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A Survey of the Helminth Parasites of Pheasants from Brown County, South Dakota

Donald E. Gilbertson

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27

A SURVEY OF THE HELMINTH PARASITES OF
PHEASANTS FROM BROWN COUNTY,
SOUTH DAKOTA

BY

DONALD E. GILBERTSON

This thesis is prepared as a satisfactory, independent investigation
by a candidate for the degree, Master of Science, and is acceptable as
meeting the degree requirements for this degree, but not being suitable
for an education in the field of the subject and consequently the
classification of the subject, manuscript.

Donald E. Gilbertson
Faculty Advisor

Donald E. Gilbertson

A thesis submitted
in partial fulfillment of the requirements for the
degree Master of Science, Department of
Entomology-Zoology, South Dakota
State College of Agriculture
and Mechanic Arts

August, 1962

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PHEASANTS FROM BROWN COUNTY,
SOUTH DAKOTA

This thesis is approved as a creditable, independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Adviser

Head of the Major Department

2661m

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INTRODUCTION

This paper presents a study of the helminth endoparasites of the Chinese or ring-necked pheasant (Phasianus colchicus). The digestive and respiratory tracts of 262 pheasants, all of which were collected from Brown County, South Dakota, were examined. Collections were made from January, 1961, through November of the same year. The problem was divided as follows: (1) locating and identifying the helminth parasites, (2) relating parasitism to the age of the birds, (3) ascertaining the seasonal distribution of the parasites, and (4) determining what gross pathological changes were due to parasitism.

Previous to this study, little or no literature was available regarding the pheasant parasites of this state, and few systematic investigations of this nature had been undertaken in any region. Most of the reports from areas in the United States where the pheasant has become established limit the discussion of parasitism to isolated notations of occurrence or to host lists. Thus, this study was made in order to obtain a record of the occurrence, incidence, and effect on the host by pheasant parasites in South Dakota.

REVIEW OF THE LITERATURE

Many species of parasitic worms are harbored in the digestive and respiratory tracts of pheasants. However, the infections are generally light and seldom cause the pheasant serious trouble. Helminth infection as a cause of death among wild pheasants seemingly is uncommon. Cheatum (1952) examined 850 pheasants which were collected in New York and found that 475 harbored helminths. He reported the importance of parasitic worms as agents of disease as being negligible, except under some circumstances where the pheasant populations are concentrated as a result of barriers to natural dispersal.

Clapham (1961) autopsied 3,830 pheasants (many of which were artificially reared) in England from 1947 to 1958. She noted 400 casualties associated with helminth infection. In a study of 156 pheasants from Minnesota, Olsen (1938) found 84 to be parasitized. No mention of pathogenicity was made in this study, but it was noted that the cecal worm (Heterakis gallinarum) was by far the most common parasite encountered. This worm is rarely found to be associated with pathogenesis.

A complete list of the helminths occurring in pheasants is found in the Appendix (Tables A, B, and C).

Nematodes

Nematodes constitute the most important group of helminths occurring in pheasants as regards numbers and pathogenicity. The small cecal worm, Heterakis gallinarum, has been reported in every study of pheasant parasites reviewed by this author. Cheatum (1952) noted the presence of H. gallinarum in 394 birds of 850 examined in New York. Other investigators reveal similar results: Leigh (1940) reported this worm in 19 of 41 birds in Illinois and noted no other helminths were present; Olsen (1938) found that 79 of 156 pheasants collected in Minnesota harbored H. gallinarum; and Morgan (1939) recorded this worm in 15 of 25 pheasants from Oregon. This worm has long been recognized as a common parasite of domestic poultry and a number of other birds, and as the vector of Histomonas meleagridis, the etiological agent of blackhead in turkeys.

The importance of H. gallinarum as an agent of disease in pheasants is negligible. Reference to a single case of macroscopic pathology associated with the presence of this worm was made in the New York study, and two pheasants recovered in Washington were found to have died as a result of H. gallinarum infections (Brugger, 1941).

Heterakis isolonche, a cecal worm causing a nodular typhlitis, has been reported from wild pheasants in the

United States (Schwartz, 1924). This species is not known to be common in North America, but it is commonly found among the wild and domestic pheasants of Europe. Clapham (1961) recorded H. isolonche in 304 of 3,830 pheasants from England and noted that this worm was responsible for the death of 143 of the birds autopsied.

Several species of Capillaria are known to infect pheasants. Two cropworms, Capillaria contorta and C. annulata, have been reported from pheasants in the United States. The former was noted in 11 of 25 pheasants from Oregon (Morgan, 1939) and in four of 156 birds from Minnesota (Olsen, 1938). The latter species was taken from pheasants in New York by Hendrickson and De Volt (1928), and from New Jersey pheasants by Graham (1935). Both species are known to cause severe pathological effects when present in large numbers. C. contorta has been shown to cause a severe catarrhal inflammation with a subsequent sloughing of the necrotic epithelium (Cram, 1936), whereas C. annulata has been found to initiate the production of a diphtheritic pseudomembrane made up of fibrin and necrotic tissue (Graham, 1935). A third capillarid, C. phasianina, was reported in the mucosa of the ceca from two artificially-reared pheasants in Illinois by Dr. T. B. Stewart of the College of Veterinary Medicine, University of Illinois (personal communication, May 25, 1962). Dispharynx spiralis was found in two pheasants collected from eastern Long

Island (Goble and Cheatum, 1943) and in two pheasants from an isolated population from Robins Island, New York (Cheatum, 1952). The latter report was extracted from a study conducted from 1938 to 1945. The two cases of parasitism by D. spiralis occurred in a sample of 203 juvenile pheasants. No proventricular worms were found among 937 adults which were examined in the same study. Madsen (1941) recorded D. spiralis in three of 67 pheasant chicks from Denmark, but 169 adult pheasants autopsied in the same study were not infected by this parasite.

