

Diseases and Parasites of the Bobwhite

Forest E. Kellog

Gary L. Doster

28. Stickel, L. F., W. H. Stickel, and R. Christensen. 1966. Residues of DDT in brains and bodies of birds that died on dosage and in survivors. *Science* 151(3711):1549-1551.
29. Sturkie, P. D. 1965. *Avian Physiology*. Cornell Univ. Press, Ithaca, New York. 766 p.
30. Von Oettingen, W. F., and N. E. Sharpless. 1946. The toxicity and toxic manifestations of 2,2-Bis-(p-chlorophenyl)-1,1,1-trichloroethane (DDT) as influenced by chemical changes in the molecule. *J. Pharmacol. Exp. Ther.* 88:400-413.
31. Voss, Terry. 1971. The metabolic effects of DDT on bobwhite quail (Colinus virginianus). M.S. Thesis, Ohio State Univ., Columbus. 48 p.
32. Welch, R. M., W. Levin, and A. H. Conney. 1968. Effects of chlorinated insecticides on steroid metabolism, pages 390-407. In M. W. Miller and G. G. Berg (Eds.) *First Rochester Conference on Toxicity, Chemical Fallout. Current Research on Persistent Pesticides*. Charles C. Thomas, Ill.
33. Wright, B. S. 1965. Some effects of heptachlor and DDT on New Brunswick woodcocks. *J. Wildl. Mgmt.* 29(1):172-185.

DISEASES AND PARASITES OF THE BOBWHITE

Forest E. Kellogg and Gary L. Doster, Southeastern Cooperative Wildlife Disease Study, of Georgia, Athens

Abstract:

The authors' experiences with disease and parasite problems of wild and pen-raised bobwhites are given. Information extrapolated from an extensive literature review is presented in tabular form. Diseases and parasites of bobwhites, location in the bird of the lesion or parasite, and geographic areas of occurrence are noted.

A variety of information concerning diseases and parasites of the bobwhite is available in the technical literature. The majority of mortality reports deal with pen-raised birds, but limited information is available concerning wild bobwhites. Basic publications related to diseases and parasites of bobwhites include: Biester and Schwarte's (1965) *Diseases of Poultry*; Davis, Anderson, Karstad, and Trainer's (1971) *Infectious and Parasitic Diseases of Wild Birds*; the section in Stoddard's (1931) book concerning diseases and parasites of the bobwhite; and Kellogg and Calpin's (1971) checklist of diseases and parasites reported from the bobwhite.

Today, 40 years after Stoddard's (1931) initial disclosure of diseases and parasites affecting quail, there is still little information

as to the role diseases and parasites play in the high annual losses sustained by wild bobwhite populations. Blackhead, tularemia, and ulcerative enteritis (Stoddard 1961, Green and Wate 1929, Shillinger and Morley 1937) have been reported to cause death in wild bobwhites. This paucity of information probably is due to the small number of wild bobwhites that are submitted to diagnostic laboratories.

Only 16 wild bobwhites have been submitted to the Southeastern Cooperative Wildlife Disease Study (SCWDS) for diagnosis during the last 5 years. Deaths were attributed to the following causes: trauma (6), e.g. flying into solid objects; egg yolk peritonitis (3), i.e. the ovum had dropped into the body cavity rather than the oviduct and caused fatal peritonitis; pesticide poisoning (3); aortic rupture (1); proliferation of the "horny" lining of the gizzard (1); fowl pox (1); and fungus infection in the lungs, kidneys, and body cavity (1).

During various research studies we have examined hundreds of wild bobwhites, which were shot or trapped, and have noted only 2 parasite problems. Severe distention of the small intestine by tapeworms has been observed, and proventriculitis caused by large numbers of nematodes (Tetrameres sp.) has been encountered rarely. The proventricular wall in such cases was thickened to the extent that the lumen was almost occluded. Whether or not these problems would have caused death is speculative.

Many disease and parasite problems are associated with pen-raised bobwhites. In our experience the most common problems causing death of pen-raised bobwhites are: quail bronchitis, ulcerative enteritis, blackhead, and infection of the crop by the nematode Capillaria contorta. Problems occasionally occur with the proventricular nematode Dispharynx nasuta and with coccidia, but seldom do these entities alone cause death.

The diseases and parasites of wild and pen-raised bobwhites are presented in Tables 1-4. Location in the bird of lesion or parasite and geographic area of occurrence are given. A few older reports of diseases and parasites listed in the tables are now considered erroneous. The chicken coccidia Eimeria acervulina, E. mitis, and E. tenella have been reported from the bobwhite, but these records are in error (Pellerdy 1965). Eimeria dispersa is the only specific coccidium reported from the bobwhite in recent literature. At least 2 additional species of coccidia, as yet undescribed in the literature, infect the bobwhite (SCWDS, unpublished data). A blood parasite, Plasmodium elongatum, was erroneously reported as Plasmodium praecox in earlier literature (Cram et al. 1931, Wetmore 1941) and an acanthocephalan referred to as Disteganius colini was reported but never described (Lehmann 1953).

The tables and references listed should prove useful to laymen and technical personnel as well. Diagnosticians often lack familiarity with bobwhite diseases and therefore prefer not to examine them. The information included here should help alleviate this problem.

Table 1. Tabulation of viral, bacterial, and mycotic diseases reported from the bobwhite.

Disease (organism)	Location or lesion area	Type of report and geographical location if given*	Refer. No.
VIRAL DISEASES			
Equine encephalitis	brain	exp. inf.	137
		sp. rev.	75
		exp. inf.	156
		exp. inf.	146
Fowl pox	head, under wings, legs, feet, and inside mouth and esophagus	case rept.-Mexico	67
		case rept.-Ga., S.C.	133
		gen. rev.	98
		gen. rev.-southern U.S.	129
Newcastle disease	no lesions, but developed anti- bodies	gen. rev., exp. inf.	65
Quail bronchitis	respiratory tract	case rept.-W.Va.	105
		case rept.-Texas	58
		gen. rev.	132
		exp. inf.	57
		exp. inf.-Texas	59
		sp. rev.	77
		gen. rev.	70
		exp. inf., case rept.-Va.	55
		sp. rev.	56
BACTERIAL DISEASES			
Avian tuberculosis (<u>Mycobacterium avium</u>)	viscera	gen. rev.	129
		gen. rev.	127
Botulism (<u>Clostridium botulinum</u>)	nervous system	exp. inf.-N.Y.	15

