METAZOAN PARASITES OF THE BLUE JAY, *CYANOCITTA CRISTATA* L.

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Research dealing with avian parasites has been concerned primarily with those affecting domesticated birds. For the passerines, a study of the parasites of the eastern crow (Morgan and Waller, 1941) and one of the starling (Boyd, 1951) have been reported. The present investigation deals with the arthropods and helminths (in the coelom, gut and its derivatives) of the blue jay. Data from the files of the Helminthological Collection of the U. S. D. A. together with published records have been incorporated with the present findings so as to present a more complete survey of the parasites of this host.

MATERIAL AND METHODS

Between October 1947 and May 1954, 100 adult jays (both sexes in approximately equal numbers) were collected from New England: 1 from Vermont, 12 from New Hampshire, and the remainder from Massachusetts. All the months of the year are represented except August and September. A detailed table on the number of birds collected per month and their parasitic fauna is filed with the senior author. Each freshly killed bird was examined for parasites following the method described by Boyd (1951). Two additional procedures were introduced which revealed the presence of parasites previously overlooked. The first consisted of the eversion of the external ear, and the ticks and chiggers thus obtained are indicated by an asterisk in Tables I and IV. In the second technique the bird skin was finally shaken in 5% detergent solution, refrigerated overnight and the sediment examined. The resulting positive findings have been indicated in the Tables. The dissection of 6 individuals was omitted; so the percentage occurrence of helminths is based on 94 birds.

OBSERVATIONS

One of the 94 birds was unparasitized. The incidence was 83 for arthropods and 80 for helminths. No significant difference in the parasitic fauna was observed in the 2 sexes. With the exception of the liver flukes, infection per host was exceedingly light. The arthropods comprised 3 species of lice, 2 of ticks and 6 of mites (Table I). Sixteen species of worms were obtained: 4 flukes, 2 tapeworms and 10 roundworms (Table III).

Received for publication, September 20, 1955.
Supported in part by a grant (E-725) from the National Institutes of Health, U. S. Public Health Service.
Sincere appreciation is due to Mrs. M. B. Chitwood and Mr. A. McIntosh of Animal Parasites Laboratory, A. R. B., U. S. D. A., Mr. G. M. Kohls of the Rocky Mountain Laboratory, U. S. P. H. S., Dr. Wharton of the University of Maryland, and Dr. Wilson of Lebanon Valley College for aid in identification of the parasites; also to Dr. E. W. Price for kindly making available to us the files of the Helminthological Collection of the U. S. National Museum.
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TABLE I.—*Arthropods recorded for the blue jay,* Cyanocitta cristata *L.*

Parasite	% incidence in present study	Published records	Localities
MALLOPHAGA			
Degeeriella eustigma	75	Peters, 1936	N.C., Va.
Menacanthus persignatus		Peters, 1933	Ala.
Philopterus cristata		Malcomson, 1929	Ill.
		Peters, 1936	Ala., Ga., Md., N.H., S.C., Va.
P. subflavescens	0	Geist, 1931	Ohio
Myrsidea funera	0	Peters, 1933, 1936	Ala., N.C.
Docophorus communis	0	Kohl, 1920	Pa.
DIPTERA			
Ornithoica vicina	0	Peters, 1933, 1936	Md., Mass.
		Bequaert, 1953	N.J.
O. fringillina	0	Bequaert, 1953	N.J.
SIPHONAPTERA			
Echidnophaga gallinacea	0	Trembley and Bishopp, 1940	S.C.
ACARINA			
Haemaphysalis leporis-palustris	1*	Bishopp & Hixson, 1936	Ga.
		Peters, 1936	Md., Va.
		Joyce & Eddy, 1943	Iowa
		Bequaert, 1946	Mass.
Amblyomma maculatum	0	Bishopp & Hixson, 1936	Ga.
Ixodes brunneus	0	Cooley & Kohls, 1945	Tenn.
I. scapularis	0	Cooley & Kohls, 1945	Ark.
Ixodes sp.	1*		
Ornithonyssus sylviarum	5†	Peters, 1936	Va.
Harpirhynchus sp.	2†		
Trombicula whartoni	11*	Brennan & Wharton, 1950	Kans.
T. alfreddugesi	0	Wolfenbarger, 1952	Kans.
Cytodites nudus	2		
Analgesidae		Robinson, 1955	Ga.
Analgopsis sp.	1		
Megninia aculeatus	0	Banks, 1915	N.S.
Proctophyllodidae		Robinson, 1955	Ga.
Proctophyllodes picae (?)	37		

* obtained following ear eversion in 58 birds.
† " " detergent technique used on 9 birds.