The gapeworm, Syngamus trachea, has been recorded from pheasants in several areas. Infections by this worm tend to be more common in juvenile than in adult birds. Goble and Kutz (1945) noted this worm in the trachea of 10 of 203 juvenile pheasants in New York, but found that only five of 937 adults were infected. Studies by Olivier (1944) and Guilford and Herrick (1954) have shown that pheasants acquire a resistance to S. trachea as a result of early infections.

S. trachea is considered to be an important parasite among turkey poults, young chickens, and guinea hens as well as pheasants (Morgan and Hawkins, 1949). Death of young birds commonly occurs as a result of occlusion of the tracheal lumen. Clepham (1961) found gapeworms to be the most important parasite, in terms of pathogenicity, among the 3,830 pheasants that she autopsied. Of the 400

casualties associated with helminth infection, gapeworms were responsible for 245.

Ascaridia galli, the large roundworm of poultry, is not frequently encountered in pheasants, although it is very common in domestic poultry and a number of wild birds. Clapham (1961), in her autopsy of 3,830 pheasants from England, recorded A. galli from only nine birds and noted no pathogenesis. Erickson, et al. (1951) recorded Ascaridia sp. from one of 278 pheasants in Minnesota.

Cestodes

Cestode infections do not seem to be common among pheasant populations. Yamaguti (1959) lists Raillietina cesticillus and Choanotaenia infundibulum as occurring in pheasants in this country. In addition, Morgan (1939) listed Hymenolepis (= Echinolepis) carioca and Hymenolepis (= Staphylepis) cantaniana from pheasants in Oregon, and Buss (1946) reported Rhabdometra nullicolis from a pheasant in Wisconsin.

Reports of gross pathologies associated with cestode infections in pheasants are rare. With the exception of R. nullicolis, all of the above-named cestodes are relatively common parasites of domestic poultry, where they have been shown to cause some retardation of growth among heavily infected birds, but show few if any symptoms when infections are light. Enteritis and hemorrhage may occur in the case

of heavy infections of R. cesticillus and C. infundibulum, but no lesions are associated with H. carioca or H. cantaniana (Morgan and Hawkins, 1949). Clapham (1961) reported a single case of nodular enteritis due to R. cesticillus in a pheasant in England.

Trematodes

The digenetic flukes, Echinoparyphium recurvatum and Echinoparyphium contiguum, were recorded in North American pheasants for the first time by Olsen (1938) in Minnesota. The former is a parasite in the small intestine of water birds, chickens, and turkeys, whereas the latter had otherwise been recorded only from the intestine of muskrats and mink. Neither parasite was commonly encountered, with E. recurvatum being found twice and E. contiguum once from 156 birds.

Flukes were not reported from the digestive or respiratory tracts of pheasants in any of the other North American studies cited in this review. However, the pheasant is known to be susceptible to infections by the oviduct fluke (Prosthogonimus macrorchis). Studies by Macy (1940) have shown that egg-laying is greatly reduced by the presence of this fluke in the pheasant oviduct.

Acanthocephala

Acanthocephala have not been recorded from pheasants

in North America. However, Clapham (1938) recorded an acanthocephalan parasite, Prosthynchus transversus, from pheasants in England. This worm occurs in the small intestine of various wild birds, where it is known to cause symptoms of inflammation and enteritis.

PROCEDURE

A total of 262 ring-necked pheasants, comprising 92 adults and 165 juveniles, was collected for this study. Collections were made by the author with assistance from the South Dakota Department of Game, Fish, and Parks. All specimens were taken in 1961, with periodic collections as follows: 106 birds taken in January and February, 31 in July, 27 in August, 31 in September, 36 in October, and 31 in November. Collecting was limited to Brown County, South Dakota, and most of the birds were taken by shooting, although a few road-killed specimens were included. Data on sex, condition, date of collection, pathology, and age¹ were recorded on individual host-parasite record sheets. The viscera were then removed, placed in individual plastic bags, and stored in a freezer until examination.

The examinations were made after segregating the major portions of the respiratory and digestive tracts (Figure 1). Each portion was placed in a separate black pan half-filled with water. The portions were then carefully slit, and systematic examinations were made under a dissecting microscope. The parasitic worms were removed, washed, and placed in numbered vials containing a 10 per

¹Criteria for age determination were spur length (Stokes, 1957) and the bursa of Fabricius (Linduska, 1943).