Table 1. (continued)

Disease (organism)	Location or lesion area	Type of report and geographical location if given*	Refer. No.
BACTERIAL DISEASES (continued)			
Chronic respiratory disease (<u>Mycoplasma gallisepticum</u>)	lungs and air sacs	unsuccessful exp. inf. case rept.	159 95
Erysipelas (<u>Erysipelothrix rhusiopathiae</u>) (= <u>E. insidiosa</u>)	heart and liver	case rept.-Iowa	142
<u>Escherichia freundii</u>	lower intestine	case rept.	61
Fowl cholera (<u>Pasteurella multocida</u>)	heart and liver	gen. rev. unsuccessful exp. inf.	129 17
Fowl typhoid (<u>Salmonella gallinarum</u>)	heart and liver	gen. rev.	129
Paratyphoids			
<u>Salmonella bareilly</u>	lower intestine	case rept.-Ill.	122
<u>Salmonella bredney</u>	lower intestine	case rept. case rept.	47 48
<u>Salmonella newport</u>	lower intestine	case rept.-Ill.	71
<u>Salmonella oranienburg</u>	liver	case rept.-Ky.	62
<u>Pseudotuberculosis</u> (<u>Pasteurella pseudotuberculosis</u>)	viscera	case rept.-England sp. rev.	24 132
Pullorum (<u>Salmonella pullorum</u>)	liver and lungs	case rept. exp. inf.	64 129
Tularemia	lungs, liver, and spleen	case rept.-Minn. exp. inf. gen. rev. sp. rev., case rept.-Mo.(?) gen. rev.	73 108 72 109 129
(<u>Pasteurella tularensis</u>)			
(= <u>P. tularense</u>)			
(= <u>Bacterium tularense</u>)			
(= <u>Fransicella tularensis</u>)			

Table 1. (continued)

Disease (organism)	Location or lesion area	Type of report and geographical location if given*	Refer. No.
BACTERIAL DISEASES (continued)			
Ulcerative enteritis	lower intestine and liver	sp. rev.-Ala., D.C., Kan., Mass., Pa., Va., Nova Scotia	103
		sp. rev.-Va.	68
		case rept.-Ga.	133
		case rept.-Md.	120
		gen. rev.	126
		gen. rev.	98
		gen. rev.	106
		case rept.-Ill. (?)	3
		sp. rev., exp. inf.	128
		gen. rev.-southern U.S.	99
		sp. rev.	100
		exp. inf.	101
		gen. rev.	129
		sp. rev.	6
		gen. rev.	127
		exp. inf.	7
		sp. rev., exp. inf.	60
		exp. inf.	23
		exp. inf., case rept.-Md.	102
		exp. inf. (drug study)	87
		exp. inf. (drug study)	88
		exp. inf. (drug study)	89
		exp. inf. (drug study)	86
		exp. inf.	112
		exp. inf.	113
		exp. inf. (drug study)	116
		gen. rev.-Wis.	81
		gen. rev.	70

Table 1. (continued)

Disease (organism)	Location or lesion area	Type of report and geographical location if given*	Refer. No.
BACTERIAL DISEASES (continued)			
Ulcerative enteritis	lower intestine and liver	sp. rev.	114
		case rept.-S.C.	84
		exp. inf.-Ga.	18
		gen. rev.	141
		exp. inf.-Ga.	51
		gen. rev.	115
		gen. rev.	139
MYCOTIC DISEASES			
Aspergillosis (<u>Aspergillus fumigatus</u>)	respiratory tract	gen. rev.	72
		case rept.-Va.	133
		gen. rev.	98
Crop mycosis (<u>Candida albicans</u>) (= <u>Oidium albicans</u>)	esophagus and crop	gen. rev.	129
		gen. rev.	132

* Abbreviations used: gen. rev. = mentioned in a general review of diseases; sp. rev. = review of that specific disease or a specific parasite description; exp. inf. = experimental infection; case rept. = case report or survey.

Table 2. Tabulation of protozoan diseases reported from the bobwhite.

Organism	Location or lesion area	Type of report and geographical location if given*	Refer. No.
<u>Chilomastix</u> sp.	lower intestine	case rept.-Ga.	50
<u>Eimeria acervulina</u> (?)	small intestine	case rept.-Ohio	155
		case rept.-Ohio	140
		gen. rev.	129
		gen. rev.	127
		gen. rev.	74
<u>Eimeria dispersa</u>	small intestine and ceca	exp. inf.	136
		gen. rev.	138
		case rept.-Ohio	155
		case rept.-Ohio	140
		gen. rev.	129
		gen. rev.	16
		gen. rev.	127
		gen. rev.	74
		case rept.-Okla.	130
		gen. rev., sp. rev.	91
		gen. rev., sp. rev.	117
<u>Eimeria mitis</u> (?)	small intestine and ceca	gen. rev.	129
		gen. rev.	127
<u>Eimeria tenella</u> (?)	ceca	case rept.-Ohio	155
		case rept.-Ohio	140
		gen. rev.	129
		gen. rev.	127
		gen. rev.	74
<u>Eimeria</u> spp.	lower intestine	case rept.-Fla., Ga., Miss., N.C., S.C., Tenn.	45
		gen. rev.	98

Table 2. (continued)

Organism	Location or lesion area	Type of report and geographical location if given*	Refer. No.
<u>Eimeria</u> spp. (continued)	lower intestine	case rept.-Miss. gen. rev., sp. rev. gen. rev., sp. rev. gen. rev.	145 91 117 141
<u>Haemoproteus</u> sp.	erythrocytes	case rept.-Md. sp. rev. (survey in N.Mex. neg.) sp. rev. (survey in Iowa neg.)	154 21 123
<u>Hexamita</u> sp.	ceca	gen. rev.	132
<u>Histomonas meleagridis</u>	ceca and liver	gen. rev. gen. rev. gen. rev. gen. rev. gen. rev. gen. rev. case rept. case rept.-Ga., S.C. sp. rev., exp. inf.-Ga. sp. rev., exp. inf.-Md.	45 126 98 99 129 127 134 84 85 94
<u>Plasmodium elongatum</u> (= <u>Plasmodium praecox</u> of Cram et al. 1931)	erythrocytes	case rept.-Ga. case rept.-Ga., Md.	45 154
<u>Plasmodium</u> sp.	erythrocytes	exp. inf. sp. rev. (survey in N.Mex. neg.) sp. rev. (survey in Iowa neg.)	153 21 123
<u>Trichomonas gallinae</u>	esophagus and crop	exp. inf.	92
<u>Trichomonas</u> sp.	ceca	case rept.-Va. gen. rev., case rept.-Va.	1 45

Table 2. (continued)

Organism	Location or lesion area	Type of report and geographical location if given*	Refer. No.
<u>Trichomonas</u> sp. (continued)	ceca	gen. rev.	98
		gen. rev.	129
		gen. rev.	127

* Abbreviations used: gen. rev. = mentioned in a general review of diseases; sp. rev. = review of that specific disease or a specific parasite description; exp. inf. = experimental infection; case rept. = case report or survey.