ARTHROPODS

INSECTA—MALLOPHAGA: Seventy-five blue jays harbored lice and/or their eggs. Infestation was extremely light; not a single bird was even moderately parasitized. Often it took a thorough search to find a louse, and sometimes eggs alone were collected. Immature stages were present consistently along with adults. The lice were identified as *Degeeriella eustigma* Kell. syn. *D. picturata* Osborn, *Philopterus cristata* Malcomson, and *Menacanthus persignatus* Kell. and Chap. The most prevalent, *D. eustigma,* occurred primarily on the breast feathers; *P. cristata* on the neck, and *M. persignatus* on feathers of the back.

Three kinds of louse eggs were identified (Figs. 1–9) and their characteristics have been summarized in Table II. Each kind was distinctive both with regard to the relation to its

TABLE II.—*Characteristics of the eggs of the three species of Mallophaga found on the blue jay* (Egg measurements in microns)

Species	*Degeeriella eustigma*	*Philopterus cristata*	*Menacanthus persignatus*
Typical location			
Type of feather	breast	neck	back
Feather length cm.	3.5 (2.5–5)	2 (2–2.2)	4.3 (2.5–5)
Position on feather	under surface barb 1–8 mm from calamus	under surface barb 1–2 mm from calamus	upper-lateral surface proximal end rachis.
Attachment	basally by overlaping barbules	basally by conspicuous secretion	along its long axis by secretion
No. on feather	3 (1–11)	1 (1–2)	1
Egg			
Size ave. (mean)	655 by 200	830 by 380	955 by 372
Shape	'neck' at cap area square base	barrel conical base	lopsided distally oval base
Cap filament	present	absent	absent
Cap height	65	74	170
Micropyles			
Number	16–30	22–31	14, 15
Arrangement	irregular row	irregular row	regular row
Distance from edge	8	14	10
Dimensions	5 (rim 7.8)	6.6 (rim 9.7)	10 (rim 17)

feather attachment and the actual shape and size of the egg itself. Since nymphs of *D. eustigma* and *M. persignatus* were observed in the process of emergence from the shells of 2 of the egg types, the third type must represent the egg of *P. cristata*. The *D. eustigma* egg (Figs. 1–3), the smallest, is held to the under surface of the vane of the breast feather by the matting together of barbules, and is usually oriented somewhat obliquely with respect to the rachis. Often more than 1 is present on the same feather. This egg possesses a square base and distinct neck at the insertion of the cap. The cap bears a filament and numerous small micropyles, variable in number, arranged in an irregular row. The egg of *P. cristata* (Figs. 4–6) is located on the neck feather, usually 1 per feather. The attachment is also to the under surface of the vane but closer to the proximal end of the rachis than that of *D. eustigma*, and it consists of a conspicuous secretory material. The barrel-shaped egg has a conical base and lacks the distal filament. Its micropyles are similar to those of *Degeeriella* but are slightly larger. The egg of *M. persignatus* (Figs. 7–9), on the contrary, is located on the dorsal body feathers, typically 1 per feather. It is attached along its long axis to the edge of the upper surface of the proximal end of the rachis. The egg, the biggest of the 3 species, is somewhat lopsided with an oval base. The cap is large, lacks a filament, and its micropyles are also large, 14 or 15 in number, arranged in a regular row.

Louse-flies and fleas were not collected from any of these birds.

ARACHNIDA—ACARINA: Forty-nine blue jays were infested by acarines, 37 of them by feather-mites. On eversion of the external ears of the last 58 birds collected, ticks were found on 2 and chiggers on 11 jays (Tables I, IV). If the percentage incidence for ticks and chiggers is calculated on 58 instead of 100, then the 2% and 11% would become 3.4% and 19.0% respectively. Their presence was typically accompanied by vascular patches on the ear's surface and accumulations of waxy secretion. This condition was observed in 6 additional birds (5, Oct. 1951: 1, Feb. 1952) and might signify recent attacks by these parasites. The ticks were larval stages of *Haemaphysalis leporis-palustris* Packard and *Ixodes* sp., and occurred singly on hosts captured in Massachusetts (Oct. 1951: Oct. 1953). Mr. Glen M. Kohls, personal communication, states that it is impossible to identify the latter to species. The chiggers, identified as *Trombicula whartoni* Ewing, were collected from 4 New Hampshire birds (Oct. 1951) and 7 Massachusetts birds (3, Oct. 1951; 2, Oct. 1953; 2, Nov. 1951). The chiggers numbered 1 to 5 (average 2) per host, found in one or both ears.

One or two specimens of the blood-sucking mite, *Ornithonyssus sylviarum* Can. and Fanz. were taken from five birds (2, Feb. 1950; 1 each, May 1954, Oct. 1951, Nov. 1951). Its presence on one host and that of numerous mites, identified as *Harpirhynchus* sp., were revealed on two occasions when the detergent technique was used on the last 9 jays collected. *Cytodites nudus* was discovered twice in the trachea and bronchial tubes close to the syrinx. The one host (Jan. 1948) harbored 19 mites; the other (Oct. 1951) a single specimen. Feather-mites occurred in relatively small numbers per bird despite their high incidence of 37%. *Analgopsis* sp. was obtained only once (Oct. 1947) and from the under surface of the inner wing coverts. The rest, identified as *Proctophyllodes picae* (?), were mostly confined to the under surface of the flight feathers, particularly the secondaries, occasionally on neighboring body plumage. Eggs, immature and adult stages were present.