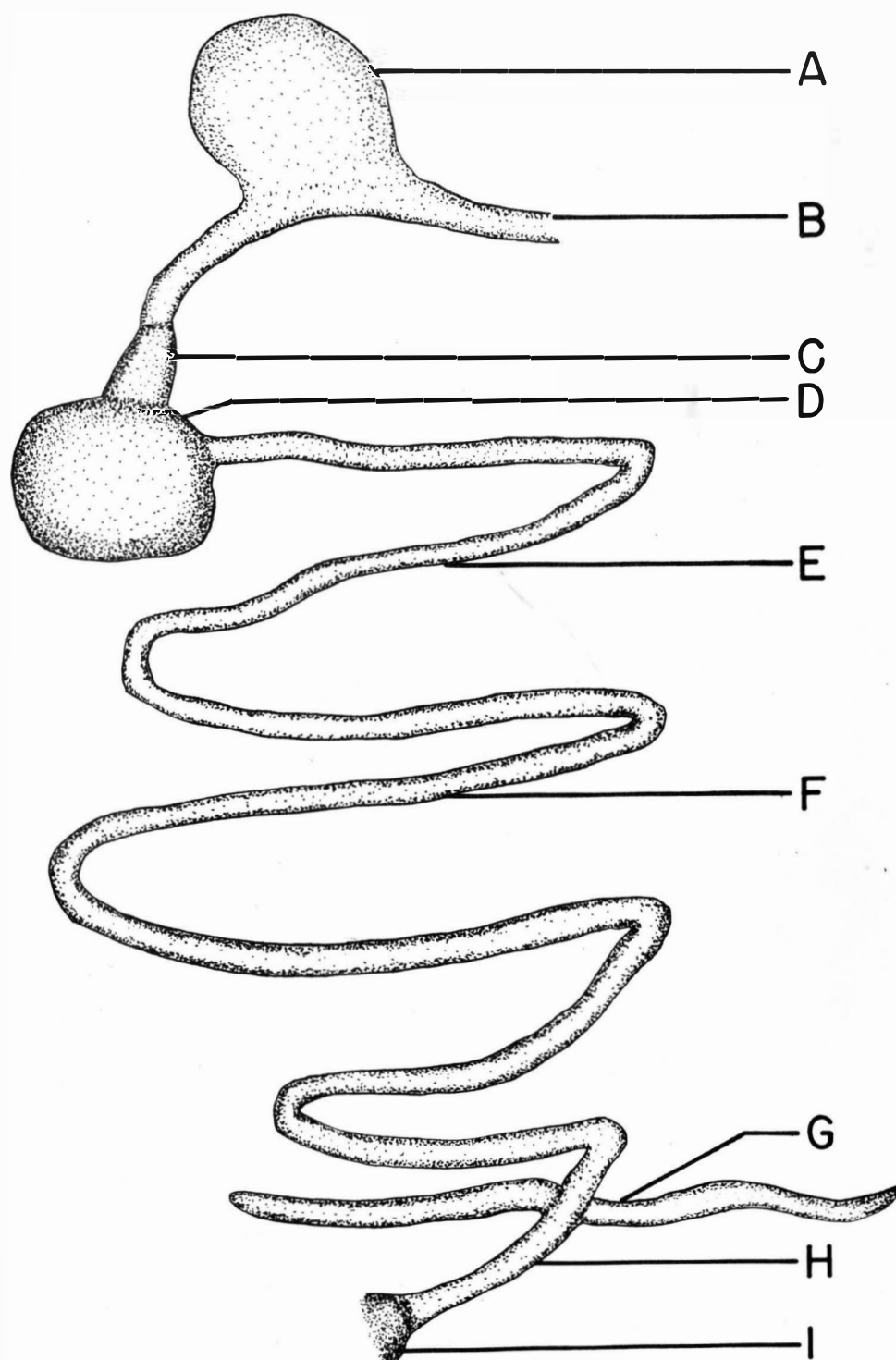


Figure I. The digestive tract of a pheasant: (A) crop, (B) esophagus, (C) proventriculus, (D) gizzard, (E) duodenum, (F) ileum, (G) cecum, (H) colon, and (I) vent

cent formalin solution. Entries were made on the host-parasite sheets regarding the number and type of parasites found in each bird.

The cestodes were removed from the formalin solution, washed with distilled water, and placed in ascending series of alcohol solutions in preparation for staining. Specimens were stained with aceto-carmin stain in 70 per cent alcohol, destained, and subsequently placed in dehydration series of 85 per cent, 95 per cent, and absolute alcohol solutions. They were then cleared in a mixture of one-half absolute alcohol and one-half xylol and finally placed in pure xylol. Selected specimens were mounted on slides with Permount.

The nematodes were cleared for study with glycerine. The worms were placed in Stender dishes containing 95 parts of 70 per cent alcohol and five parts of glycerine. The alcohol was allowed to evaporate and glycerine was added until it completely replaced the alcohol.

INCIDENCE AND NATURE OF HELMINTH INFECTIONS

Of the 262 pheasants examined, 97, or 37.02 per cent harbored one or more species of parasitic worms. Eighty-six birds were parasitized by a single species of helminth, whereas only eleven birds were involved with multiple infections. Three species of parasites were found. The small cecal worm, Heterakis gallinarum, occurred in 92 birds (35.11%) whereas other helminths were much less frequently encountered. A tapeworm, Choanotaenia infundibulum, occurred in 15 birds (5.73%) and a single specimen of the roundworm, Ascaridia galli, was found in one bird (.38%). The latter two parasites were found in the anterior one-third of the small intestine. No evidence of macroscopic pathology was noted in the birds.

Adult pheasants were more frequently parasitized than the young-of-the-year birds, or juveniles. Forty-four (47.83%) of 92 adults were parasitized, whereas of the 165 juveniles examined, helminth parasites were recorded from 51 (30.91%). An additional five birds examined were of undetermined age.

H. gallinarum infections were more common in adult than in juvenile birds, whereas C. infundibulum infected nearly equal percentages of birds in the two groups (Table 1). The specimen of A. galli was found in an adult bird. The number of H. gallinarum per bird ranged

Table 1. Relative Frequency of Helminth Parasites
of Adult and Juvenile Pheasants

Parasite	Number of adult birds examined	Number infected	Per cent	Number of juveniles examined	Number infected	Per cent	Birds of unknown age examined	Number infected	Per cent	Total Number infected	Per cent
Nematodes											
<u>Heterakis</u> <u>gallinarum</u>	92	44	48.83	165	46	27.88	5	2	40.00	92	35.11
<u>Ascaridia galli</u>	92	1	1.09	165	0	-	5	0	-	1	1.03
Cestodes											
<u>Choanotaenia</u> <u>infundibulum</u>	92	5	5.43	165	9	5.45	5	1	20.00	15	5.73

from one to 81, with an average of 9.68 per Heterakis-infected bird. Three pheasants harbored heavy infections of C. infundibulum. One of these birds was an adult, one was a juvenile, and one was of uncertain age.

H. gallinarum infections reached the greatest frequency among the adult birds which were collected in July (Figure II). Seventy-two per cent of these birds were parasitized by cecal worms, but five juvenile pheasants collected during the same period did not harbor this parasite. The number of worms per bird was highest in the July adult group, also with each Heterakis-parasitized bird averaging 12.72 cecal worms, as compared with an average of 9.68 for all groups.

