brooded 4 to 5 weeks on wire, and held in all-metal cages suspended over dropping pans to permit collection of cecal discharges for examination. The birds were thus kept free of parasites until experimentally infected, usually at 8 weeks. All chickens used were New Hampshires, similarly maintained except that they were kept in the brooder only 4 weeks and were experimentally infected when 6 to 7 weeks old. The poults were Beltsville Small Whites, maintained and used the same as the chickens.

Heterakis eggs. The eggs of *Heterakis gallinarum* used for the first test were pooled from worms grown in caged New Hampshire chickens known to have had infections with *Histomonas meleagridis*. The eggs for the second test were pooled from worms gathered from caged New Hampshire chickens not known to have harbored *Histomonas meleagridis*. In both instances, the eggs were embryonated in 1.0% formalin at about 72° F, followed by washing, and calibration of suspensions and feeding, as described in various earlier reports.[8,6,7]

Earthworms. The earthworms used for the third test were dug from yards used for many years for breeding flocks of ring-necked pheasants *(Phasianus colchicus torquatus)*, and only recently vacated. Most of the worms were *Eisenia foetida* and *Allolobophora caliginosa*, but some *Lumbricus terrestris* of comparable size were collected.

Procedure. For the first test, each bird to be infected received 1 ml of the suspension of *Heterakis* eggs calibrated to constitute a calculated dose of 165 embryonated eggs. For the second test, the number of eggs given each bird was increased to 200 because infections with *Histomonas meleagridis* were considered unlikely and a fairly good retention of larvae could be expected, at least in the chickens.[6,2]

At each of 9 intervals after the embryonated eggs were fed, 6 infected birds and one uninfected control of each species were necropsied for study. These intervals were 10, 14, 17, 21, 28, 35, 42, 49 and 56 days after infection. Each bird was examined for gross pathological changes in the ceca, liver and other abdominal organs, and for the presence of *Histomonas meleagridis, Heterakis gallinarum* and other intestinal parasites. All heterakids were removed, counted, and sexed, and up to 10 of each sex were measured. All mature females were washed and kept in 1.0% formalin to permit eggs to embryonate. With the first test, the eggs from worms recovered from bobwhites were pooled and 25 given to each of 15 chicks 6 weeks old, to test for transmission of *Histomonas*. The same procedure was followed with eggs from heterakids removed from the chickens.

In the second test, where *Histomonas meleagridis* was absent in all except one chicken, differences in worm recovery and size could be studied most advantageously.

The third test, using 2 earthworms per bird as the source of *Histomonas* and *Heterakis*, was conducted in a very similar manner, but emphasis was again on the responses of the bobwhite to both parasites. In this test, such responses were compared with those of the relatively resistant host, the chicken, and the rather susceptible young turkey.

Results

The results of the first test are shown in Table 1. Infections with *Histomonas meleagridis* were less than 3/4 as prevalent in bobwhites as in chickens. Likewise, during the first 4 weeks, the bobwhites harbored about 3/4 as many *Heterakis gallinarum* as the chickens. Only a few birds of either species had gross cecal responses, and there was no liver involvement and no mortality. However, after the 4th week, worm recovery fell sharply in the bobwhites, and development of the surviving *Heterakis* was so retarded that only 1/6 as many mature females were recovered from bobwhites as from chickens. Furthermore, egg production was also adversely affected. Ultimately, the worms from bobwhites produced only 1/10 as many eggs capable of embryonation as were produced by worms from chickens. However, the cecal worm eggs of bobwhite origin transmitted *Histomonas meleagridis* to test chicks as readily as did such eggs of chicken origin. All control birds remained free of parasites.

The results of the second test are shown in Table 2. Since *Histomonas meleagridis* was absent in both the bobwhites and the turkeys and was detected only in one chicken and that without visible host response, the comparative development of *Heterakis gallinarum* should depend solely on host - parasite compatibility. Throughout, this strain of *Heterakis* did poorly in bobwhites, with half as many or fewer larvae present at 10 days as were found in chickens or turkeys. Furthermore, the larvae were abnormally small, already having been retarded, apparently, by almost 2 days.[6] Usually, these disparities increased progressively. Ultimately, the chickens, exclusive hosts for this strain of *Heterakis* for many years,[9] yielded 580 mature worms, while the turkeys produced 481 and the bobwhites, none. Moreover, except for one bobwhite that had 25 undersized juveniles when necropsied at 42 days, all worms were extremely retarded, numbered only 1 or 2 per cecum, and could not possibly have survived to pro-

TABLE 1. *Results of feeding 165 embryonated eggs of* Heterakis gallinarum *from chickens that had also had* Histomonas meleagridis.

