

SURVEY OF SALMONELLA SPP. AND HELMINTHS OF THE ALIMENTARY
TRACT OF THE GREATER PRAIRIE CHICKEN
(Tympanuchus cupidio pinnatus) IN KANSAS

by

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INTRODUCTION

European workers searching for the cause of fluctuations in grouse populations made the first investigations into diseases and parasites of grouse. American scientists became interested in parasites and diseases of ruffed grouse (Bonasa umbellus) in early 1900, but these investigations were not intensive until after about 1920. Studies on other tetraonids have been limited and only a few have been specifically devoted to or even included the greater prairie chicken (Tympanuchus cupidio pinnatus) (Leigh 1940, Hamerstrom 1941, Ammann 1957).

At the present time little is known about parasites and diseases of prairie chickens in Kansas. This study was initiated to survey the helminth parasites occurring in the alimentary tract of the prairie chicken and to determine whether or not these birds harbor Salmonella. Such information is essential to a basic understanding of prairie chicken ecology.

Collections of prairie chicken viscera were made in the fall of 1964 and 1965. Examinations of the viscera for parasitic helminths were conducted for the 1964 and 1965 collections while only the 1965 samples were used for the salmonella survey.

REVIEW OF LITERATURE

Trematodes

Previous to 1941, trematodes were regarded as rare in grouse in the United States (Mueller 1941). Cram (1931a) found Glaphyrostomum sp. in the intestine of a ruffed grouse from Labrador. A new species, Leucochloridium pricei, was recorded from the spruce grouse (Cana-chites canadensis) and ruffed grouse by McIntosh (1932) and later found by Mueller (1941). Kagan (1953) found L. pricei to be a synonym of L. varia and stated that the latter has priority. Leucochloridium varia was found in ptarmigan (Lagopus spp.) in Alaska by Babero (1953). Stafseth and Kotlan (1925) found trematode cysts in the intestines of ruffed grouse which appeared to be closely related to Distomum commutatum of domestic chickens. This trematode is now known as Brachylaemus commutatus (Dawes 1946). Harmostomum pellucidum was found in the ceca of ruffed grouse from Minnesota and New Hampshire (Boughton 1937, Mueller 1941). Mueller (1941) made the first discovery of Prosthogonimus macrorchis from the cloaca of a ruffed grouse in New Hampshire. Ishii (1942) discovered Echinoparyphium aconiatum for the first time in the intestine of a ruffed grouse and Erickson et al. (1949) also found this parasite. Brachylaima fuscata has been reported from ruffed grouse in Minnesota (Erickson et al. 1949) and from ptarmigan in Alaska (Babero 1953). A single case of Lyperosomum monenteron occurring in the intestine of a ruffed grouse was observed by

Erickson et al. (1949). Lyperosomum monenteron normally occurs in the liver according to Ishii (1942).

Cestodes

Tapeworms occur more frequently than trematodes in grouse and were found as early as 1887 by Leidy (1887), who listed Taenia (Hymenolepis) microps as occurring in sage grouse (Centrocercus urophasianus) in Wyoming. Jones (1935) recorded H. microps from ruffed grouse and stated that the specimen Leidy (1887) described was a Raillietina sp. and not H. microps, but Simon (1940) was of the opinion that the specimen was a Rhabdometra sp. Hymenolepis carloca was reported from ruffed grouse by Mueller (1941).

Rhabdometra nullicollis was found in sage and sharp-tailed grouse (Pedioecetes phasianellus) by Ransom (1909), who described the parasite from the first named host. This parasite has also been located in ruffed grouse from Minnesota (Boughton 1937), sage grouse in Montana (Simon 1940), prairie chicken and sharp-tailed grouse in Wisconsin (Morgan and Hamerstrom 1941), blue grouse (Dendragapus obscurus) in Washington (Beer 1944) and British Columbia (Bendell 1955), ptarmigan in Alaska (Babero 1953) and sharp-tailed grouse in South Dakota (Boddicker 1965). Swales (1934) and Mahon (1956) have reported R. odiosa from sharp-tailed and blue grouse in Canada.

Davainea tetraoensis was found in ruffed grouse by Stafseth and Kotlan (1925), Fisher (1939) and Gram (1931a). Stafseth and Kotlan (1925) stated that this parasite

appears to be common to the Tetraonidae. Davainea prolottina has been recorded in ruffed grouse (Cram 1931a, Boughton 1937, Mueller 1941, Erickson et al. 1949, Mahon 1956) and in ptarmigan (Babero 1953).