HELMINTHS

TREMATODA: Flukes were found in 2 locations, liver and cloaca (Table III). Liver fluke incidence was 30%; birds from all three states and from each month except July were involved. These flukes, comprising 3 species, ranged from 1 to over 100 blue jay, with an average of 20. Heavy infections resulted in inflammation of gall bladder and bile duct. All the hosts harbored *Lutztrema microstomum* Denton and Byrd; in addition one contained *L. monenteron* Price and McIntosh (Jan. 1952), and three *Zonorchis petiolatum* Denton and Byrd (May, 1951, 1954; Nov., 1951).

Five specimens of the cloacal fluke, *Leucochloridium cyanocittae* McIntosh were retrieved by the detergent method from one bird (May, 1954). An immature form was collected from each of the large intestines of two jays (Jan., Feb. 1950). Thus the percentage incidence is 3.2 for cloacal flukes.

CESTODA: Tapeworms were recovered only twice: a single specimen from a female (Oct., 1951) and three from a male (May, 1954). Unfortunately none of the scolices was retrieved thus making identification difficult.

Tapeworm from blue jay (Oct., 1951) (Fig. 10). Length approximately 150 mm. Proglottids short, wide, ranging from 70 by 500 microns to 300 by 1,100 microns. Genital pores irregularly alternate. Cirrus pouch distinct. Vas deferens coiled. Testes less than 10, between

TABLE III.—*Helminths recorded for the blue jay* Cyanocitta cristata *L.*

Parasite	Location in host	% incidence present study	Published reference or cat. No. Helm.Coll. U.S.D.A.	Remarks
TREMATODA				
Brachylecithum americanum	liver, bile ducts	0.0	Denton, 1945	Ga. imm. hosts
B. stunkardi	liver, bile ducts	0.0	Denton, & Byrd, 1951	Texas, Va.
Lutztrema microstomum	liver, bile ducts	29.8	Denton, & Byrd, 1951	Ga., N.C., Texas
L. monenteron	liver, bile ducts	1.1	———	
Lyperosomum oswaldi	liver, bile ducts	0.0	Denton, & Byrd, 1951	Texas
Zonorchis petiolatum	liver, bile ducts	3.2	Denton, & Byrd, 1951	Texas
Leucochloridium cyanocittae	cloaca	3.2†	McIntosh, 1932	Mich.
Collyriclum faba	skin of vent	0.0	Farner & Morgan, 1944	Md., Mich., Minn. Mass., N.J., Wisc. imm. hosts
CESTODA				
Oligorchis sp.	intestine	1.1	———	
Culcitella sp. ?	intestine	1.1	#39719	
ACANTHOCEPHALA				
Plagiorhynchus formosus	intestine		#29607, 1929	D.C.
NEMATODA				
Syngamus trachea	trachea	3.2	#33925, 1934	D.C. imm. host
Capillaria contorta	esophagus	20.2	———	
Dispharynx nasuta	proventriculus }	12.8	———	
Microtetrameres spiculata	proventriculus }		#27639; #31822, 1923, 1932 Boyd, 1956	D.C., N.J. Mass.
Acuaria anthuris	gizzard }	29.8	———	
Cheilospirura cyanocitta	gizzard }		Boyd, 1956	Mass.
Acuaria sp.	gizzard		Williams, 1929	
Spiroptera sp. (?)	?		#3850	
Capillaria obsignata	intestine	17.2	———	
Diplotriaena tricuspis	coelom	30.9		
Diplotriaena sp.	coelom		#2031, 1893	
"	coelom		#45290, 1946	Wisc.
"	coelom		#42395, 1934	Ont.
"	coelom		Robinson,* 1954	Ga.
Pseudoprocta sp.	wall of alim. tract	1.1	———	
Splendidofilaria sp. ?	wall of alim. tract	1.1	(Robinson, 1955 as unident. sp. same family)	Ga.

* Description of worms in 1954, identification given as *Diplotriaena sp.* in private communication.
† Obtained following detergent technique used on 9 birds.

excretory canals. Ovary and vitelline gland central. Uterus a transverse sac. Paruterine gland anterior to ovary and uterus.