C. infundibulum was present in one of 31 birds taken in November, but was not found in 27 adult and 79 juvenile birds comprising the January-February¹ collection (Table 2). This worm was encountered most frequently in the birds taken during October, when they were present in six of 36 birds examined.

¹Because collection dates were not available for some birds collected during this period, all of the birds taken during January and February are considered as one group. All of these pheasants were collected from January 1 to February 15.

Figure II. Relationship between time of year and infection with Heterakis gallinarum

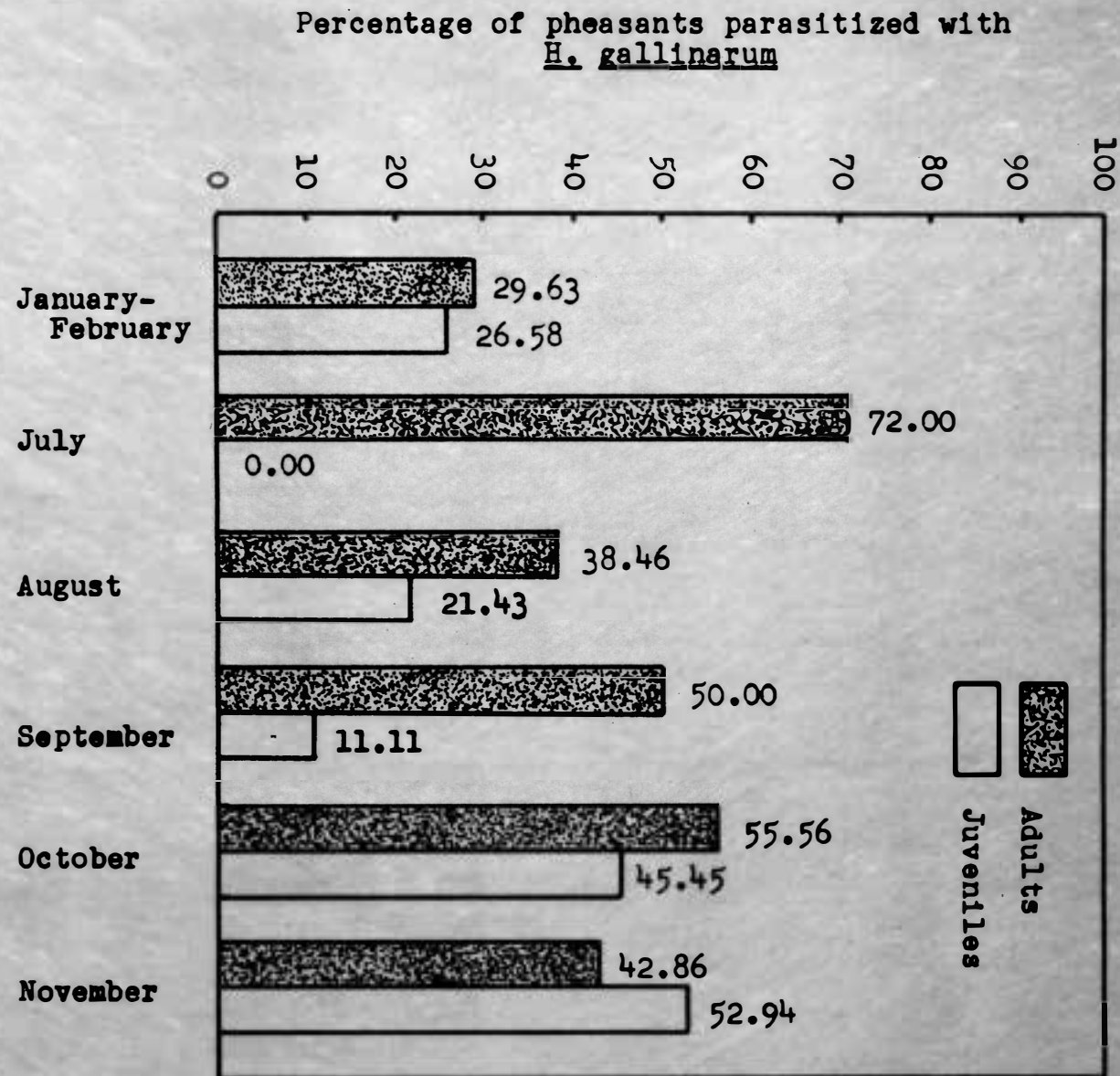


Table 2. Distribution of Parasitism According to Time
of Year and Pheasant Age Class

Month	Age class of pheasant	Number examined	Number infected with <u>Heterakis</u> <u>gallinarum</u>	Per cent	Number infected with <u>Chenotaenia</u> <u>infundibulum</u>	Per cent	Number infected with <u>Ascaridia</u> <u>galli</u>	Per cent	Total infected	Per cent
Jan.-	Adult	27	8	29.63	0	-	0	-	8	29.63
Feb.	Juvenile	79	21	26.58	0	-	0	-	21	26.58
July	Adult	25	18	72.00	3	12.00	1	4.00	18	72.00
	Juvenile	6	0	-	0	-	0	-	0	-
Aug.	Adult	13	5	38.46	0	-	0	-	5	38.46
	Juvenile	14	3	21.43	3	21.43	0	-	5	35.71
Sept.	Adult	4	2	50.00	0	-	0	-	2	50.00
	Juvenile	27	3	11.11	2	7.41	0	-	4	14.81
Oct.	Adult	9	5	55.56	2	22.22	0	-	5	55.56
	Juvenile	22	10	45.45	3	13.64	0	-	12	54.55
	Unknown	5	2	40.00	1	20.00	0	-	2	40.00
Nov.	Adult	14	6	42.86	0	-	0	-	6	42.86
	Juvenile	17	9	52.94	1	5.88	0	-	9	52.94
Totals		262	92		15		1		97	

DISCUSSION

The results of this and other studies indicate that parasites are not significant contributing factors to pheasant losses, provided the birds are not restricted by barriers to natural distribution. However, the sampling technique which seems to characterize this type of study may prevent the finding of the true nature of parasitism among pheasant populations. Most of the specimens were collected by flushing birds to the gun, therefore favoring the collection with stronger, healthier birds. An intensive and continuous search for sick and dead birds, especially during the summer months, might be useful in gaining a more accurate picture of helminth parasitism of pheasants.