Beer (1944) found Raillietina sp. in blue grouse and Leigh (1939, 1941) found a variation of the genus in prairie chicken which he described as R. variabila. The new species, R. variabila, was thought to be an indigenous species to the prairie chicken (Leigh 1941). To date it has not been recovered from a host other than prairie chicken. Another new species, R. centrocerci, was reported from sage grouse by Simon (1937) and recently from sharp-tailed grouse (Boddicker 1965). Raillietina cesticillus has been recovered from grouse in Canada (Mahon 1956), R. urogalli from ptarmigan (Babero 1953) and R. tetragona from ruffed grouse (Boughton 1937, Mueller 1941).

Choanotaenia sp. and C. infundibulum parasitize ruffed grouse (Boughton 1937, Erickson et al. 1949) and prairie chicken (Leigh 1940, Hamerstrom 1941).

Babero (1953) made the original description of Haploparaxis galli from ptarmigan which constituted its first record in gallinaceous birds in North America.

Nematodes

The roundworms have the highest frequency of infection and diversification of species of the helminth parasites. Stafseth and Kotlan (1925) discovered the first Cheilospirura from ruffed grouse in Michigan. This nematode was named C. spinosa by Cram (1927) using some of the material collected by Stafseth and Kotlan (1925).

It is usually referred to as the "gizzard worm" and occurs frequently in ruffed grouse (Cram 1929, Boughton 1937, Shillinger and Morley 1937, Fisher 1939, Mueller 1941, Levine and Goble 1947, Erickson et al. 1949), and blue grouse (Bendell 1955); with a record of Cheliospirura sp. from the blue grouse (Beer 1944). Wehr (1932) listed C. spinosa from sage grouse, but Simon (1939) stated that Wehr's (1932) specimens were the same species that he described as a new species C. centrocerci from sage grouse. A similar species, Seurocyrnea colini, occurs in prairie chicken and sharp-tailed grouse (Boughton 1937, Leigh 1940, Wehr 1940a, Morgan and Hamerstrom 1941, Boddicker 1965). Cyrnea colini is a synonym of S. colini and the latter is correct (Strand 1929). Bendell (1955) recovered Yseria sp. from blue grouse which is similar to the above mentioned species.

Ascaridia sp. was reported from ruffed grouse by Stafseth and Kotlan (1925). To date, A. galli, A. borealis, A. compar, A. magnipapilla and A. bonasae have been reported from ruffed grouse, prairie chicken, sharp-tailed or blue grouse by Cram (1926, 1927), Gross (1928), Boughton (1937), Fisher (1939), Wehr (1940a, 1940b), Morgan and Hamerstrom (1941), Mueller (1941), Connell and Fowle (1944), Rankin (1946), Levine and Goble (1947), Erickson et.al. (1949), Bendell (1955) and Dorney (1959). Ascaridia bonasae was described as a new species from the ruffed grouse by Wehr. (1940b).

The first record for Dispharynx spiralis was made by Cram (1926) from ruffed grouse. In a study of the genus Dispharynx, Goble and Kutz (1945) concluded that D. nasuta was a synonym of D. spiralis and Dispharagus nasuta

and had priority over them. Other workers have reported D. nasuta from ruffed grouse (Gross 1928, Fisher 1939, Levine and Goble 1947), sharp-tailed grouse (Swales 1933, 1934, Boddicker 1965) and blue grouse (Bendell 1955).

Of the Heterakis spp. which inhabit the ceca, H. bonasae occurs in ruffed grouse (Wehr 1940a, Levine and Goble 1947), H. gallinarum is common in most grouse (Boughton 1937, Shillinger and Morley 1937, Leigh 1940, Simon 1940, Wehr 1940a, Morgan and Hamerstrom 1941, Beer 1944, Erickson et al. 1949, Madsen 1950) and a new species, H. pedioecetes, has been recorded from sharp-tailed grouse (Mawson 1956). Madsen (1949) stated that H. gallinae is a synonym of H. gallinarum and that the latter has priority. Subulura strongylina is also found in the ceca of ruffed grouse and sharp-tailed grouse (Boughton 1937, Boddicker 1965).

Cram (1926) and Fisher (1939) located Thominx annulata in the crops of ruffed grouse. A new species of crop worm, Goncydonema phasianella was described by Wehr (1938) from sharp-tailed grouse.

Capillaria recorded from ruffed grouse, prairie chicken, sharp-tailed grouse and ptarmigan include C. annulata, C. contorta, C. caudinflata and Capillaria sp. (Cram 1936, Wehr 1940a, Morgan and Hamerstrom 1941, Levine and Goble 1947, Read 1949, Babero 1953).

A new species of nematode recovered from under the horny lining of the gizzard of a sage grouse was determined to be Habronema urophasiana by Wehr (1931) and was also found in sage grouse by Simon (1940). Trichostrongylus tenuis and Trichostrongylus sp. have been reported in grouse and ptarmigan (Wehr 1940a, Babero 1953).