Table 3. Tabulation of helminths reported from the bobwhite.

Helminth	Location or lesion area	Type of report and geographical location if given*	Refer. No.
TREMATODES			
<u>Harmostomum</u> sp. (= <u>Brachylaema</u> sp.)	small intestine	case rept.-Md., N.C.	45
CESTODES			
<u>Davainea</u> sp.	small intestine	case rept.-Texas	90
<u>Hymenolepis cantaniana</u> (= <u>Staphylepis cantaniana</u>)	small intestine	case rept.-Md. sp. rev., case rept.-Md. exp. inf.	79 45 80
<u>Hymenolepis carioca</u> (= <u>Echinolepis carioca</u>)	small intestine	exp. inf., case rept. sp. rev., case rept.-Fla., Ga., Va. case rept.-Miss. case rept.-Miss. case rept.-Ga.	44 45 144 145 84
<u>Hymenolepis</u> sp.	small intestine	case rept.-Ohio case rept.-Ohio case rept.-Texas	155 140 110
<u>Paricterotaenia</u> sp.	small intestine	case rept.-Texas case rept.-Texas case rept.-Texas	151 148 90
<u>Raillietina cesticillus</u> (= <u>Davainea cesticillus</u>)	small intestine	exp. inf., case rept. case rept.-Fla. sp. rev., case rept.-Fla., Ga., Miss., Tenn. case rept.-Texas case rept.-Miss.	44 135 45 147 145

Table 3. (continued)

Helminth	Location or lesion area	Type of report and geographical location if given*	Refer. No.
CESTODES			
<u>Raillietina cesticillus</u> (continued)	small intestine	case rept.-Texas	151
		case rept.-Fla., Ga.	84
		case rept.-Tenn.	14
<u>Raillietina colini</u>	small intestine	sp. rev., case rept.-Texas	147
		case rept.-Texas	151
		case rept.-Texas	148
		sp. rev.	125
<u>Raillietina klebergi</u>	small intestine	sp. rev., case rept.-Texas	148
		case rept.-Texas	150
		case rept.-Texas	90
		sp. rev.	125
<u>Raillietina minuta</u>	small intestine	sp. rev., case rept.-Texas	148
		case rept.-Texas	150
		case rept.-Texas	90
		sp. rev.	124
<u>Raillietina tetragona</u>	small intestine	sp. rev., case rept.-Fla., Ga., S.C., Va.	45
		case rept.-Texas	148
		case rept.-Texas	110
		case rept.-Texas	90
<u>Raillietina</u> sp.	small intestine	case rept.-Texas	110
		case rept.-Fla., Ga., S.C.	84
		case rept.-Tenn.	14
<u>Rhabdometra odiosa</u>	small intestine	sp. rev., case rept.-Fla., Ga.	78
		sp. rev., case rept.-Fla., Ga.	45

Table 3. (continued)

Helminth	Location or lesion area	Type of report and geographical location if given*	Refer. No.
CESTODES (continued)			
<u>Rhabdometra odiosa</u> (continued)	small intestine	case rept.-Miss.	144
		case rept.-Miss.	145
		case rept.-Texas	151
		case rept.-Texas	148
		case rept.-N.C.	104
		case rept.-Texas	90
		case rept.-Ill.	19
		case rept.-Tenn.	14
<u>Rhabdometra</u> spp.	small intestine	case rept.-Ga.	84
		case rept.-Tenn.	14
ACANTHOCEPHALANS			
<u>Mediorhynchus bakeri</u>	small intestine	case rept.-Fla.	20
<u>Mediorhynchus colini</u> (= <u>Disteganius colini</u>)	small intestine	sp. rev., case rept.-Texas	149
		case rept.-Texas	110
		case rept.-Texas	90
<u>Onicola canis</u>	immature worms encysted in connective tissue outside crop and esophagus	case rept.-N.C., Mexico	37
NEMATODES			
<u>Aproctella stoddardi</u>	free in body cavity	sp. rev., case rept.-Fla., Ga.	45
		sp. rev., case rept.-Fla., Ga., S.C.	43
		sp. rev.	2

Table 3. (continued)

Helminth	Location or lesion area	Type of report and geographical location if given*	Refer. No.
NEMATODES (continued)			
<u>Ascaridia compar</u>	small intestine	sp. rev.	29
		case rept.-Fla.	193
<u>Ascaridia lineata</u>	small intestine	case rept.-Ga.	45
<u>Aulonocephalus guaricensis</u>	ceca	sp. rev., case rept.-Cuba	4
		sp. rev., case rept.-Cuba	5
<u>Aulonocephalus lindquisti</u>	ceca	case rept.-Texas	151
		case rept.-Texas	148
		case rept.-Texas	90
<u>Capillaria annulata</u>	crop	case rept.-Fla.	135
		case rept.-Va.	45
		gen. rev.	106
		gen. rev., sp. rev.	42
<u>Capillaria contorta</u>	crop	gen. rev., case rept.-N.J.	34
		exp. inf.	45
		gen. rev., sp.rev.-N.C.	42
		sp. rev.	152
		case rept. (drug study)-N.Y.	26
		case rept. (drug study)-N.Y.	27
		case rept.-Ga., S.C.	84
		case rept. (drug study)-Ga.	52
		case rept. (drug study)-Ga.	53
<u>Capillaria obsignata</u>	small intestine and	exp. inf.	45
(= <u>C. retusa</u> of Cram et al. 1931)	ceca	exp. inf.	93
		sp. rev.	121
(= <u>C. columbae</u> of Levine 1938)		case rept. (drug study)-Ga.	53

Table 3. (continued)