Heterakis gallinarum, although present in a large number of the birds examined, is not considered to seriously affect the health of the pheasants. In fact, this worm might possibly be considered to be a commensal rather than a parasite.

The life history and morphology of H. gallinarum were investigated in detail by Clapham (1933). This worm is small (7 to 16 mm long), white, and is covered with a finely striated cuticle which is expanded laterally into two flanges. The male is characterized as having two dissimilar spicules (Figure III), the right and left being

about 2 mm and .65 mm long, respectively. The tail is straight, terminating in a point. The posterior region of the cuticle is expanded into well developed caudal alae which are supported by 12 pairs of papillae. A chitinous pre-anal sucker, 60 to 75 microns in diameter, is also present. The female is usually bulkier and more flexed than the male and has a short (about 1 mm) attenuated tail.

The life cycle of H. gallinarum is direct. The eggs are passed in the feces of the host and become infective in 12 to 17 days. The larvae undergo the first molt within the shell of the egg. Infection of the bird takes place through ingestion of embryonated eggs in contaminated food or water. Hatching of eggs generally occurs in the gizzard or duodenum, and the larvae begin to reach the cecum within six and one-half hours after infection. After the larvae reach the cecum, they begin to invade the superficial mucosa, where they may remain for two to five days, after which they return to the lumen. The second molt occurs four to six days after infection, the third molt nine to ten days, and the final molt about 14 days after infection has occurred. The worms become mature in about 24 to 36 days after infection.

The presence of Heterakis in pheasants throughout the year may be ascribed to the fact that the eggs of this worm are extremely resistant to freezing and desiccation. Eggs may survive desiccation for 16 to 18 days, and eggs

kept at temperatures of zero to ten degrees Fahrenheit for as long as six months have been found to develop embryos (Cram, 1927). It is not known how long this species is able to survive in the pheasant.

The higher frequency of Heterakis in adult birds was found to be highly significant ($P < .01$) using a method described by Snedecor (1956). Cheatum (1952) and Madsen (1948) also reported a greater incidence of this parasite in older birds. It is not known whether this difference is a result of younger birds being more refractory to this parasite, or simply a matter of older birds accumulating their infections through more chance exposure.

Choanotaenia infundibulum infects several species of birds, and is cosmopolitan in distribution. The morphology of this species was studied by Gutberlet (1916) and the life history was worked out by Horsfall and Jones (1937). This cestode is 50 to 200 mm in length and has a rounded or conoidal scolex. The anterior proglottids are very short whereas the older ones tend to be narrower at anterior than at posterior margins, giving a characteristic funnel-shape to each segment. The genital pores are irregularly alternating, situated one in each segment in the anterior third of the lateral margin. Each mature proglottid contains 25 to 40 large testes, all of which are located in the posterior half of the segment (Figure VI). The scolex is rather small with four prominent suckers

and an ovoid rostellum (Figure V).

It is not known how long C. infundibulum is able to remain in the pheasant, but the absence of tapeworms in 105 birds comprising the winter collection suggests that the maximum duration is three or four months. Development of the infective cysticercoids within the insect host is dependent upon the temperature. At 75 to 90 degrees F., 17 to 20 days are required for the development of the cysticercoids to the infective stage, whereas at 65 to 75 degrees F., 48 days is the minimum time for development. Development to the infective stage does not occur at temperatures of 40 to 60 degrees F. (Horsfall and Jones, 1937). The mean monthly temperatures in Brown County in 1961 were favorable to the development of infective cysticercoids only during June, July, and August (Figure VII). Not only do cysticercoids fail to develop during spring and early fall, but there is also less likelihood of the cestode eggs being ingested by insects (Horsfall and Jones, 1937).

The following species of insects may serve as intermediate hosts for C. infundibulum: Grasshoppers, Melanoplus femus-rubrum and Dicromorpha viridis; house fly, Musca domestica; beetles, Geotrupes sylvaticus, Crathanthus dubius, Stenocellus debilipes, Stenolophus conjunctus, Alphitophagus bifasciatus, Apocellus sphaericollis, Ataenius cognatus, Aphodius granarius, Lebia grandis, and Tribolium confusum.