The possession of the paruterine gland places this worm in PARUTERININAE, DILEPIDIDAE, but further identification is impossible without the scolex. However, in the Helminthological Collection of the U. S. D. A. is a cestode (#39719) collected from a blue jay in Washington, D. C. by M. F. Jones, June 1934. This was loaned to the senior author. Microscopic preparation shows a scolex containing 62 thorn-like hooks, arranged in two rows. The hooks (Fig. 11) of the anterior row measure 102 microns in length; while those of the posterior row are 65 microns long. Unfortunately, mature and gravid proglottids are lacking, but those present are somewhat similar to the specimen with irregularly alternate genital pores collected by us. If these two cestodes belong to the same species, then they cannot be in the genus *Anonchotaenia*, relatively common in passerines (Rausch and Morgan, 1947), since the scolex has hooks (Wardle and McLeod, 1952). They have been tentatively placed in the genus *Culcitella*, parasitic in hawks, on account of the occurrence of a transversely located uterus.

Tapeworm from blue jay (May, 1954). Four testes and unilaterally located genital pores identified this cestode as belonging to the genus *Oligorchis*, family HYMENOLOPIDIDAE. It bears a striking resemblance to *O. cyanocittii*, described from the stellar jay of Mexico by Coil (1955), in the position and size of the reproductive organs. Like the latter, the vagina enlarges proximally into a large conspicuous seminal receptacle, the proglottids are consistently broader than long, and a velum is present. Since scolex and gravid proglottids are lacking and it was collected from a different, though closely related, species of host, the 3 specimens of this tapeworm from the male blue jay have been tentatively identified as *Oligorchis* sp.

NEMATODA: Twenty-six of the dissected blue jays were negative for nematodes. Infection was scattered throughout the year. The greatest percentage infections, 30 and 32, are due to gizzard and filarial worms, followed by 20 and 17 due to esophageal and intestinal thread worms. The nematodes are described in sequence according to their habitation:—trachea first, then esophagus, proventriculus, gizzard, intestine and finally the body cavity (Table III). One pair of gapeworms, *Syngamus trachea* Montague, was present in the trachea of each of three jays,—one from New Hampshire (Oct., 1951) and two from Massachusetts (May, 1954; July, 1953). The average number of *Capillaria contorta* Creplin per host was 2.7 with a range of 1 to 25. However, of the 25 capillariids that occurred in the one bird (Feb., 1952), 16 were free in the mouth, indicating that they had not had time to become established in the jay.

Proventricular worms were present in 12 birds, and averaged 1.8 per individual, range from 1 to 5. Some were recovered from the scraped contents of the proventriculus; those partially embedded were usually surrounded by a mass of hypertrophied tissue in the form of finger-like projections of the wall. Two species were identified, *Dispharynx nasuta* Rudolphi and *Microtetrameres spiculata* Boyd. The former was more common and included 2 immature specimens. One of the immature specimens, a female, was 3 mm in body length, and its cordons, 300 microns for the posteriorly directed portion and 105 microns for the anteriorly directed portion. (Fully mature females measure 5.6–6.2 mm, and their cordons 525 and 190 microns.) The second immature specimen was 1.78 mm in body length with a corresponding cordon measurement of 137 and 34 microns. The species of the sexually dimorphic *Microtetrameres* was represented by 2 females and 3 males.

The gizzard worms averaged 1.8 per bird, range of 1–13. However, 23 of the 28 hosts harbored a single specimen, and the remaining five hosts contained 2 to 13 worms. Each worm was readily observed on the surface of the horny tunica facing the muscular wall by separating the tunica from the rest of the gizzard. On removal, a sinuous imprint of the nematode remained. The worms comprise 2 species. The first is the crow gizzard worm, *Acuaria anthuris* Rudolphi. It has long cordons and the males have similar spicules and 4 and 8 pre- and post-anal papillae. The more prevalent second species described by Boyd (1956) has now been named *Cheilospirura cyanocitta*. It has short cordons, with dissimilar spicules and 4 and 6 pre- and post-anal papillae in the males.

The intestinal threadworm, *Capillaria obsignata* Madsen occurred in both the small and large intestines, typically with the body partially embedded in the mucosa. The number of worms per bird varied from 1 to 9, mean 2.8.

The suborder FILARIOIDEA is represented by 3 species, the commonest being *Diplotriaena tricuspis* Fedtschenk, FILARIIDAE, with a percentage incidence of 31. It was consistently found in the body cavity, ordinarily adjacent to the gizzard. The average was 2.5 per bird, though 9 were found in 1 host. The other 2 species were retrieved from the gut wall (May, 1954; Oct., 1951). The filaria from the jay killed in May also belonged to the FILARIIDAE but to the APROCTINAE. Only a single specimen, a female, was obtained, partially embedded in the duodenum. This stoutish dark brown worm, without the male, has been tentatively classified as a species of *Pseudaprocta* Schikhobalowa.

Pseudaprocta sp. (Figs. 12–14) : Body length 17 mm. Width at head 150 microns; at base esophagus, 375 microns; near middle of body 600 microns. Mouth with four lips; tridents absent. Cuticular cordons delicate between cephalic papillae and amphids. Buccal capsule small. Esophagus simple, 660 microns long. Egg oval, thick shelled, 45–47 microns by 18–20 microns.