	Bobwhites	Chickens
Number of birds used	53	59
Frequency (%):		
Histomonas meleagridis	43.3	61.0
Cecal pathology	9.4	5.1
Liver involvement	0	0
Mortality	0	0
Heterakis per bird (Avg. no.):		
10-28 days after inoculation	10.1	13.4
35 or more days after inoculation	4.6	16.7
Mature female *Heterakis* (Total no.)	47	285
Embryonated eggs produced (Total no.)	1708	17,527
Embryonated eggs per female (Avg. no.)	36.3	61.5
No. embryonated eggs given for each *Histomonas* infection in young chickens	188	188

TABLE 2. *Comparative survival and development of* Heterakis gallinarum *in young bobwhites, chickens, and turkeys, following the feeding of 200 embryonated eggs from worms from chickens (Six birds of each species were necropsied at each of 9 intervals after the feeding).*

Heterakis	Bobwhites		Chickens		Turkeys	
Age in days	Avg. no.	Length (mm)	Avg. no.	Length (mm)	Avg. no.	Length (mm)
10	39.1	2.2	78.5	3.6	100.7	3.9
14	10.8	2.7	53.2	3.8	27.8	3.9
17	6.7	2.9	27.5	5.6	7.8	4.4
21	0.8	2.4	47.2	7.7	5.3	6.1
28	0.2	3.2	43.0	9.8	32.2	8.2
35	1.5	6.7	30.2	9.8	9.2	9.9
42	4.2	7.7	26.0	11.0	45.5	9.6
49	1.0	5.8	24.7	11.0	17.3	10.8
56	1.0	5.5	15.8	11.4	8.2	10.5
Mature *Heterakis* (Total No.)	580		481		0	

TABLE 3. *Results of feeding each bird 2 earthworms from yards used by ring-necked pheasants.*

	Bobwhites	Chickens	Turkeys
Number of birds used	31	29	29
Frequency (%):			
Histomonas meleagridis	6.5	6.9	75.8
Cecal pathology	6.5	3.4	69.0
Liver involvement	3.2	0	65.5
Mortality	0	0	65.5
Heterakis gallinarum	24.1	62.1	89.7[1]
Heterakis (Total no.)	62	973	211
Heterakis per bird (Avg. no.)	2.0	33.6	17.6
Mature *Heterakis* (35-56 days) (Total no.)	0[2]	328	37[3]

[1] Only 3 poults acquired no *Heterakis*. Five others lost all worms because of severe cecal pathology.

[2] The 18 worms that persisted 35 days or more were only as developed as 10-16 day worms.

[3] All in 1 bird; 5 other worms in 3 birds were immature.

duce fertile eggs. Control birds had no heterakids.

The results of the third test, employing earthworm transmission, are shown in Table 3. Again *Heterakis*, this time long associated only with ring-necked pheasants, did so poorly in bobwhites that no worms survived to maturity. This time, *Histomonas meleagridis* was present in enough *Heterakis* larvae distributed in

enough earthworms to initiate *Histomonas* infections in 22 of the 29 young turkeys. Furthermore, the strain of *H. meleagridis* was highly pathogenic for poults, as 20 of them died of histomoniasis. In contrast, *Histomonas* infections developed in only 2 chickens and both recovered promptly without the liver being invaded. Two bobwhites also became infected with *H. meleagridis,* and in one of these, the liver was invaded; both survived. As before, all control birds remained free of *Heterakis* and *Histomonas.*

Discussion

The bobwhite is a rather poor host for both *Heterakis gallinarum* and *Histomonas meleagridis,* at least when these parasites have had chickens and pheasants as their recent hosts. An occasional bobwhite may retain *Heterakis gallinarum* until it matures, and if *Histomonas meleagridis* had also been present, the protozoan could be transmitted via the *Heterakis* egg or larva. The apparent infrequency with which these conditions are met suggests that the bobwhite is unimportant in contaminating range or poultry yards. Except among birds in close confinement and crowded, it seems doubtful that the 2 parasites could maintain themselves in this host alone, unless considerable adaptation were to occur.[9]

Young bobwhites appear to be almost as susceptible to infection and slightly more susceptible to tissue invasion by *Histomonas meleagridis* than are young New Hampshire chickens, but they resist the disease far better than young turkeys. It appears unlikely that appreciable mortality would occur among bobwhites unless they were confined on soil heavily contaminated with infective stages of *Heterakis* and *Histomonas* and concentrated by accumulation in earthworms. Such contamination could occur if the area were used by some gallinaceous bird in which the parasites thrive better than they do in bobwhites.

Bobwhites not kept in confinement could possibly acquire sufficient *Heterakis* and *Histomonas* by visiting contaminated chicken yards to result in an occasional death. However, it seems very improbable that these visits alone could result in any significant contamination of the birds' own habitat or that shared with another gallinaceous bird.

Addendum

After this paper had been submitted for publication, another on a similar subject came to our attention. It is: Kellogg, F. E., and W. M. Reid. 1970. Bobwhites as possible reservoir hosts for blackhead in wild turkeys. J. Wildl. Mgmt. 34: 155-159.

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