Cram and Cuvillier (1934) found Trichostrongylus tenuis to be pathogenic to game birds in the United States. Grouse epizootics in Great Britain were attributed to Trichostrongylus pertracilis which is a synonym of T. tenuis and the latter has priority (Cram and Wehr 1934). Leigh (1940) found one case of an acanthocephala, Mediorhynchus papillosus, in a prairie chicken which he regarded as an accidental host. Tetrameres americana has been established experimentally in ruffed grouse, but no natural infection has thus far been recorded (Wehr 1940a, Levine and Goble 1947). Bendell (1955) found the acanthocephalan Placiorhynchus formosus in blue grouse from British Columbia.

Salmonella

The genus Salmonella is composed of approximately 800 serological types belonging to the paratyphoid group in the large family Enterobacteriaceae (Williams 1965) except for S. pullorum and S. gallinarum. There is evidence that salmonella can be transmitted from domestic poultry to upland game birds. Salmonella infections cause enteritis in birds and can result in high mortality of young with decreased fertility in adult hens. These infections also cause gastroenteritis in man (Hull 1955).

The only known record of salmonella occurring in grouse was detected in a brood of prairie chickens being raised in captivity by Shoemaker (1961). It was suggested that the chicks may have contacted the disease from the hen as she showed signs of illness at the time

of her broods' hatching. No losses were reported as a result of the infection.

MATERIALS AND METHODS

Viscera of prairie chickens were collected at two Kansas Forestry, Fish and Game Commission check stations on 6-7 November 1964 and from one check station on 6 November 1965. The viscera collected were all from hunter-killed prairie chickens. The birds were killed in Allen, Anderson, Coffey, Lyon, Wabaunsee and Woodson counties. The viscera of each bird was removed by hand after opening the abdominal cavities with dissecting shears. Visceral samples included the alimentary tract from the proventriculus to the cloaca. As the viscera were removed they were numbered, placed individually in water-tight plastic bags, and temporarily stored in an ice cooler. The sex and age (Mosby 1963) of each bird was recorded along with the location of the kill. All visceral samples were placed in a refrigerator by 10:00 p.m. the night of collection. The 1964 samples were stored in a refrigerator and examined for helminths within three days of collection. Samples collected in 1965 were frozen the morning following collection to prevent bacterial growth and decomposition. These 1965 samples were then thawed before analysis. Analysis of the 1965 samples was completed within 35 days of collection. For the Salmonella survey, parts of the liver and spleen were cut off after the viscera was thawed. These parts were then macerated and incubated in selenite broth for 12 hours at 37 degrees C. Culture plates of Bacto-E. M. B.

agar and B. G. agar were then streaked with the broth culture and incubated for 24 hours at 37 degrees C. Plates which had suspect growth were streaked on agar slants, incubated for 24 hours and then gram stained. Colonies from the agar slants were inoculated into Kligler Iron Agar slants and incubated with results being recorded at 24 and 48 hours of incubation. Nutrient broth, urea broth and differential media were used in identification of the bacteria.

Viscera which were frozen before being analyzed for helminths were placed in physiological saline, 0.85 percent, and refrigerated after being thawed. Thereafter, the thawed and previously unfrozen samples were treated similarly. The proventriculus, gizzard, small intestine, ceca, large intestine and cloaca were separated, slit longitudinally with surgical sissors and placed with their contents into individually numbered flasks containing physiological saline. The flasks were placed on a gyratory shaker at moderate speed for 20 minutes. The contents of each flask and the organ were then examined macroscopically and under a dissecting scope. All helminths were dead when recovered and were placed in Ward's Cestode Fixative. Specimens were cleared and temporarily mounted on slides in glycerine for later identification.

RESULTS

One hundred and six prairie chicken visceral samples were examined during 1964 and 1965. Thirty-five samples were collected in 1964 and 29 were found to be infected by helminth parasites while 58 of 71 samples were para-

sitized in 1965. The helminth parasites occurring in these samples represented two categories: nematodes and cestodes.

Nematodes

The following nematodes were found in the 106 visceral samples examined.

Family: Spiruridae

Seurocyrnea colini (Cram, 1927) Cram 1930

Habitat: Proventriculus wall at junction with gizzard

Location: Southeastern Kansas

This parasite was the most common helminth observed in both years. Twenty-nine of 35 prairie chickens examined were infected in 1964 and 53 of 71 in 1965 (Table 1). Of the birds parasitized, all were infected with S. colini in 1964 and 91.4 percent were infected in 1965. Degrees of infections were 1-20 for 1964 and 1-22 for 1965. The bird in which there were 22 worms did not have any apparent damage to the proventriculus or gizzard. A copious amount of mucous was present in the proventriculus, but not in sufficient quantities to block passage of food through the organ. Body fat was also plentiful on the viscera of this bird.