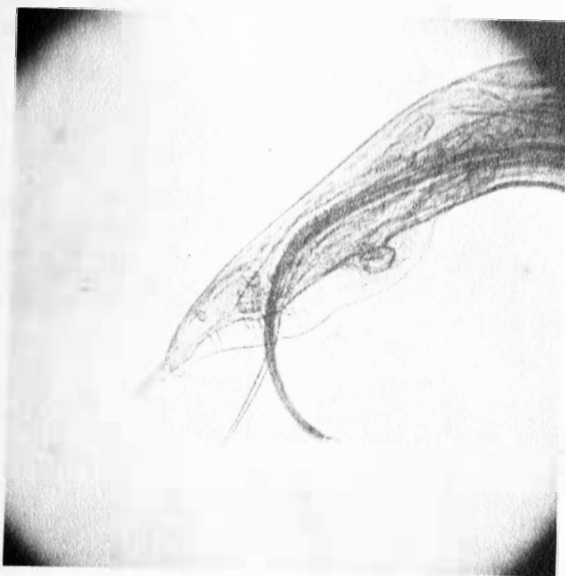


Figure III. Tail of
Heterakis gallinarum

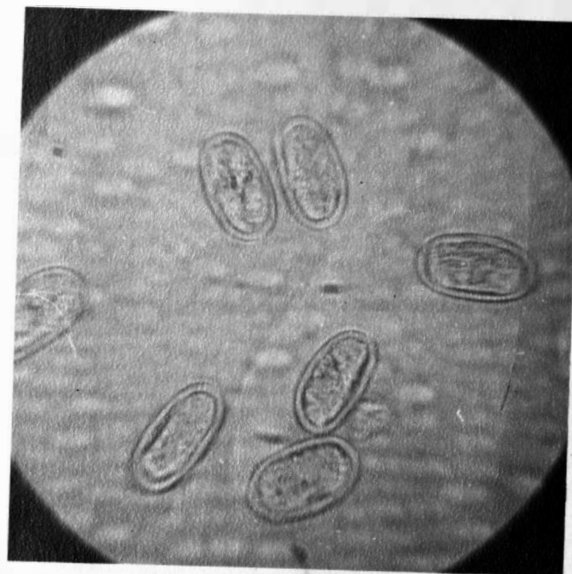


Figure IV. Eggs of
Heterakis
gallinarum

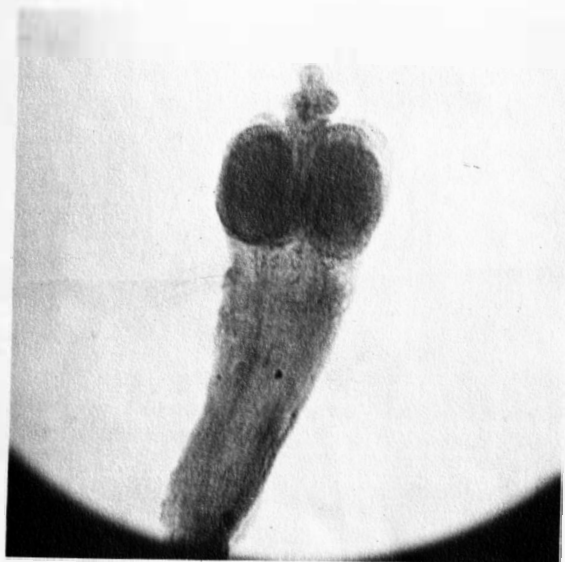


Figure V. Scolex of
Choanotaenia
infundibulum

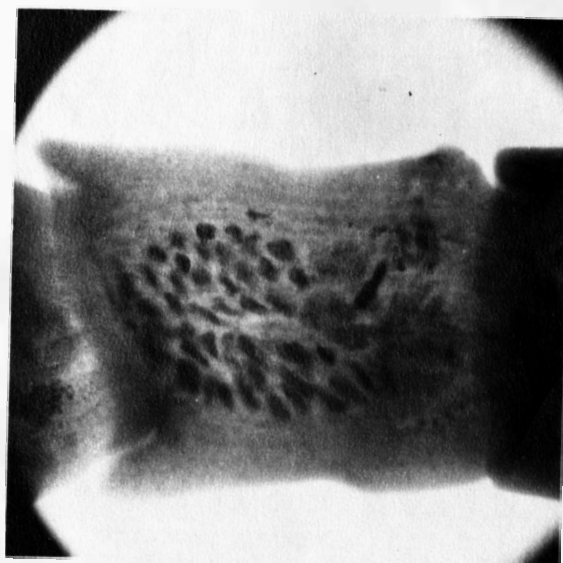


Figure VI. Mature proglottid
of Choanotaenia
infundibulum

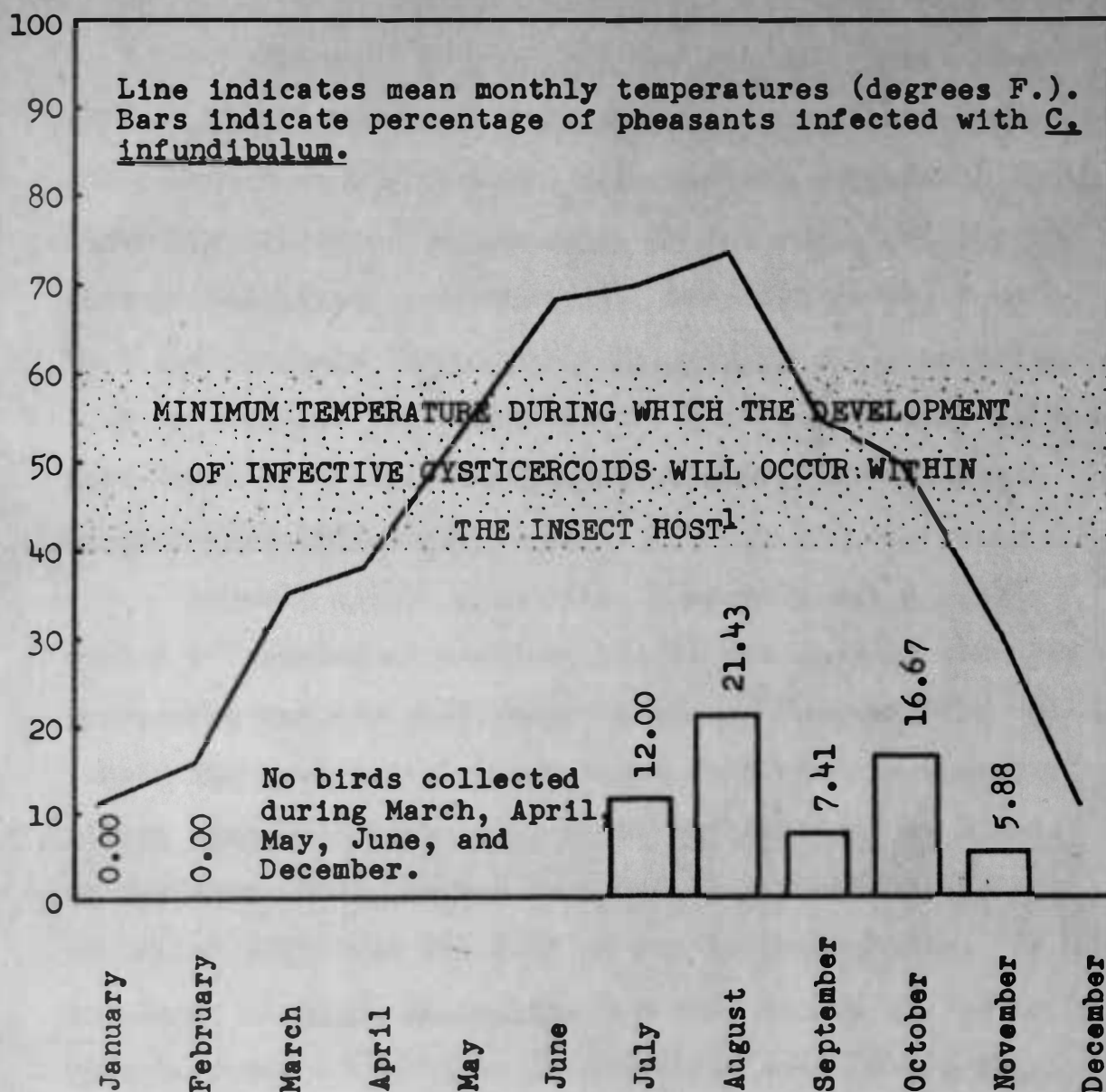


Figure VII. Relationship between temperature and occurrence of Choanotaenia infundibulum

¹After Horsfall and Jones (1937).

Grasshoppers constituted the largest insect food item of the pheasants in this study. During the months of July, August, and September, grasshoppers were found in the digestive tracts of 58 per cent, 89 per cent, and 100 per cent of the birds, respectively. Trautman (1952) found that grasshoppers (principally Melanoplus spp.) comprised 2.29 per cent of the yearly amount and 5.6 per cent of the food taken by pheasants during September, the month of highest representation.

Severin (1933) found that pheasants eat a large number of species of beetles, but do not seem to show any preference for any particular species. However, the soil-inhabiting beetles and those which feed upon low-growing plants were most frequently found in the birds examined. In the same study, it was reported that pheasants do not use flies (Diptera) for food in any large quantity. No specimens of Musca domestica, the only member of the order Diptera found to serve as intermediate host for C. infundibulum, were found in 285 food tubes.

Most of the insect species which will serve as the intermediate host of C. infundibulum occur in eastern South Dakota. Specimens of M. femur-rubrum, D. viridis, M. domestica, C. dubius, S. debilipes, S. conjunctus, A. bifasciatus, A. granarius, L. grandis, and T. confusum have been collected from this region and are present in the insect collection at South Dakota State College.

Although several species of arthropod hosts occur in the area from which the infected pheasants were taken, none can definitely be incriminated as having harbored the infective stages since no attempt was made to locate cysticercoids in insects.

The life cycle of Ascaridia galli is similar to that of H. gallinarum, except that it is found in the small intestine rather than the cecum of the host. This worm is very common in domestic poultry flocks and is also found in turkeys. It is large (30 to 120 mm), with three lips surrounding the mouth. The male, usually smaller than the female, possesses narrow caudal alae which are supported by 10 pairs of papillae. The spicules are subequal and about 4 mm in length. The female has a straight tail, the end of which is conical. The vulva is in the anterior portion of the body (Morgan and Hawkins, 1949).