Helminth	Location or lesion area	Type of report and geographical location if given*	Refer. No.
NEMATODES (continued)			
<u>Capillaria</u> spp.	crop	gen. rev.	141
<u>Cheilospirura spinosa</u> (= <u>Acuaria spinosa</u>)	under horny gizzard lining	exp. inf.	31
		sp. rev., exp. inf.	36
		sp. rev., case rept.-Tenn., Va.	45
		gen. rev.	129
		case rept.-Fla.	84
		case rept.-Tenn.	14
<u>Cyrnea colini</u> (= <u>Seurocyrnea colini</u>)	proventricular-gizzard junction	sp. rev., case rept.-Ga.	29
		case rept.-Pa. (zoo)	22
		case rept.-N.J.	8
		sp. rev., case rept.-Ala., Fla., Ga., Miss., N.C., S.C.	45
		sp. rev., exp. inf.	36
		case rept.-Ohio	155
		case rept.-Ohio	140
		sp. rev., exp. inf.	41
		case rept.-Miss.	145
		sp. rev., case rept.-Cuba	4
		case rept.-Fla., Ga., S.C.	84
		sp. rev., case rept.-Cuba	5
<u>Cyrnea</u> sp. (= <u>Seurocyrnea</u> sp.)	proventricular-gizzard junction	case rept.-Texas	90
		case rept.-Texas	151
		case rept.-La.	107
<u>Diplotrriaenoides minutus</u>	body cavity	case rept.-Fla.	143
<u>Dispharynx nasuta</u> (= <u>Dispharynx spiralis</u>)	proventriculus	case rept.-N.J.	8
		exp. inf.	35

Table 3. (continued)

Helminth	Location or lesion area	Type of report and geographical location if given*	Refer. No.
NEMATODES (continued)			
<u>Dispharynx nasuta</u> (continued) (= <u>Dispharynx spiralis</u>)	proventriculus	sp. rev., exp. inf.	36
		gen. rev., case rept.-N.J.	37
		exp. inf.	38
		case rept.-Ohio	155
		gen. rev., case rept.-N.C.	97
		case rept.-Ohio	140
		gen. rev.	129
		gen. rev., case rept.-N.Y.	69
		case rept.-Ill.	19
		case rept.-Fla., Ga.	84
		case rept.-La.	107
<u>Gongylonema ingluvicola</u>	esophagus and crop	sp. rev., case rept.-Ga.	45
		gen. rev.-Cuba	118
		sp. rev.-Cuba	4
<u>Habronema bialatum</u> (= <u>Spiroptera bialata</u>) (= <u>S. tenuis</u>)	proventriculus	case rept.-Fla.	143
<u>Habronema pileata</u>	proventriculus	sp. rev., case rept.-Ga.	45
		case rept.-Miss.	144
		case rept.-Miss.	145
<u>Heterakis bonasae</u>	ceca	sp. rev., case rept.-Ala., Fla., Ga., Mass., Miss., N.C., S.C.	45
		case rept.-Ohio	155
		case rept.-Ohio	140
		case rept.-Miss.	145
		case rept.-Ill.	19
		case rept.-Fla., Ga.	84
		case rept.-Tenn.	14

Table 3. (continued)

Helminth	Location or lesion area	Type of report and geographical location if given*	Refer. No.
NEMATODES (continued)			
<u>Heterakis gallinae</u> (= <u>H. gallinarum</u>)	ceca	sp. rev.	29
		case rept.-Pa. (zoo)	22
		sp. rev., case rept.-Va.	45
		case rept.-Ohio	155
		case rept.-Ohio	140
		gen. rev.	129
		case rept.-Miss.	144
		case rept.-Miss.	145
		case rept.-Texas	110
		case rept.-Ill.	19
		sp. rev., case rept.-Cuba	4
		case rept.-Ga., S.C.	84
		sp. rev.-Cuba	5
		case rept. (drug study)-Ga.	53
		sp. rev., exp. inf.-Ga.	85
		sp. rev., exp. inf.-Md.	94
<u>Heterakis vesicularis</u> (= <u>H. papillosa</u>)	ceca	case rept.-Fla.	143
<u>Oxyspirura mansonii</u>	eyes	sp. rev., case rept.-Cuba	4
		sp. rev., case rept.-Cuba	5
<u>Oxyspirura matogrosensis</u>	eyes	case rept.-La.	107
<u>Physaloptera</u> sp.	immature worms en- cysted in breast muscle	case rept.-Wis.	37
		case rept.-La.	54
<u>Strongyloides avium</u>	ceca and small intestine	sp. rev., exp. inf.	32
		gen. rev.	33
		sp. rev.	45

Table 3. (continued)

Helminth	Location or lesion area	Type of report and geographical location if given*	Refer. No.
NEMATODES (continued)			
<u>Subulura brumpti</u>	ceca	case rept.-Pa. (zoo)	22
		case rept.-Miss.	144
		case rept.-Miss.	145
		case rept.-Texas	110
<u>Subulura strongylina</u>	ceca	sp. rev., case rept.-Ga., N.C.	45
		case rept.-Ohio	155
		case rept.-Ohio	140
<u>Syngamus americana</u> (?)	trachea	checklist	158
<u>Syngamus trachea</u>	trachea	gen. rev.	34
		sp. rev., case rept.-Va.	45
		gen. rev.	129
		case rept.-Miss.	144
		case rept.-Miss.	145
		case rept.-Texas	151
		case rept.-Texas	90
<u>Tetrameres americana</u> (= <u>Tropisurus americanus</u>)	glands of proventriculus	sp. rev., exp. inf.	36
		sp. rev., case rept.-Ga., Va.	45
		case rept.-Fla.	84
<u>Tetrameres pattersoni</u> (= <u>Tropisurus pattersoni</u>)	glands of proventriculus	sp. rev., case rept.-Md., N.C.	39
		sp. rev., exp. inf.	40
<u>Tetrameres</u> sp.	glands of proventriculus	gen. rev., case rept.-N.C.	37
<u>Trichostrongylus tenuis</u> (= <u>T. pergracilis</u>)	ceca	case rept.-Ga.	28
		sp. rev., case rept.-Ga.	29
		gen. rev.	30

Table 3. (continued)

Helminth	Location or lesion area	Type of report and geographical location if given*	Refer. No.
NEMATODES (continued)			
<u>Trichostrongylus tenuis</u> (continued) (= <u>T. pergracilis</u>)	ceca	sp. rev., case rept.-Ala., Fla., Ga., Miss., S.C., Tenn.	45
		sp. rev.	46
		gen. rev.	129
		case rept.-Miss.	145
		case rept.-Fla., Ga., S.C.	84
		case rept.-La.	107

* Abbreviations used: gen. rev. = mentioned in a general review of diseases; sp. rev. = review of that specific disease or a specific parasite description; exp. inf. = experimental infection; case rept. = case report or survey.