A jay examined in October harbored 13 filariids that have been identified as a species of *Splendidofilaria* Skrjabin, family DIPETALONEMATIDAE.

Splendidofilaria sp. (Figs. 15–17) : Anterior end lacking cephalic cuticular formation and cervical alae. Esophagus simple. *Male:* body length 6.84 mm. Width at base esophagus, 113 microns; at cloaca, 58 microns. Esophagus 410 microns. Tail 68 microns long. Spicules, right 68 and left 75 microns long. Pre-cloacal papillae 3. *Female:* body length 11.35–12.94 mm. Width, at anterior end, 123 microns; at base esophagus, 170 microns, at vulva level, 205 microns. Vulva 825 microns from anterior end.

DISCUSSION

Certain parasites previously overlooked in the routine examination of the bird's body were obtained by use of two procedures. Ticks and mites were discovered by everting the outer ears, and the *Harpirhynchus* mite and cloacal fluke by the detergent technique. This latter technique also accounted for a higher incidence of infestation by lice and blood-sucking mites.

A list of ectoparasites so far described from this host has been compiled from the results of the present study together with previously published data (Table I). The fluke that occupies cysts of the vent region, *Collyriclum faba* Kossack has been included with the endoparasites. Representatives, 1 each of 2 families of mites, constitute additional records for the parasitic fauna for this bird: *Harpirhynchus* sp., MYOBIDIIDAE and *Cytodites nudus,* CYTODITIDAE. The former is exceptionally small and appears to inhabit the surface of the skin of the host; the latter has been reported from the respiratory system including the air sacs and the body cavity of poultry (Baker and Wharton, 1952).

The data in the literature, except for the work of Robinson (1954, 1955), are the outcome of investigations that stressed the collection of parasites from a wide variety of animals, which happened to include the blue jay, rather than any concerted effort on this particular bird. Nevertheless, though our survey involved the examination of 100 jays, several ectoparasites already reported from this host were conspicuous by their absence. One possible reason for these negative findings is that of geographical distribution. Many of these parasites are limited to the southern part of the United States; others, for example some ticks, are more typical of the South where they exist in greater numbers. The flea, *Echidnophaga gallinacea* Westwood is a serious pest in the south but does not exist in Massachusetts, New Hampshire or Vermont (Trembley and Bishopp, 1940). The ticks, *Amblyomma maculatum* Koch and *Ixodes brunneus* Koch, *I. scapularis* Say are southern forms (Bishopp and Hixson, 1936; Cooley and Kohls, 1945) ; so also are the chiggers, *Trombicula whartoni* and *T. (Eutrombicula) alfreddugèsi* Oudemans, according to Brennan and Wharton (1950) and Wolfenbarger (1952). Collecting *T. whartoni* on birds from Massachusetts and New Hampshire is thus of special interest and constitutes two new state records for this chigger. The blue jay population in New England is composed of permanent and transient residents and probably the hosts for this chigger were migrant birds. Migrant animals often account for isolated records of southern species of parasites in the North.

The rabbit tick, *Haemaphysalis leporis-palustris,* has a widespread distribution and its immature stages have been reported several times from the blue jay. Joyce

and Eddy (1943) collected 4 nymphs and 30 larvae from 8 out of 12 jays in Iowa and they state that the tick occurs between April and September, the larvae being most abundant in August. Bishopp and Hixson (1936) took 4 nymphs and 10 larvae from a single bird in Georgia; they collected them from the head, especially the eyes and ears, but occasionally from other parts of the body. The only previous record from this host in Massachusetts is that of Bequaert (1946) who found a larva on October 15th. In the present study one larval rabbit tick and one of an unidentified *Ixodes* were obtained on October 20th and 11th, respectively. No birds, however, were examined in August and September, only 15 between May and July, and only 58 underwent ear eversion. Thus the percentage figures for ticks and chiggers on this host as given in Tables I and IV should undoubtedly be higher.

The survey comprised solely adult birds; juveniles were lacking. This is also important when one considers the association between bird and nest, parent and young relationships offer opportunity for the spread of parasites, and certain parasites tend to be nest-dwellers. These include fleas, hippoboscid flies and blood-sucking mites. Hippoboscids, according to Thompson (1937, 1938), may be collected between April and November, but especially in July and August. In this vicinity blue jays nest in May and June. Therefore a higher incidence of ectoparasites and the presence of the common hen flea and louse-flies would be expected in this survey had more birds, including juveniles, been collected in the summer months.

The egg of each of the 3 species of lice found on the blue jay shows distinguishing features. These characters are based on its position on the host, type of feather and attachment thereon, size and shape of egg and nature of its cap and micropyles. These observations substantiate those by Boyd and Chutter (1948) in their study of avian mallophagan eggs. Using the above bases of comparison they were able to identify the eggs of 10 species of lice examined by them.