A. galli does not appear to be a common parasite among pheasant populations. Reasons for the few records of infection by this worm are not known, but perhaps further studies on host resistance would be useful. Studies by Ackert, Edgar, and Frick (1939) have shown that an increased number of goblet cells in the duodenal epithelium of chickens which are three months of age or older provide these birds with considerable resistance to infection. Also, Ackert, et al. (1935) have shown that

there is a natural resistance of various breeds of chickens to A. galli.

The occurrence in this study of only a few of the potential pheasant parasites may be attributed to several factors. The amount of rainfall and soil drainage are known to be important environmental aspects to most helminth infections. Parasite eggs and larvae generally survive best in an abundance of atmospheric and soil moisture. Furthermore, these environmental conditions are more favorable to the intermediate hosts, such as isopods in the case of Dispharynx spiralis and earthworms for Syngamus trachea. The total precipitation in Brown County in 1961 was 15.07 inches, a departure of minus 4.56 inches from the long-term mean. Further investigation is necessary in order to determine whether or not precipitation is a significant factor in the occurrence and distribution of parasites in this region.

There is generally greater danger of parasitism in game-farm pheasants than in natural populations. South Dakota pheasant populations may harbor few, if any, of the parasites which are often found in populations which are supplemented with artificially-reared birds. Pheasants which range in close association with domestic poultry flocks may also acquire helminth infections, as many helminths have a wide host distribution among related gallinaceous birds. Members of the Veterinary Science Department at

South Dakota State College informed the author that Heterakis gallinarum and Ascaridia galli are the helminth parasites most frequently encountered in poultry, and that occasional cestode infections have also been noticed. They further stated that infections with Capillaria, Syngamus, and Dispharynx have not been encountered in their examinations.

A more comprehensive study of pheasant parasitism in this state would be desirable. Some investigators (Chestum, 1952; Clapham, 1961) have found that infections are not spread evenly over the years, but that there are significant yearly variations. Therefore, a four or five year study is advised. Concentrated collections from several areas throughout the state, with the examination of sick and dead birds as well as healthy birds of both age groups, would provide useful information. Such a project would be more feasible if it were carried out in conjunction with other studies, such as investigations of encephalitis and protozoan diseases.