Family: Heterakidae

Heterakis gallinarum Schrank, 1788

Habitat: Cecum

Location: Southeastern Kansas

In both years, this parasite was second in percent incidence. It occurred in 7 birds in 1964 and 19 in 1965. Infections ranged from 1-4 per bird to 1-11 in

1964 and 1965, respectively. All the infected birds appeared in good condition.

Family: Acuariidae

Dispharynx nasuta (Rudolphi, 1819)

Habitat: Proventriculus

Location: Southeastern Kansas

This nematode is commonly referred to as the "stomach worm". It was the least commonly occurring of the three nematodes found in this study. In 1964, it occurred in 2 of the 35 birds examined and in 12 of the 71 birds examined in 1965. The degree of infection was 1-2 in 1964 and 1-11 in 1965. Only 2 of 29 parasitized birds had Dispharynx in 1964 and 12 of 58 were infected in 1965 (Table 1). The prairie chicken with the heaviest infection had a thin mucous plug in the proventriculus. However, the gizzard of this bird was full of food and there was enough body fat present on the viscera to indicate the bird was in good condition.

Table 1. Endoparasitic helminths found in 35 and 71 greater prairie chicken alimentary tracts in 1964 and 1965, respectively.

HELMINTHS	INCIDENCE			
	1964		1965	
	Number	Percent	Number	Percent
<u>Seurocyrnea colini</u>	29	82.9	53	74.6
<u>Heterakis gallinarum</u>	7	20.0	19	26.8
<u>Dispharynx nasuta</u>	2	5.7	12	16.9
Cestodes	3	8.6	0	0.0

Cestodes

Family: Davaineidae and/or Dilepididae

Species not determined

Habitat: Small intestine

Location: Southeastern Kansas

Cestodes were found in the small intestines in 3 of 35 birds examined in 1964. No cestodes were recovered from samples collected in 1965. One adult and two juvenile prairie chickens harbored the parasites with a degree of infection 1-3 and no apparent damage to the intestines was noted. Three severely damaged scoleces were recovered from one bird and the other two birds yielded only a series of proglottids without scoleces. The specimens lacking scoleces had genital pores irregularly alternate, a paruterine organ anterior to the uterus and numerous testes. The paruterine organ was spherical in shape and had a double-layered membrane surrounding it. These specimens have characteristics resembling Metroliaesthes lucida Ransom, 1900 which occurs in domestic poultry. Metroliaesthes lucida is the only species occurring in domestic poultry with characteristics resembling the proglottid specimens collected in this study (Wehr 1965).

The scoleces recovered were too mutilated for a species diagnosis to be made. A withdrawable rostellum was present, but it was not possible to tell if one or two rows of rostellar hooks were present. The specimens had characteristics resembling those of Choanotaenia or Raillietina.

All parasites

The percentage of parasitized birds having one, two or three species of helminth parasites was calculated for 1964 and 1965. Those birds having one species of parasite present comprised 63.3 and 58.6 percent of the birds parasitized in 1964 and 1965, respectively. Two species of parasites were present in 36.6 percent of the 1964 birds and 37.9 percent of the 1965 birds. None of the birds examined in 1964 had more than two species of parasites present and only 3.4 percent of the birds parasitized in 1965 had three species present. The bird in which the highest number of Dispharynx nasuta was present (11) also had 16 Seurocyrnea colini. It was the most heavily parasitized of all the birds examined with a total of 27 nematodes. The organs of this bird appeared normal and were covered with fat, although the proventriculus was slightly enlarged and reddish in appearance.

Salmonella

There were no pathogenic bacteria isolated in the study. Salmonella sp. was not detected in any of the 71 specimens examined. No bacterial colonies occurred in 35 of the 71 cultures. Coliform colonies were the most numerous of the 32 specimens yielding bacterial growth. Aerobacter aerogenes was identified by its reactions in differential media from 12 specimens, Pseudomonas aeruginosa from one specimen, Proteus morgani from one specimen and Proteus sp. from one specimen. Six coliform types were present and five colonies were identi-

fied as Escherichia coli. The remaining 11 specimens did not yield suspect growth and were disregarded.

DISCUSSION

Heterakis gallinarum was the only helminth found in this study which had a direct life cycle. Hosts become infected by ingesting eggs which are in the infective stage. The presence of Heterakis in moderate numbers is not harmful, but large numbers may be detrimental to the host. Leigh (1940) considered its presence in wild game birds to be indicative of their contact with domestic poultry.

In other studies of parasitic helminths in prairie chicken, Heterakis occurred in 20.5 (Morgan and Hamerstrom 1941), 36 (Schwartz 1945) and 39 (Leigh 1940) percent of the birds examined. It was present in 24.5 percent of the 106 birds examined in this study (Table 2). This was not considered to be a heavy infection.