The helminths reported from blue jays are listed in Table III. The data were obtained from our findings, previously published records and from the files of the Helminthological Collection of the U. S. D. A. Published material includes no cestodes or acanthocephalans and only a few nematodes.

Infection in blue jays by five species of liver flukes is reported by Denton (1945) and Denton and Byrd (1951) following an investigation of 700 birds from southern United States. New state records for two of these species are established in the present study:—Massachusetts, New Hampshire and Vermont for *Lutztrema microstomum,* and Massachusetts for *Zonorchis petiolatum.* The latter is of interest, since this species was taken previously from several birds including jays but only those occurring in Texas. The commonest liver fluke is *L. microstomum,* and according to Denton and Byrd (1951), it occurs in no other host and shows an infection rate of 27% with a range of 1 to 200 per bird, similar to the present findings. Of the other three species, *Brachylecithum stunkardi* Pande, they point out, is less common and again is found in no other bird. The blue jay is probably an accidental host for *B. americanum* Denton and *Lyperosomum oswaldi* Travassos, for only immature specimens of the former were obtained by Denton (1945) and from 1 of 12 birds; and the latter was reported by Denton and Byrd (1951) in 1 of 26 birds examined. The new and single occurrence of *Lutztrema monenteron* in

a jay (Jan., 1952) may be similarly accounted for. The cloacal fluke, *Leucochloridium cyanocittae* McIntosh was described from specimens in 2 of 4 adult jays dissected by McIntosh (1932). The 5 individuals obtained from a blue jay killed in May 1954 match this description except that the ovary touches or overlaps the posterior testis as it does in *L. actitis* McIntosh. For the fluke, *Collyriclum faba* Kossack, that inhabits cutaneous cysts in the vent region of birds, Farner and Morgan (1944) have presented a complete host list. They noted that it typically parasitizes young birds, so it is not surprising it was absent from the present survey.

The only acanthocephalan infection recorded for blue jays is the collection of 4 specimens by M. F. Jones in Washington, D. C., October 1929. They were tentatively identified as *Plagiorhynchus formosus* Van Cleave and catalogued in an unmounted condition as #29607 in the Helminthological Collection of the U. S. D. A. The material was loaned to the senior author, who on making permanent preparations verified the identification, since the nature of the hooks conforms with that described by Van Cleave (1942) for this species, reported from several avian hosts. He considered that it was confined to northeastern U. S. A. with Washington as its geographical center. However, it was later recorded from Alaska (Van Cleave and Williams, 1951).

The recovery of *Capillaria* from the esophagus and intestine and of *Dispharynx nasuta* from the proventriculus constitutes new records of nematode infection in the blue jay. Examination of freshly killed birds greatly aids their detection, which is almost impossible in preserved bodies. The previous record of gapeworms, *Syngamus trachea,* in blue jays was one from a nestling taken in June, 1934 by E. B. Cram and catalogued as #33925 in the Helminthological Collection. Goble and Kutz (1945a, b) and Madsen (1952) have shown that susceptibility to *D. nasuta* and *S. trachea* infections is greater in younger birds. Had juveniles been included in the present study it is likely that the percentage frequency for these two nematodes would have been higher than that obtained.

The two records of gizzard worm infections in addition to *Cheilospirura cyanocitta* described by Boyd (1956) consist of a *Spiroptera,* catalogued as #3850 in the Helminthological Collection, and an unidentified *Acuaria* obtained by Williams (1929) during a study of this genus. The *A. anthuris* in the present survey is similar to a new species, *A. nebraskensis,* which he collected from 8 of 9 crows, but which is regarded by Cram (1934a) as synonymous to *A. anthuris.* Material formally classified as *Spiroptera* now represents several genera according to Cram (1934a) including *Dispharynx* and *Cheilospirura,* so that the former record may even be a proventricular instead of a gizzard worm.

Filarial infections are strikingly high in the blue jay. Not only was there a 31% incidence of *Diplotriaena tricuspis* in the present investigation but there are 3 records of *Diplotriaena* sp. from this bird in the Helminthological Collection (#2031, 45290, 42395), 2 being from Wisconsin and Ontario. Robinson's studies (1954, 1955) on the filariae in Georgia bear this out. On examining 490 jays of varying age, he found microfilariae in 269 individuals, with a 65% incidence in adults (1955). In 1954 he observed at least 2 species of adult worms. One was stout, opaque, measured 2 to 17 cm long and was recovered from the coelom of 8 hosts. In a private communication to the senior author, he stated this nematode was a species of *Diplotriaena.* On further inspection, this species and the *Diplotriaena* speci-

mens in the Helminthological Collection will probably prove to be *D. tricuspis* since Robinson (1955) observed 1 of the microfilariae in the jay to be identical with that in the crow. The other mature worm was small, thread-like and inhabited the pericardial and peritoneal regions. According to Robinson (1955) both the microfilaria and adults possessed characters in common with the DIPETALONEMATIDAE. This worm may prove to be a species of *Splendidofilaria*. In the present study *Splendidofilaria* sp. was retrieved from the gut wall, and not under the skin nor in the heart region as is typical of the genus (Chabaud and Choquet, 1953). However, nematodes often exhibit a wanderlust, especially following death of the host. A species rather similar to this specimen was obtained from ground doves in the Virgin Islands by Augustine (1937). He described it as *Vagrifilaria columbigallinae* n. g., n. sp. According to Chabaud and Choquet (1953), this genus