SUMMARY AND CONCLUSIONS

1. The viscera of 262 pheasants were examined for helminth parasites. All of the pheasants were collected from Brown County, South Dakota, during various seasons in 1961. Ninety-seven of the viscera contained parasitic worms.

2. Heterakis gallinarum was the most abundant parasite encountered. This helminth was recovered from 92 birds. Choanotaenia infundibulum, the only cestode present, was carried by 15 birds, and Ascaridia galli was found once. Eleven birds harbored more than one species of helminth. No gross pathologies were noted. All of these helminths had previously been recorded from pheasants, and none is known to be an important agent of disease.

3. Adult birds were significantly higher carriers of H. gallinarum than were juveniles. The reason for this difference is not known. C. infundibulum infected nearly equal percentages of juvenile and adult birds.

4. The greatest infections of H. gallinarum occurred in the adult birds which were collected in July, but this species occurred throughout the year. C. infundibulum was carried only by the birds collected in the summer and fall.

5. Several helminths which have been reported from pheasants in other states were not noted in this study.

The maintenance of a natural pheasant population which is not restricted in distribution is likely to be a factor in keeping parasitism at a minimum in South Dakota.

6. Further investigation is necessary to determine the incidence of parasitism by years and the regional distribution of parasitism, since this study involved only the pheasants collected in a concentrated area over a one-year period. Sampling techniques which do not favor the collection of healthier birds should be practiced in order to obtain a more accurate picture of parasitism in the pheasant population.

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APPENDIX

Table A. Nematodes Found in Pheasants¹

Name of Parasite	Habitat
<u>Ascaridia galli</u> (Schrank, 1788)	Small intestine
<u>Capillaria annulata</u> (Molin, 1858)	Crop
<u>Capillaria cadovulvata</u> Madsen, 1945 ²	Ceca
<u>Capillaria caudinflata</u> (Molin, 1858) ² Synonym: <u>C. longicollis</u> (Rudolphi, 1819)	Small intestine
<u>Capillaria collaris</u> (von Linstow, 1873) ²	Ceca
<u>Capillaria collumbae</u> (Rudolphi, 1819)	Small intestine
<u>Capillaria contorta</u> (Creplin, 1839)	Crop
<u>Capillaria obsignata</u> Madsen, 1945 ²	Small intestine, large intestine, ceca
<u>Capillaria perforans</u> Kotlan and Orosz, 1931 ³	Crop
<u>Capillaria phasianina</u> Kotlan, 1940	Ceca
<u>Capillaria retusa</u> (Railliet, 1893) ²	Ceca
<u>Capillaria uropapillata</u> Freitas, 1935 ⁴	Crop

¹Refer to Cheatum (1952), Clapham (1961), Cram (1927), Goble and Cheatum (1943), Goble and Kutz (1945), Graham (1935), Madsen (1941), McClure (1949), Morgan and Hawkins (1949), Olsen (1938), Schwartz (1924), and Yamaguti (1961).

²Reported only from Europe.

³Reported only from Brazil and Croatia.

⁴Reported only from Brazil.

Table A. (continued)

Name of Parasite	Habitat
<u>Cheilospirura hamulosa</u> (Diesing, 1861) Synonym: <u>Acuaria hamulosa</u> (Diesing, 1851)	Small intestine
<u>Dispharynx spiralis</u> (Molin, 1858) Synonym: <u>D. nasuta</u> (Rudolphi, 1819)	Proventriculus
<u>Heterakis gallinarum</u> (Schrank, 1788) Synonym: <u>H. gallinae</u> (Gmelin, 1790)	Ceca
<u>Heterakis isolonche</u> von Linstow, 1906 Synonym: <u>H. neoplastica</u> Wassink, 1917	Ceca
<u>Oxyspirura manson</u> i (Cobbold, 1879)	Eye
<u>Oxyspirura papawi</u> Skrjabin, 1929	Eye
<u>Subulura skrjabini</u> (Semenov, 1926) ⁵	Small intestine
<u>Subulura suctoria</u> (Molin, 1860) ⁶	Small intestine
<u>Syngamus trachea</u> (Montagu, 1811)	Trachea
<u>Tetrameres americana</u> (Cram, 1927)	Proventriculus
<u>Trichostrongylus tenuis</u> (Mehlis, 1846)	Small intestine

⁵Reported only in Russia from Phasianus colchicus chrysomelas.

⁶Reported only from Russia.

Table B. Cestodes Found in Pheasants¹

Name of Parasite	Habitat
<u>Choanotaenia infundibulum</u> (Block, 1779)	Small intestine
<u>Davainea proglottina</u> (Davaine, 1860) ²	Small intestine
<u>Hymenolepis cantaniana</u> (Polonio, 1860) Synonym: <u>Staphylepis cantaniana</u> (Polonio, 1860)	Small intestine
<u>Hymenolepis carioca</u> (Magalhaes, 1898) Synonym: <u>Eichinolepis cantaniana</u> (Magalhaes, 1898)	Small intestine
<u>Raillietina cesticillus</u> (Molin, 1858)	Small intestine
<u>Raillietina echinobothrida</u> (Megnin, 1889)	Small intestine
<u>Raillietina friedbergeri</u> (von Linstow, 1877) ²	Small intestine
<u>Raillietina multicapsulata</u> (Baczynska, 1914) ³	Small intestine
<u>Rhabdometra nigromaculata</u> Dubinina, 1950 ⁴	Small intestine
<u>Rhabdometra nullicolis</u> Ransom, 1909	Small intestine

¹Refer to Buss (1946), Cheatum (1952), Erickson (1951), Hughes and Schultz (1942), Madsen (1941), Morgan (1939), Olsen (1938), Wardle and McLeod (1952), and Yamaguti (1959).

²Reported only in Europe.

³Reported from Phasianus sp. in Germany.

⁴Reported from Phasianus colchicus bianchii in Russia.