The chief importance of Heterakis lies in its role as a carrier of the blackhead organism, Histomonas meleagridis, (Wehr 1965). Two cases of blackhead were encountered in Wisconsin prairie chickens (Gross 1930), two female prairie chickens died from blackhead disease in Missouri (Schwartz 1945), one prairie chicken in Illinois had the clinical signs of the disease (Leigh 1940), and four young prairie chickens being raised in captivity died from blackhead disease in Kansas (Erwin, 1966). Blackhead disease produces higher mortality in females than cocks, possibly because of the strain on the

vitality of the hen during egg-laying season (Schillingner and Morley 1937).

The other helminth parasites found in this study have indirect life cycles and prairie chickens become infected by eating the intermediate hosts. Cockroachs, Blattella germanica, appear to be the intermediate host for Seurocyrnea colini (Cram 1931b). This parasite has been found in most studies on prairie chickens. Schwartz (1945) found what he termed "gizzard worms" in 5 of 11 (45.5 percent) prairie chickens in Missouri. They were thought to be S. colini but were not positively identified. Seurocyrnea colini was found in 50 percent of the birds examined by Leigh (1940) and was found in the greatest number of individuals examined by Hamerstrom (1941). As some of the specimens lacked proventriculi, Hamerstrom (1941) did not list the number of birds having S. colini. Seurocyrnea colini was considered to be of no pathological significance to prairie chickens in this study. It may be possible for the parasite to occur in great enough numbers to impair the function of the proventriculus and mechanical damage could possibly provide a means of entry for a secondary infection. Seurocyrnea colini had a higher degree of incidence (77.3 percent) in this study than in studies by other workers.

Cram (1930, 1931b) found the sow bug, Porcellio scaber, and the pillbug, Armadillidium vulgare, to be intermediate hosts for Dispharynx nasuta. These nematodes are of pathological significance to game birds (Cram 1928) and are found with their heads buried deeply into the mucosa of the proventriculus. Wehr (1965:979) states;

"The formations of ulcers are often observed

in the proventriculi of infected birds. In case of heavy infections, the wall of the proventriculus becomes tremendously thickened and macerated, tissue layers are indistinguishable, and the parasites become almost completely concealed beneath the proliferating tissue."

This parasite has been incriminated in causing the deaths of ruffed grouse and Bendell (1955) concluded that parasitism by D. nasuta was an important mortality factor in the chicks and a major cause of population stability in blue grouse. He noted that this parasite occurred commonly and almost exclusively in the chicks. Results of this study paralleled Bendell's (1955) work, *i. e.*, 13 juveniles and only 1 adult were infected with D. nasuta (Table 2). There is no previous record of this nematode from prairie chicken, so no intraspecies comparisons are possible.

Avian cestodes usually utilize house flies, Musca domestica, grasshoppers, Melanoplus sp., and several species of beetles as their intermediate hosts. These hosts become infected with cestode eggs, are then ingested by prairie chickens and infect the birds with cestodes.

Cestodes may cause degenerations and inflammations of the villi of the intestine at the point of attachment by the rostellum. Heavy infections in young birds may cause emaciation. Raillietina variabilis occluded the lumen of the small intestine in four prairie chickens examined by Leigh (1940). They were found in 10 of 14 young birds Leigh (1940) examined. Two young and one adult prairie chickens were infected with cestodes of the 106 birds

Table 2. Endoparasitic helminths occurring in the alimentary tracts of 106 greater prairie chickens.

Host Category	Samples (No.)	Total sample	Percent Incidence			
			<u>Seurocyrnea colini</u>	<u>Heterakis gallinarum</u>	<u>Dispharynx nasuta</u>	Cestodes
Adults	29	75.8	75.8	10.3	3.4	3.4
Juveniles	77	84.4	77.9	29.8	16.8	2.6
All specimens	106	82.1	77.3	24.5	13.2	2.8

examined in this study (Table 2).

Those helminths with Arthropod and Isopod intermediate hosts probably infect young chicks soon after hatching. This is because young prairie chickens consume considerably more animal matter than older birds (Yeatter 1943). Bendell (1955) thought that this fact also accounted for the heavy infections of D. nasuta in blue grouse chicks.

Endoparasitic helminths had a high frequency of occurrence in this study indicating that over 80 percent of the prairie chicken population in southeastern Kansas is parasitized (Table 2). No infection appeared heavy enough to be detrimental to the host. The nematode which occurs most frequently, Seurocyrnea colini, is not known to be pathogenic to the host. Dispharynx nasuta may cause mortality in heavy infections (Edminster 1947) but was not considered detrimental to prairie chickens in this study. Heterakis, as a carrier of the blackhead disease organism, Histomonas meleagridis, could pose a potential threat to prairie chickens. Cestodes occurred with a frequency too small to be important as a factor in mortality. The importance of helminths may be as a portal of entry for secondary infections. Morgan (1944) thought that helminths are only rarely instrumental in precipitating the death of hosts.