28. Cram, E. B. 1925. New records of economically important nematodes in birds. J. Parasitol. 12:113-114.
29. Cram, E. B. 1927a. Bird parasites of the nematode suborders Strongylata, Ascaridata, and Spirurata. U. S. Nat. Mus. Bull. 140. 465 p.
30. Cram, E. B. 1927b. Nematodes of pathological significance found in economically important birds of North America. J. Parasitol. 13:223.
31. Cram, E. B. 1929a. The life history of the gizzard worm of ruffed grouse and bobwhite quail. J. Parasitol. 15:285-286.
32. Cram, E. B. 1929b. A new roundworm parasite, Strongyloides avium of the chicken with observations on its life history and pathogenicity. North Am. Vet 10(8):27-30.
33. Cram, E. B. 1930a. New host records for Strongyloides avium. J. Parasitol. 17:55-56.
34. Cram, E. B. 1930b. Parasitism in game birds. Trans. Am. Game Conf. 17:203-206.
35. Cram, E. B. 1930c. Porcellio scaber as intermediate host of Dispharynx spiralis of birds in this country. J. Parasitol. 16:169.
36. Cram, E. B. 1931a. Developmental stages of some nematodes of the Spiruroidea parasitic in poultry and game birds. USDA Tech. Bull. No. 227. 27 p.
37. Cram, E. B. 1931b. Recent findings in connection with parasites of game birds. Trans. Am. Game Conf. 18:243-247.
38. Cram, E. B. 1932. Additional observations on bird hosts of Dispharynx spiralis. J. Parasitol. 18:310.
39. Cram, E. B. 1933. A new species of Tetrameres from the bobwhite. J. Parasitol. 19:245-246.
40. Cram, E. B. 1934a. Observations on the life history of Tetrameres pattersoni. J. Parasitol. 20:97-98.
41. Cram, E. B. 1934b. Observations on the life history of Seurocyrnea colini. J. Parasitol. 20:98.
42. Cram, E. B. 1936. Species of Capillaria parasitic in the upper digestive tract of birds. USDA Tech. Bull. No. 516. 28 p.
43. Cram, E. B. 1939. Redescription and emendation of the genus Aproctella (Filariidae), nematodes from gallinaceous birds. Proc. Helminthol. Soc. Wash. 6:94-95.

44. Cram, E. B., and M. F. Jones. 1929. Observations on the life histories of Raillietina cesticillus and of Hymenolepis carioca, tapeworms of poultry and game birds. North Am. Vet. 10(2):49-51.
45. Cram, E. B., M. F. Jones, and E. A. Allen. 1931. Internal parasites and parasitic diseases of the bobwhite. p. 229-313. In H. L. Stoddard, (Ed.), The bobwhite quail; its habits, preservation, and increase. Scribner's Sons, New York. 559 p.
46. Cram, E. B., and E. E. Wehr. 1934. The status of species of Trichostrongylus of birds. Parasitology 26:335-339.
47. Cunningham, C. H. 1941. Paratyphoid infection in quail. J. Am. Vet. Med. Assoc. 99:217.
48. Cunningham, C. H. 1943. Paratyphoid infection in quail. Am. J. Vet. Res. 4:190-193.
49. Davis, J. W., R. C. Anderson, L. Karstad, and D. O. Trainer, (Eds.). 1971. Infectious and parasitic diseases of wild birds. 1st Ed. Iowa State Univ. Press, Ames. 344 p.
50. Davis, D. E., L. D. Schwartz, and H. E. Jordon. 1964. A case report: Chilomastix sp. infection in pen raised quail. Avian Dis. 8:465-470.
51. Davis, R. B., J. Brown, and D. L. Dawe. 1971. Quail - biological indicators in the differentiation of ulcerative and necrotic enteritis of chickens. Poult. Sci. 50:737-740.
52. Davis, R. B., R. E. Good, J. T. Tumlin, and J. Brown. 1969. An effective anthelmintic in treatment of quail with Capillaria contorta. Avian Dis. 13:690-691.
53. Dawe, D. L., J. Brown, R. B. Davis, and F. E. Kellogg. 1969. Effectiveness of Maretin and Meldane as treatments for capillariasis in bobwhites. Avian Dis. 13:662-667.
54. Dixon, J. M., and J. H. Roberson. 1967. Case report: aberrant larvae of Physaloptera sp. in a quail (Colinus virginianus). Avian Dis. 11:41-44.
55. DuBose, R. T. 1967. Quail bronchitis. Bull. Wildl. Dis. Assoc. 3:10-13.
56. DuBose, R. T. 1971. Quail bronchitis. p. 42-47. In J. W. Davis, R. C. Anderson, L. Karstad, and D. O. Trainer (Eds.), Infectious and parasitic diseases of wild birds. 1st Ed. Iowa State Univ. Press, Ames. 344 p.