TABLE IV.—*Comparison of percentage incidence of parasitism in the blue jay (present paper) with that in the crow (Morgan and Waller, 1941) and the starling (Boyd, 1951)*

	Blue jay adults	Crow adults	Starling juveniles and adults	
ARTHROPODS				
Mallophaga	75.0†	23.2	81.5	both
Mites, respiratory tract	2.0	–	4.3	"
Feather-mites	37.0	6.2	60.3	"
Skin mites	2.0†	–	5.9	adult
Ticks	2.0*	–	–	
Chiggers	11.0*	–	–	
Associated particularly with nest of bird				
Fleas	–	–	1.7	both
Hippoboscid flies	–	–	0.3	juv.
Blood-sucking mites	5.0†	–	3.8	juv.
HELMINTHS				
Trematodes	31.9	6.2	1.0	adult
Liver flukes	(29.8)	–		(0.3)
Intestinal flukes	–	–		(0.3)
Cloacal "	(3.2†)	–		(0.3)
Anal skin "	–	(6.2)		–
Cestodes	2.1 (2 spp.)	39.3 (2 spp.)	71.0 (3 spp.)	both
Nematodes				
Syngamus	3.2	– (exam. ?)	0.0	
Esophageal *Capillaria*	20.2	1.8	11.3	both
Proventricular worms	12.8	43.0	4.7	"
Gizzard worms	29.8	16.9	3.3	"
Intest. *Capillaria*	17.2	–	60.7	"
Diplotriaena tricuspis	30.9	5.3	–	
Misc. filariids	2.1	–	–	
Misc. intest. nematodes	–	–	5.7	"
Acanthocephala	–	–	6.0	"

* obtained following ear eversion in 58 birds.
† " " detergent technique used on 9 birds.

along with *Chandlerella* Yorke and Maplestone and *Parachandlerella* Caballero are synonyms of *Splendidofilaria*.

The only 2 extensive surveys in the United States on parasites of individual passerines prior to the present one are one dealing with the eastern crow (Morgan and Waller, 1941) and the other with the starling (Boyd, 1951). Since the blue jay belongs with the crow in the family CORVIDAE and all 3 possess characters in common, a comparison of their arthropods and helminths is presented in Table IV. The percentage figures are based on an examination of 100 adult blue jays, 112 adult crows and 300 juvenile and adult starlings. In general, the common name of the parasites is used, as the specific names ordinarily do not apply to all 3 hosts.

It should be noted as regards the lice, that the presence of their eggs alone was recorded as a positive finding in both blue jays and starlings, and this may account in part for their much higher incidence in these birds (75%, 82%) than in the

crow (23%). The absence of ticks and chiggers from the records for the crow and starling is not surprising since they were found only by everting the ear in the blue jay. Improved technique may alter the figures for the parasitic fauna of the crow, in particular with regard to the relative scarcity of ectoparasites and absence of intestinal *Capillaria*.

There was a marked contrast in degree of louse infestation per individual bird between the blue jay and starling. One had to search diligently on the former before finding lice, whereas the latter was typically "crawling" with them. Several factors are undoubtedly involved in the heavy louse infestation of the starling, in its high feather-mite incidence (60%) as well as in the occurrence of fleas and hippoboscid flies. In this investigation, 135 starlings were collected in August and September and approximately half of the 300 examined were juveniles. As already pointed out, a higher frequency of ectoparasites, especially of nest-dwellers, is to be expected in birds that have had recent association with the nest. Starlings, unlike jays and crows, nest successively in the same hole, having 2 or 3 broods per season. While investigating parasitism in nestling starlings the senior author (unpublished) was amazed to observe the increase in the parasitic population of the nesting site with the advancing weeks. The nest of the third brood was swarming with blood-sucking mites, which probably helped in causing the high mortality characteristic for these late nestlings over those hatched earlier.