Although prairie chicken visceral samples examined in this study were negative for Salmonella sp., the possibility of this organisms' presence in Kansas prairie chickens still exists. Williams (1965) stated that chronic intestinal carriers of paratyphoid infections are common. Prairie chickens have been observed to feed in

barnlots when snow cover was heavy (Schwartz 1945) and, as domestic poultry constitutes the largest single reservoir of salmonella organisms existing in nature (Williams 1965), they could become infected with the bacterium from feeding in barnlots. There are many reports of salmonella infections in game farm birds and the one known case of salmonella in prairie chickens was in a brood of captive birds.

Paratyphoid infections seldom occur in the acute septicemic form except in young fowl or in mature birds under stress conditions such as virus diseases, inadequate diet or unsanitary environment (Williams 1965). Perhaps parasitism could also produce the stress that would enable a latent paratyphoid infection to become acute.

The author concludes that juvenile and adult prairie chickens in southeastern Kansas are not seriously parasitized by endoparasitic helminths and appear to be free of infection by salmonella. However, since diseased and heavily parasitized birds may fall victim to predators and other natural mortality factors before they are taken by hunters, the hunter-killed birds used in this study may present biased results. In future studies it would be desirable to unbiasedly sample all age classes of prairie chickens at several periods of the life span to determine if and to what extent they are parasitized by endoparasitic helminths.

SUMMARY

Viscera of 106 prairie chickens collected in 1964 and 1965 were examined for helminths. Three species of

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nematodes were found in this study: Seurocyrnea colini, Heterakis callinarum and Dispharynx nasuta in that order of occurrence from high to low. None of these nematodes in the present study is considered as a factor causing mortalities among prairie chickens in Kansas.

Two species of cestodes were found in prairie chickens killed during 1964; however, these tapeworms were too mutilated to be identified. They appeared similar to Choanotaenia, Raillietina or Metroliasthes spp. One of the specimens had a paruterine organ present in the gravid proglottids relating it to Metroliasthes.

The incidence of parasitism was 82.1 percent for all samples examined. The heaviest degree of infection was 27 nematodes in one bird. Dispharynx nasuta has not previously been recorded from prairie chickens and was recorded for the first time in this study.

The 71 specimens collected in 1965 were tested for the presence of Salmonella sp. All the samples were negative for salmonella and other pathogenic bacteria.

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LITERATURE CITED

- Ammann, G. A. 1957. The prairie grouse of Michigan. Michigan Dept. Cons. Tech. Bull. 200pp.
- Babero, B. B. 1953. Studies on the helminth fauna of Alaska. XIV. A survey of the helminth parasites of ptarmigan (Lagopus spp.). J. Parasitol. 39(5): 538-546.
- Beer, J. 1944. Parasites of the blue grouse. J. Wildl. Mgmt. 8(1):91-92.
- Bendell, J. F. 1955. Disease as a control of a population of blue grouse, Dendragapus obscurus fuliginosus (Ridgeway). Canadian J. Zool. 33(3):195-223.
- Boddicker, M. L. 1965. Some parasites of sharp-tailed grouse in South Dakota. Proc. 6th Prairie Grouse Tech. Council. p. 31.
- Boughton, R. V. 1937. Endoparasitic infestation in grouse, their pathogenicity and correlation with metero-topographic conditions. Univ. Minnesota Agr. Expt. Sta. Tech. Bull. 121. 50pp.
- Cram, Eloise B. 1926. New records of nematodes for birds. J. Parasitol. 12:180.
- , 1927. Nematode parasites of birds. U. S. Natl. Museum Bull. 140. 465pp.
- , 1928. Nematodes of pathological significance found in some economically important birds in North America. USDA Tech. Bull. 49. 9pp.
- , 1930. Sow bug found to be host of parasite of ruffed grouse, a game bird. U. S. Dept. Agr. Off. Rec. 9(8):5.
- , 1931a. (a) New records of nematodes in domestic birds. (b) A comparison of intestinal parasites of ruffed grouse of Labrador with those of ruffed grouse of U. S. J. Parasitol. 18:48.