57. DuBose, R. T., and L. C. Grumbles. 1959. The relationship between quail bronchitis virus and chicken embryo lethal orphan virus. *Avian Dis.* 3:321-344.
58. DuBose, R. T., L. C. Grumbles, and A. I. Flowers. 1958. The isolation of a nonbacterial agent from quail with a respiratory disease. *Poult. Sci.* 37:654-658.
59. DuBose, R. T., L. C. Grumbles, and A. I. Flowers. 1960. Differentiation of quail bronchitis virus and infectious bronchitis by heat stability. *Am. J. Vet. Res.* 21:740-743.
60. Durant, A. J., and E. R. Doll. 1941. Ulcerative enteritis in quail. *Mo. Agric. Exp. Sta. Res. Bull. No. 325.* 27 p.
61. Durfee, T., and M. W. Lerner. 1940. A coliform intermediate from diseased quail. *J. Am. Vet. Med. Assoc.* 96:245-246.
62. Edwards, P. R. 1936. The occurrence of Salmonella, Oranienburg type, in an infection of quail. *J. Bacteriol.* 32:259-263.
63. Emerson, K. C. 1951. A list of Mallophaga from gallinaceous birds of North America. *J. Wildl. Mgmt.* 15:193-195.
64. Emmel, M. W. 1936. Pullorum disease in captive quail. *J. Am. Vet. Med. Assoc.* 89:716-717.
65. Fenstermacher, R., B. S. Pomeroy, and W. A. Malmquist. 1946. Newcastle disease in Minnesota. *Proc. U. S. Livestock Sanitary Assoc.* 1946:151-157.
66. Fox, I. 1940. Fleas of the eastern United States. Iowa State College Press, Ames. 191 p.
67. Gallagher, B. A. 1916. Epithelioma contagiosum of quail. *J. Am. Vet. Med. Assoc.* 50:366-369.
68. Gallagher, B. A. 1921. Coccidia as a cause of quail disease. *J. Am. Vet. Med. Assoc.* 59:85-88.
69. Goble, F. C., and H. L. Kutz. 1945. The genus Dispharynx (Nematoda: Acuariidae) in galliform and passeriform birds. *J. Parasitol.* 31:323-331.
70. Goldhaft, T. M. 1965. Diseases of game birds. *Proc. Ann. Poult. Health and Mgmt. Short Course, Dept. of Poult. Sci., Clemson Univ., Clemson, South Carolina.* 9:50-58.
71. Graham, R. 1936. Salmonella isolated from baby quail. *J. Am. Vet. Med. Assoc.* 88:763-764.
72. Green, R. G. 1931. Disease in relation to game cycles. *Trans. Am. Game Conf.* 18:108-117.

73. Green, R. G., and E. M. Wade. 1929. A natural infection of quail by B. tularensis. Proc. Soc. Exp. Biol. and Med. 26:626-627.
74. Hardcastle, A. B. 1943. A check list and host-index of the species of the protozoan genus Eimeria. Proc. Helminthol. Soc. Wash. 10:35-69.
75. Herman, C. M. 1962. The role of birds in the epizootiology of eastern encephalitis. Auk 79:99-103.
76. Hightower, B. G., V. M. Lehmann, and R. B. Eads. 1953. Ectoparasites from mammals and birds on a quail preserve. J. Mammal. 34:268-271.
77. Hofstad, M. S. 1965. Quail bronchitis. P. 619-620. In H. E. Biester and L. H. Schwarte (Eds.), Diseases of poultry. 5th Ed. Iowa State Univ. Press, Ames. 1382 p.
78. Jones, M. F. 1929. Tapeworms of the genera Rhabdomertra and Paruterina found in the quail and yellow-billed cuckoo. Proc. U. S. Nat. Mus. 75(20):1-8.
79. Jones, M. F. 1930. New host records for bird cestodes. J. Parasitol. 16:159.
80. Jones, M. F., and J. E. Alicata. 1935. Development and morphology of the cestode Hymenolepis cantaniana in coleopteran and avian hosts. J. Wash. Acad. Sci. 25:237-247.
81. Kabat, C., and R. D. Thompson. 1963. Wisconsin quail, 1834-1962 population dynamics and habitat management. Wisc. Conserv. Dept. Tech. Bull. No. 30. 135 p.
82. Katz, J. 1941. A collection of Ohio ticks and their hosts. J. Parasitol. 27:467-468.
83. Kellogg, F. E., and J. P. Calpin. 1971. A checklist of parasites and diseases reported from the bobwhite quail. Avian Dis. 15:704-715.
84. Kellogg, F. E., and A. K. Prestwood. 1968. Gastrointestinal helminths from wild and pen-raised bobwhites. J. Wildl. Mgmt. 32:468-475.
85. Kellogg, F. E., and W. M. Reid. 1970. Bobwhites as possible reservoir hosts for blackhead in wild turkeys. J. Wildl. Mgmt. 34:155-159.
86. Kirkpatrick, C. M., and H. E. Moses. 1953. The effects of streptomycin against spontaneous quail disease in bobwhites. J. Wildl. Mgmt. 17:24-28.

87. Kirkpatrick, C. M., H. E. Moses, and J. T. Baldini. 1950. Streptomycin studies on ulcerative enteritis in bobwhite quail. I. Results of oral administration of the drug to manually exposed birds in the fall. *Poult. Sci.* 29:561-569.
88. Kirkpatrick, C. M., H. E. Moses, and J. T. Baldini. 1952a. The effects of certain antibiotic products in feed on experimental ulcerative enteritis in quail. *Am. J. Vet. Res.* 13:99-101.
89. Kirkpatrick, C. M., H. E. Moses, and J. T. Baldini. 1952b. Streptomycin studies on ulcerative enteritis in bobwhite quail. II. Concentrations of streptomycin in drinking water suppressing the experimental disease. *Am. J. Vet. Res.* 13:102-104.
90. Lehmann, V. W. 1953. Bobwhite population fluctuations and vitamin A. *Trans. N. Am. Wildl. Conf.* 18:199-246.
91. Levine, N. D. 1953. A review of the Coccidia from the avian orders Galliformes, Anseriformes, and Charadriiformes, with description of three new species. *Am. Midl. Nat.* 49:696-719.
92. Levine, N. D., L. E. Boley, and H. R. Hester. 1941. Experimental transmission of Trichomonas gallinae from the chicken to other birds. *Am. J. Hyg.* 33(section C):23-32.
93. Levine, P. P. 1938. Infection of the chicken with Capillaria columbae (Reed). *J. Parasitol.* 24:45-52.
94. Lund, E. V., and A. M. Chute. 1971. Bobwhite, Colinus virginianus, as host for Heterakis and Histomonas. *J. Wildl. Dis.* 7:70-75.
95. Madden, D. L., W. H. Henderson, and H. E. Moses. 1967. Isolation of Mycoplasma gallisepticum from bobwhite quail (Colinus virginianus). *Avian Dis.* 11:378-380.
96. Malcomson, R. O. 1960. Mallophaga from birds of North America. *Wilson Bull.* 72:182-197.
97. Moore, E. J. 1933. The parasite problem in game birds. *Atlantic Sportsman* 2:28. (Orig. not seen, cited by Goble and Kutz, 1945.)
98. Morley, L. C. 1933. Diseases of quail in captivity. P. 153-160. In L. B. Smith (Ed.), *American game preserve shooting*. Winward House, New York. 200 p.
99. Morley, L. C. 1935. Recent observations on game farm losses. *Trans. Am. Game Conf.* 21:232-237.
100. Morley, L. C., and P. W. Wetmore. 1936a. Discovery of the organism of ulcerative enteritis. *Proc. N. Am. Wildl. Conf.* 1:471-473.

