COCCIDIOSIS IN CALIFORNIA QUAIL

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Coccidia are microscopic protozoan parasites which produce a disease known as coccidiosis. In birds they occur usually in the cells lining the intestine. The cysts of the resistant stage are discharged from the intestine in the fecal droppings and enter the same or other birds by contaminated food. They remain viable under ordinary field conditions for long periods and often resist influences which would kill most other parasites.

Different species of coccidia exhibit variations in the life cycle, but it is the same in essential details. The stage in which the parasites are eliminated from the intestine is called an oocyst. In the coccidian, *Eimeria,* the oocysts become divided internally into four sections, or sporoblasts. Two sickle-shaped, nucleated organisms, or sporozoites, are formed within each sporoblast. When an oocyst is ingested, the sporozoites break through the resistant membrane of the sporocyst, penetrate the mucous lining of the intestine, and continue with that part of the life cycle which takes place within the host.

By a process of multiple division, or schizogony, each sporozoite becomes a mother cell, dividing into many merozoites. These may enter other cells of the intestinal epithelium and repeat the process, or they may develop into male and female sexual bodies, or gametes. Fertilization takes place between male and female gametes, resulting in the formation of an oocyst. The oocysts leave the host in the fecal droppings and develop into the infective stage. This brief description of the life cycle illustrates the possibilities for the enormously rapid increase in numbers of these organisms when conditions are favorable.

Coccidiosis may be suspected from symptoms such as a general appearance of malaise, lack of appetite, and diarrhea, and it may be surmised at autopsy from a spotted or inflamed condition of the intestine. Positive diagnosis can be made by microscopic identification of oocysts in the feces, or of other stages in scrapings of the intestinal mucosa.

Adult quail frequently are infected with coccidia without apparent effect upon their well being, even though the percentage of infection is high. Such "carriers" are a constant source of infection to young birds, to whom an infection frequently may be fatal. In a number of fledglings autopsied concurrently with this study, coccidiosis was the cause of death. Coccidia have been reported from many other species of birds, but little is known of the incidence in most birds.

Publications dealing with the occurrence of coccidia in quail are limited both in number and scope. Tyzzer (1929) reported *Eimeria dispersa* in the Eastern Bob-white (*Colinus virginianus virginianus*). Venard (1933), in a study of 67 bob-whites of Ohio, found 32 birds, 47.8 per cent, infected with coccidia of three species. Stoddard (1931), in an extensive survey of quail in the southeastern states, found in North Carolina only 6 of 25 mature bob-whites infected, none having large numbers of oocysts. In South Carolina, 19 of 75 mature bob-whites showed infection, with numerous oocysts in only one specimen. Of 23 birds from Grand Junction, Tennessee, 7 were infected, most of them lightly. No oocysts were found in the intestinal tracts of 7 winter bob-whites from Alabama, although the number was considered too small to be conclusive. From the Biloxi district of Mississippi, 9 of 18 winter birds, shot in a wild, sparsely populated region, were infected, some with more oocysts than noted previously in wild bob-whites. Of 78 birds killed at all seasons during two years in

southwestern Georgia and northern Florida, 19 showed from a very few to many oocysts. From Beachton, Georgia, 8 of 14 mature birds were infected, although in only one case was it heavy. Cock bob-whites examined in spring and early summer showed from 25 to 50 per cent infection in fecal droppings. It was observed that coccidia became more prevalent in 1927, a year especially favorable for bob-whites in the districts studied.

Henry (1931) examined California Quail (*Lophortyx californica*) and Mountain Quail (*Oreortyx picta*) from game farms, together with a few wild birds, and identified two species of coccidia, with a questioned third. O'Roke (1928), in a fifteen months' survey of California Quail, found no coccidia in the visceral organs of birds examined, and considered them free from parasites of the digestive tract and in a healthy condition "at this time of the year." In a previous paper Herman and Jankiewicz (1942) reported upon the presence of at least three species of *Eimeria* in both wild and captive California Quail.

Coccidia of the genus *Isospora* have been reported from 32 species of birds from California by Henry (1932) and by Boughton (1938), who cited previously unpublished records of Henry.

The present paper reports coccidia in wild California Quail, and gives the percentages and intensity of infection. Data are based upon 121 birds procured from April to October, 1941, inclusive. Specific identification of four species of *Eimeria*, with a possible fifth, will be discussed in a later paper. Coccidia are reported also from several other species of birds.

This contribution is the joint effort of the San Joaquin Experimental Range, United States Forest Service, and the Los Angeles Wildlife Disease Research Station of the Fish and Wildlife Service as a part of the Cooperative Quail Study. Work Projects Administration Official Project No. 65-2-07-344 assisted in the study. The material for examination was collected at the San Joaquin Experimental Range, situated in the foothills of the Sierra Nevada near O'Neals, Madera County, California. Quail were trapped and held in individual cages until fecal droppings were obtained; the birds were then banded and released. Each fecal sample was placed in a small glass vial and covered with a two per cent solution of potassium bichromate to prevent growth of bacterial contaminents.