- , 1931b. Developmental stages of some nematodes of the spiruroidea parasites in poultry and game birds. USDA Tech. Bull. 227. 27pp.
- , 1936. Species of *Capillaria* parasitic in the upper digestive tract of birds. USDA Tech. Bull. 516. 27pp.
- , and Eugenia Cuvillier. 1934. Observations on *Trichostrongylus tenuis* infestation in domestic and game birds in the United States. Parasitol. 26(3): 340-345.
- , and E. E. Wehr. 1934. The status of species of *Trichostrongylus* of birds. Parasitol. 26(3):335-339.
- Connell, F. H. and C. D. Fowle. 1944. Endoparasitism in ruffed grouse near Hanover, New Hampshire. Auk 54 (3):321-323.
- Dawes, B. 1946. The trematoda. Cambridge Univ. Press, Great Britian. 644pp.
- Dorney, R. S. 1959. Relation of hunting, weather and parasitic disease to Wisconsin ruffed grouse population. Dissertation Absts. 20(3):832-833.
- Edminster, F. C. 1947. The ruffed grouse. The MacMillan Co., New York. 385pp.
- Erickson, A. B., P.R. Highby and C. E. Carlson. 1949. Ruffed grouse populations in Minnesota in relation to blood and intestinal parasitism. J. Wildl. Mgmt. 13(2):188-194.
- Erwin, L. E. 1966. Personal communication dated 8 Sept. 66 in author's personal file.
- Fisher, L. W. 1939. Studies of the eastern ruffed grouse (*Bonasa u. umbellus*) in Michigan. Bull. Michigan Agr. Expt. Sta. 166. 46pp.
- Goble, F. C. and H. L. Kutz. 1945. The genus *Dispharynx* (Nematoda: Acuariidae) in galliform and passeriform birds. J. Parasitol. 31(5):323-331.

- Gross, A. O. 1928. Progress report of the New England ruffed grouse investigation committee. Massachusetts Fish and Game Assoc. 10pp. (From Bio. Abst. 8(3):7591).
- 1930. Progress report of the Wisconsin prairie chicken investigations. Wisconsin Cons. Comm. 112pp.
- Hamerstrom, F. N., Jr. 1941. A study of Wisconsin prairie grouse (Breeding habits, winter foods, endoparasites, and movements). Unpublished Ph.D. thesis, Univ. Wisconsin. 140pp.
- Hull, T. G. 1955. Diseases of animals transmissible to man. Chas. Thomas, Springfield, Illinois 4th ed. 717pp.
- Ishii, N. 1942. New parasite records from the ruffed grouse. J. Parasitol. 28(1):92.
- Jones, Myrna F. 1935. The cestode Hymenolepis microps in ruffed grouse. Proc. Helm. Soc. Washington 2:92.
- Kagan, I. G. 1953. Revision of the subfamily Leucochloridiinae Poche, 1907. (Trematoda:Brachylaemidae). Amer. Mid. Nat. 48:257-301.
- Leidy, J. 1887. Tape-worms in birds. J. Comp. Med. 8:1-11.
- Leigh, W. H. 1939. Variation in a new cestode of the genus Raillietina (Skrjabinia) from the prairie chicken. J. Parasitol. 25(6):Suppl. 10.
- 1940. Preliminary studies on parasites of upland game birds and fur-bearing mammals in Illinois. Illinois Nat. Hist. Sur. Bull. 21(5):185-194.
- 1941. Variation in a new species of cestode, Raillietina (Skrjabinia) variabila from the prairie chicken in Illinois. J. Parasitol. 27(2):97-106.
- Levine, P.P. and F.C. Goble. 1947. Parasitism and disease. In Bump, Darrow, Edminster and Crissey, The Ruffed Grouse. New York State Cons. Dept. 915pp.

- Madsen, H. 1949. Heterakis gallinarum (Schrank, 1788) nec. Heterakis gallinae (Gemelin, 1790). J. Parasitol. 35(5):543.
- , 1950. Studies on species of Heterakis (nematodes) in birds. Danish Rev. Game Biol. 1(3):1-43.
- Mahon, June. 1956. On a collection of avian cestodes from Canada. Canadian J. Zool. 34(2):104-119.
- Mawson, Patricia M. 1956. Ascaroid nematodes from Canadian birds. Canadian J. Zool. 34(1):104-119.
- McIntosh, A. 1932. Some new species of trematode worms of the genus Leucochloridium Carus, parasitic in birds from northern Michigan, with a key and notes on other species of the genus. J. Parasitol. 19(1):32-53.
- Morgan, B.B. and F. N. Hamerstrom, Jr. 1941. Notes on the endoparasites of Wisconsin pinnated and sharp-tailed grouse. J. Wildl. Mgmt. 5(2):194-198.
- , 1944. Bird mortality. Passenger Pigeon 6(2):27-34.
- Mosby, H.S. (Ed.). 1963. Wildlife investigational techniques. Edwards Bros., Inc. Ann Arbor Michigan. 419pp.
- Mueller, J.F. 1941. Some parasites newly recorded for the ruffed grouse, Bonasa umbellus, in the United States. Proc. Helm. Soc. Washington 8(1):14-15.
- Rankin, J.S. 1946. Helminth parasites of birds and mammals in western Massachusetts. Amer. Mid. Nat. 35:745-768.
- Ransom, B.H. 1909. The taenoid cestodes of North American birds. U. S. Natl. Museum Bull. 69. 141pp.
- Read, C. P. 1949. Studies on North American helminths of the genus Capillaria Zender, 1800 (Nematoda): III. Capillarids from the lower digestive tract of North American birds. J. Parasitol. 35(3):240-249.