101. Morley, L. C., and P. W. Wetmore. 1936b. The etiology of ulcerative enteritis in upland game birds. *Science* 84(2177):272-273.
102. Morris, J. A. 1948. The use of complement fixation test in the detection of ulcerative enteritis in quail. *Am. J. Vet. Res.* 9:102-103.
103. Morse, G. B. 1907. Quail disease in the United States. USDA, Bur. of Anim. Industry, Cir. No. 109. 11 p.
104. Neylans, O. S. 1952. Helminth parasites of birds from selected areas in the southeastern United States. M.S. Thesis. Univ. of Ga., Athens. 119 p.
105. Olson, N. O. 1950. A respiratory disease (bronchitis) of quail caused by a virus. *Proc. U. S. Livestock Sanitary Assoc.* 1950:171-174.
106. O'Roke, E. C. 1933. Some important problems in game bird pathology. *Trans. Am. Game Conf.* 19:424-431.
107. Palermo, R. J., and G. L. Doster. 1970. A comparison of the late winter foods and parasites of bobwhite quail and black francolins in southwestern Louisiana. *Proc. Ann. Conf. Southeastern Assoc. Game and Fish Comm.* 24:206-212.
108. Parker, R. R. 1929. Quail as a possible source of tularemia in man. *Public Health Rep.* 44:999-1000.
109. Parker, R. R., C. B. Phillip, and G. E. Davis. 1932. Tularemia: occurrence in the sage hen, Centrocercus urophasianus. Also report of additional cases following contacts with quail, Colinus virginianus. *Public Health Rep. Wash.* 47:479-487.
110. Parmalee, P. W. 1952. Ecto- and endoparasites of the bobwhite: their numbers, species, and possible importance in the health and vigor of quail. *Trans. N. Am. Wildl. Conf.* 17:174-188.
111. Parmalee, P. W., and M. A. Price. 1953. Bruellia illustris (Kellogg) and other ectoparasites from the bobwhite quail in Texas. *J. Parasitol.* 39:222-223.
112. Peckman, M. C. 1959. An anaerobe, the cause of ulcerative enteritis, "quail disease." *Avian Dis.* 3:471-478.
113. Peckham, M. C. 1960. Further studies on the causative organism of ulcerative enteritis. *Avian Dis.* 4:449-456.
114. Peckham, M. C. 1965. Ulcerative enteritis, quail disease. P. 481-493. In H. E. Biester and L. H. Schwarte (Eds.), *Diseases of poultry*. 5th Ed. Iowa State Univ. Press, Ames, 1382 p.

115. Peckham, M. C. 1971. Quail disease (ulcerative enteritis). p. 95-99. In J. W. Davis, R. C. Anderson, L. Karstad, and D. O. Trainer (Eds.), Infectious and parasitic diseases of wild birds. 1st Ed. Iowa State Univ. Press, Ames. 344 p.
116. Peckham, M. C., and R. Reynolds. 1962. The efficacy of chemotherapeutic drugs in the control of experimental ulcerative enteritis in quail. Avian Dis. 6:111-118.
117. Pellerdy, L. P. 1965. Coccidia and coccidiosis. Publ. House of Hungarian Sci., Budapest. 657 p.
118. Perez Vigueras, I. 1936. Notas sobre la fauna parasitologica de Cuba. Parte I: Vermes (continuacion). Mem. Soc. Cubana Hist. Nat. 10(2):53-86. (Orig. not seen, cited by Barus, 1968).
119. Peters, H. S. 1936. A list of external parasites from birds of the eastern part of the United States. Bird Banding 7:9-27.
120. Pickens, E. N., H. M. Devolt, and J. E. Shillinger. 1932. An outbreak of quail disease in bobwhite quail. Maryland Conserv.(9)(2). (Orig. not seen, cited by Durant and Doll, 1941).
121. Read, C. P. 1949. Studies on North American helminths of the genus Capillaria Zeder, 1800 (Nematoda). III. Capillarids from the lower digestive tract of North American birds. J. Parasitol. 35:240-249.
122. Rhoades, H. E. 1946. Salmonella bareilly in quail. N. Am. Vet. 27:419.
123. Roslien, D. J., P. L. Fore, and A. O. Haugen. 1962. Blood parasites in relation to pheasants and quail in Iowa. J. Iowa Acad. Sci. 69:239-244.
124. Sawada, I. 1964. On the genus Raillietina Fuhrmann 1920 (I). J. Nara Gakugei Univ. (Nat.). 12:19-36.
125. Sawada, I. 1965. On the genus Raillietina Fuhrmann 1920 (II). J. Nara Gakugei Univ. (Nat.). 13:5-39.
126. Shillinger, J. E. 1932. Prevention and control of disease in propagated game birds. Trans. Am. Game Conf. 19:320-327.
127. Shillinger, J. E., and D. R. Coburn. 1940. Diseases of game birds. Vet. Med. 35:124-127.
128. Shillinger, J. E., and L. C. Morley. 1934. Studies on ulcerative enteritis in quail. J. Am. Vet. Med. Assoc. 84:26-33.