Each sample was centrifuged in a 15 milliliter tube filled with distilled water. The supernatant fluid was decanted and the tube was refilled with zinc sulphate solution (331 grams per liter of water), after Faust *et al.* (1939). The tube was again centrifuged, after which the flattened end of a glass rod was used to remove the top film to a slide for examination under the microscope. The intensity of infection was recorded according to the number of oocysts in the drop thus obtained: no oocysts, negative; 1-10, 1+; 11-50, 2+; 51-100, 3+; 101-500, 4+; 501-1000, 5+; 1001 and over, 6+.

TABLE I

Percentages of infection of California Quail

Age of quail	Under 4 weeks	4 months to one year			One year or over			Totals		
Sex	Undetermined	♂	♀	total	♂	♀	total	♂	♀	All birds
Number examined	8	27	22	57	37	27	64	64	49	121
Number infected	1	21	11	33	31	25	56	52	36	89
Percentages of infection	12.5	77.7	50.0	57.9	83.8	92.6	87.5	81.2	73.5	73.5

Occurrence of infection.—Adult female birds, as noted in table I, were 92.6 per cent infected over the period of the survey, with adult males 83.8 per cent infected. Since young birds remain in close proximity to the females, it is presumable that the possibility of their infection is thereby increased.

Intensity of infection.—A rise and fall in the intensity of infection was noted in five birds which were retrapped several times. Table II shows under each bird the various dates on which samples were taken and the findings for each sample.

TABLE II

Intensity of infection in five birds

No. 36439, ad. ♂		No. 36086, ad. ♂		No. 36493, im. ♂		No. 36331, ad. ♂		No. 36386, ad. ♂	
April 29	1+	June 13	4+	July 17	—	May 6	2+	May 5	—
May 28	1+	June 25	2+	Sept. 8	—	May 26	5+	June 10	2+
June 3	4+	July 14	5+	Sept. 25	—	June 9	2+	June 20	4+
June 5	1+	July 28	1+	Sept. 30	4+	June 12	3+	June 24	—
June 9	5+	Sept. 22	1+	Oct. 6	—			June 28	—
June 19	3+	Sept. 30	—	Oct. 13	3+				

The decrease of infection evidenced in the preceding figures probably is accounted for by the spontaneous elimination of most of the parasites within a week, while the increase in infection was due to reingestion of contaminated food, as noted by Herman and Jankiewicz (*op. cit.*) from laboratory observations.

From the 56 immature birds examined, the data are insufficient for statistical analysis. Stoddard (*op. cit.*) noted that "the severity of coccidia infection in growing quail is roughly in inverse proportion to their age." The data here presented do not confirm this statement. Seasonal or other factors may be involved in the intensity of infection.

TABLE III

Monthly incidence of coccidia

Month	Number examined	Number infected	Percentage of total infected
April	19	18	94.7
May	16	13	81.2
June	38	29	76.3
July	15	7	46.7
August	4	1	25.0
September	21	5	23.8
October	45	17	37.8

Reports by other authors have drawn no definite conclusions in regard to seasonal incidence of coccidian infection, but it is possible, judging from a comparison of these monthly findings, that a relationship does exist between the seasons and the intensity of infection, as suggested by Madsen (1941) in his study of helminths and coccidia in partridges and pheasants in Denmark. However, a more extensive sampling of birds over a period of several years would be necessary to substantiate this hypothesis.

Infection in other species of birds.—Thirty individual birds of species other than quail were examined in the course of this survey and coccidians of the genus *Isospora* were observed in 11 individuals, of 7 species, as follows:

	No. Exam.	No. Inf.
Killdeer (*Oxyechus vociferus*)	1	0
Mourning Dove (*Zenaidura macroura marginella*)	5	0
Red-shafted Flicker (*Colaptes cafer collaris*)	1	0
California Jay (*Aphelcoma californica immanis*)	9	1
Bewick Wren (*Thryomanes bewickii drymoecus*)	1	0
Green-tailed Towhee (*Oberholseria chlorura*)	1	1

Spotted Towhee (*Pipilo maculatus falcinellus*)	1	1
Brown Towhee (*Pipilo fuscus carolae*)	8	5
*Lark Sparrow (*Chondestes grammacus strigatus*)	1	1
*White-crowned Sparrow (*Zonotrichia leucophrys gambelii*)	1	1
*Golden-crowned Sparrow (*Zonotrichia coronata*)	1	1

*Infection previously reported by Dora P. Henry (Boughton, *op. cit.*).

SUMMARY

The presence of coccidian infection in California Quail at the San Joaquin Experimental Range, Madera County, California, has been reported from an examination of the fecal droppings of 121 birds over a period of four months. Infection was noted in 89 birds. Percentages of infection have been given for adult and immature quail and for males and females. A rise and fall in intensity of infection was observed in individual birds at different samplings. An analysis was made of monthly incidence of infection, with a decrease noted from April to August, suggesting a possibility of seasonal variation. A higher percentage of infection seems evident in female birds. Coccidian infection was noted in 11 individual birds other than quail, representing 7 species, from the same locality.

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