- Schwartz, C.W. 1945. The ecology of the prairie chicken in Missouri. Univ. of Missouri Studies 20(1):1-99.
- Shillinger, J.E. and L. C. Morley. 1937. Diseases of upland game birds. USDA Farmers Bull. 1781. 34pp.
- Shoemaker, H. H. 1961. Rearing of young prairie chickens in captivity. Illinois Wildl. 16(4):
- Simon, F. 1937. A new cestode, Raillietina centrocerci, from the sage grouse Centrocercus urophasianus. Tran. Amer. Mic. Soc. 56(3):340-343.
- 1939. Cheilospirura centrocerci, a new nematode from the sage grouse Centrocercus urophasianus. Trans. Amer. Mic. Soc. 58(1):78-80.
- 1940. The parasites of the sage grouse. Univ. of Wyoming Publ. 7(5):77-100.
- Stafseth, H. J. and A. Kotlan. 1925. Report of investigation on an alleged epizootic of ruffed grouse in Michigan. J. Amer. Vet. Med. Assoc. 67:260-267.
- Strand, E. 1929. Zoological and palaeontological nomenclatorial notes. Latvijas Univ. Sist. Zool Inst. Riga Darbi (29):1-29.
(Reprinted from Acto Univ. Latviensis 20:1-29).
- Swales, W. E. 1933. A review of Canadian helminthology. 1. The present status of knowledge of the helminth parasites of domesticated and semidomesticated mammals and economically important birds in Canada, as determined from work published prior to 1933. Canadian J. Res. 8:458-477.
- 1934. Rhabdometra odiosa (Leidy, 1887) Jones, 1929, a cestode parasite of Pedioecetes phasianellus in Quebec. J. Parasitol. 20(5):313-314.
- Wehr, E. E. 1931. A new species of nematode worm from the sage grouse. Proc. U. S. Natl. Museum 79(3): 1-3.
- 1932. Occurrence of a nematode, Cheilospirura spinosa Cram, 1927, as a parasite of the sage grouse

of western U. S. J. Parasitol. 19:90.

- , 1938. A new species of crop worm, Goncytonema phasianella, from the sharp-tailed grouse. Livro Jubilar Prof. Lauro Travassos:523-525.
- , 1940a. Nematodes of domestic fowls transmissible to wild game birds. Vet. Med. 35(1):52-58.
- , 1940b. A new intestinal roundworm from the ruffed grouse (Bonasa umbellus) in the United States. J. Parasitol. 26(5):373-376.
- , 1965. Nematodes and acanthocephalids of poultry. In Diseases of Poultry, Biester and Schwarte Ed. 5th ed., The Iowa State Univ. Press, Ames. 1382pp.
- Williams, J. E. 1965. Paratyphoid and Arizona infections. In Diseases of Poultry, Biester and Schwarte Ed. 5th ed. The Iowa State Univ. Press, Ames. 1382pp.
- Yeatter, R. E. 1943. The prairie chicken in Illinois. Illinois Natl. Hist. Sur. Bull. 22(4):377-416.

SURVEY OF SALMONELLA SPP. AND HELMINTHS OF THE ALIMENTARY
TRACT OF THE GREATER PRAIRIE CHICKEN
(Tympanuchus cupidio pinnatus) IN KANSAS

by

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AN ABSTRACT OF A MASTER'S REPORT

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Viscera of 106 prairie chickens collected in 1964 and 1965 were examined for endoparasitic helminths. Three species of nematodes were found in this study: Seurocyrnea colini, Heterakis gallinarum and Dispharynx nasuta. Seurocyrnea colini occurred in 77.3, H. gallinarum in 24.5 and D. nasuta in 13.2 percent of the 106 visceral samples examined in 1964 and 1965. None of the nematodes were considered serious mortality threats to prairie chicken in the observed infections.

Two species of cestodes were found in 1964, but were too badly damaged to be identified. One of the specimens had a paruterine organ present in the gravid proglottids. Three scoleces which had withdrawable rostellums were recovered from one bird. The specimens recovered appeared similar to Choanotaenia, Raillietina and Metroliasthes.

The incidence of parasitism was 82.1 percent for all samples examined. Adult birds had a 75.8 and juveniles an 84.4 percent incidence of parasitism. The heaviest degree of infection was 27 nematodes in one bird. Dispharynx nasuta has not previously been recorded from prairie chickens and was recorded for the first time in this study.

A survey for the presence of Salmonella spp. was conducted for the 71 specimens collected in 1965. All the samples were negative for salmonella and other pathogenic bacteria.