129. Shillinger, J. E., and L. C. Morley. 1937. Diseases of upland game birds. USDA Farmer's Bull. No. 1781. 34 p.
130. Sneed, K., and G. Jones. 1950. A preliminary study of coccidiosis in Oklahoma quail. J. Wildl. Mgmt. 14:169-174.
131. Sonenshine, D. E., and I. J. Stout. 1970. A contribution to the ecology of ticks infesting wild birds and rabbits in the Virginia-North Carolina Piedmont (Acarina: Ixodidae). J. Med. Entomol. 7:645-654.
132. Stafseth, H. J. 1958. Advances in knowledge of poultry diseases over the past fifty years. Poult. Sci. 37:741-775.
133. Stoddard, H. L. 1931. The bobwhite quail; its habits, preservation, and increase. Charles Scribner's Sons, New York. 559 p.
134. Stoddard H. L. 1961. The Cooperative Quail Study Association, May 1, 1931-May 1, 1943. Misc. Pub. No. 1:27,173. Tall Timbers Res. Sta., Tallahassee, Florida 500 p.
135. Thomas, E. F. 1930. Capillaria annulata in quail. J. Am. Vet. Med. Assoc. 76:95.
136. Tyzzer, E. E. 1929. Coccidiosis in gallinaceous birds. Am. J. Hyg. 10:269-383.
137. Tyzzer, E. E., A. W. Sellards, and B. L. Bennett. 1938. The occurrence in nature of "equine encephalomyelitis" in the ringneck pheasant. Science 88:505-506.
138. Tyzzer, E. E., H. Theiler, and E. E. Jones. 1932. Coccidiosis in gallinaceous birds. Am. J. Hyg. 15:319-393.
139. Van Kruiningen, H. J., and S. B. Blodgett. 1971. Tyzzer's disease in a Connecticut rabbitry. J. Am. Vet. Med. Assoc. 158:1205-1212.
140. Venard, C. 1933. Helminths and coccidia from Ohio bobwhite. J. Parasitol. 19:205-208.
141. Walker, W. S. 1970. Raising bobwhite quail for commercial use. Clemson Univ. Agric. Exp. Sta. Circular 514, Clemson, S. C. 42 p.
142. Waller, E. F. 1939. Erysipelothrix infection in a quail. J. Am. Vet. Med. Assoc. 95:512-513.
143. Walton, A. C. 1927. A revision of the nematodes of the Leidy collections. Proc. Acad. Nat. Sci. Phila. 79:49-163.

144. Ward, J. W. 1945a. A new locality for five species of helminth parasites of the bobwhite quail. Proc. Helminthol. Soc. Wash. 12:71-72.
145. Ward, J. W. 1945b. Parasite studies of quail, Colinus virginianus texanus, in Mississippi. J. Parasitol. 31(Suppl.):23.
146. Watts, D. M., and J. E. Williams. 1972. Experimental infection of bobwhite quail (Colinus virginianus) with western equine encephalitis (WEE) virus. J. Wildl. Dis. 8:44-48.
147. Webster, J. D. 1944. A new cestode from the bobwhite. Trans. Am. Micros. Soc. 63:44-45.
148. Webster, J. D. 1947. Helminths from the bobwhites in Texas, with descriptions of two new cestodes. Trans. Am. Micros. Soc. 66:339-343.
149. Webster, J. D. 1948. A new acanthocephalan from the bobwhite. J. Parasitol. 34:84-86.
150. Webster, J. D. 1951. Additional notes on the helminth parasites of the bobwhite in Texas. J. Parasitol. 37:322-323.
151. Webster, J. D., and C. J. Addis. 1945. Helminths from the bobwhite quail in Texas. J. Parasitol. 31:286-287.
152. Wehr, E. E. 1965. Nematodes and acanthocephalids of poultry. p. 965-1005. In H. E. Biester and L. H. Schwarte (Eds.), Diseases of poultry. 5th Ed. Iowa State Univ. Press, Ames. 1382 p.
153. Wetmore, P. W. 1939. A species of Plasmodium from the sharp-tailed grouse infective to other birds. J. Wildl. Mgmt. 3:361-364.
154. Wetmore, P. W. 1941. Blood parasites of birds of the District of Columbia and Patuxent Research Refuge vicinity. J. Parasitol. 27:379-393.
155. Wickliff, E. L. 1932. Game research in Ohio. Trans. Am. Game Conf. 19:351-361.
156. Williams, J. E., O. P. Young, D. M. Watts, and T. J. Reed. 1971. Wild birds as eastern (EEE) and western (WEE) equine encephalitis sentinels. J. Wildl. Dis. 7:188-194.
157. Wiseman, J. S. 1968. A previously undescribed species of Menacanthus (Mallophaga: Menoponidae) from bobwhite quail. J. Kans. Entomol. Soc. 41:57-60.
158. Yamaguti, S. 1961. Systema helminthum Vo. III. The nematodes of vertebrates. Interscience Publishers, New York. 1261 p.
159. Yoder, H. W., Jr., and M. S. Hofstad. 1964. Characterization of avian mycoplasma. Avian Dis. 8:481.

SOME ASPECTS OF THE DYNAMICS OF A HUNTED BOBWHITE POPULATION

John L. Roseberry and W. D. Klimstra, Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale.

Abstract:

Dynamics of a hunted bobwhite population have been investigated on a 1,450-acre study area near Carbondale, Illinois since 1952. Habitat conditions have not changed greatly during the study, and November densities have oscillated regularly about a rather stable long-term mean. Most of the variance of annual rates of population change is due to variation in net productivity from spring to fall rather than to variation in net losses from fall to spring. Population declines from November to April averaged 66% (range 36 to 81%); about 0.66 of this resulted from hunting. Post-hunting mortality, which was slightly density-related, partially compensated for hunting losses. Spring densities were correlated with ($r = +0.75$) and almost as variable as preceding fall populations. Net increases from spring to fall varied from 17 to 383 and averaged 235% of the breeding population. Multiple regression analysis showed that annual rates of productivity were significantly influenced by the combined effect of breeding density, length of snow cover during the previous 2 winters, and amounts of prenesting rainfall. Annual rates of population change were inversely related to the preceding fall density, but strong correlations between successive seasonal population levels caused periods of change as well as highs and lows to persist for several years. Major highs and lows each occurred at 8- to 10-year intervals. It was not clear whether 2 severe winters caused the apparent cyclic regularity or merely accentuated the lows.

Introduction and Methods

In 1952, the Cooperative Wildlife Research Laboratory (CWRL) of Southern Illinois University and the Illinois Natural History Survey initiated a long-term investigation of the dynamics of a hunted bobwhite population on 1,450 acres of privately owned, unmanaged farmland (Carbondale Research Area) in southern Illinois. From 1953 to the present, seasonal population levels have been censused by crews of 6-12 men using trained bird dogs. Counts are made in early November (prehunting), early January (posthunting), mid February and late March prior to covey breakup. During the hunting season, each hunter is interviewed and his quail checked to determine size and composition of the harvest and total hunting pressure. Land-use and cover conditions have been recorded continuously since the project began. From 1953 through 1963 field crews attempted to locate and study all nests on the area.

Maximum census error is estimated at $\pm 10\%$ and average deviations $\leq 5\%$. Hunting pressure and harvest estimates (which include known cripples) are minimal but thought to be at least 95% accurate. Annual trends in quail abundance in southern Illinois, as determined from