The gregarious habit of the species is important as regards parasitism of the individual. Blue jays are relatively non-gregarious, compared with crows and starlings, which move in flocks and mass together in roosts at night. This fraternization affords opportunity for the spread of certain parasites. Another consideration involves the feeding habits of the bird. This applies especially to many endoparasites that require an intermediate host in order to fulfill their life history. The gapeworm and the 2 species of *Capillaria* are not in this category as they do not require a second host (Madsen, 1952). Blue jays are foliage seekers, three-quarters of their diet consists of vegetable matter (Forbush, 1927). The animal matter making up the remainder of their food is largely grasshoppers, caterpillars and fruit-eating beetles. It is not surprising that they show a high incidence of fluke infection (32%) as flukes have snails (vegetarians and dung-eaters) as their intermediate hosts. The incidence is in marked contrast to that of crows (6%) and of starlings (1%). Possibly there is a correlation between grasshopper consumption and the large number of jays infected by stomach worms (13%, 30%). Cram (1931, 1934a, b) demonstrated that the proventicular worm, *Microtetrameres helix* Cram, and the gizzard worm, *Acuaria anthuris*, of the crow, and species of *Cheilospirura* of poultry and game birds must pass through grasshoppers or crickets to complete their life cycles. Probably this holds true for the species of *Microtetrameres* and *Cheilospirura* of the blue jay along with the crow gizzard worm. Isopods act as the vectors for the other proventricular worm, *Dispharynx nasuta* according to Cram (1931) and for the acanthocephalan, *Plagiorhynchus formosus* according to Van Cleave (1942).

In the comparison of parasitism in the three hosts, one of the two most striking differences exhibited by the blue jay is its paucity of cestodes. Crows and starlings showed a 40% and 71% prevalence of tapeworm infection, respectively, whereas that in the jay was only 2.1%. It has been demonstrated that the immature stage

of the crow tapeworm, *Hymenolepis variabile* Mayhew is spent in the bodies of dung beetles and grasshoppers (Jones, 1934). Crows and starlings are omnivorous in their diet and tend to be ground-feeders and these facts may have a bearing on the frequency of cestodes in both.

The second major difference in the parasitic fauna of the three hosts lies in the high number of jays infected with filarial worms (31%). As a result of his study, Robinson has shown that the infection is contracted in the nest for he obtained microfilariae from many juvenile birds, from a jay approximately 5 weeks old (1954) and finally from a jay raised in captivity after having been removed from its nest when 16 days old (1955). He estimated that it took about 8 weeks for worms to reach maturity in blue jays. He observed that the microfilariae exhibit nocturnal periodicity. In discussing the possible vectors for these worms, Robinson suggests that gnats may act as the intermediate hosts. Engorged *Culicoides haematopotus* were found in the jay's nest and the gnats are to be found in abundance in the woodland nesting territory during the breeding season (Robinson, 1955). However, the possibility that the blood-sucking mites may serve as vectors should not be ruled out. These ectoparasites are known to occur in large numbers in the nest of starlings, yet they were present in only 3.8% of the 300 starlings investigated and all the hosts were juveniles. In contrast, 5% of the jays harbored them and these were all adult birds. It has been proved that species of *Bdellonyssus* may serve as vectors of St. Louis encephalitis virus and for the filarial worm of cotton rats (Baker and Wharton, 1952).

SUMMARY

1. One hundred blue jays were collected from New England (Mass., 87; N. H., 12; Vt., 1) between October 1947 and May 1954, all months being represented except August and September. The freshly killed birds were examined for arthropods and all but 6 individuals for helminths.

2. Arthropods were few in number on each host, and exhibited an 83% prevalence:—75% for 3 species of *Mallophaga;* 49% for 8 species of *Acarina* (37% for feathermites) (Table I). These figures should probably be higher since (a) ticks and chiggers were obtained only following eversion of the ears of the last 58 jays examined, and (b) the detergent technique for the last 9 individuals uncovered organisms that had previously escaped detection.

3. Original descriptions have been given for the eggs of *Degeeriella eustigma, Philopterus cristata* and *Menacanthus persignatus* (Table II).

4. Arthropods recorded for the blue jay from the present study and from published reports number 20 (Table I). The finding of *Harpirhynchus* and *Cytodites* mites constitutes new host records. New state records are established for *Trombicula whartoni.*

5. There was 80% infection of blue jays by helminths. Liver flukes (3 species) were found in 30%, a cloacal fluke in 3% and 2 species of cestodes in 2% of the birds. Nematodes included 10 species. Three percent of the jays harbored gapeworms; 20% and 17% esophageal and intestinal *Capillaria* respectively; 13% and 30% proventricular and gizzard worms (2 species of each) and 32% filarial worms (3 species, one of which, *Diplotriaena tricuspis,* was found in 31% of the birds) (Table III).

6. Twenty-one helminths are recorded for the blue jay from the present study

and from data in the literature and in the files of the Helminthological Collection, U. S. D. A. (Table III).

7. Six worms constitute new host records—*Lutztrema monenteron, Oligorchis* sp., *Dispharynx nasuta, Capillaria contorta, C. obsignata* and *Pseudaprocta* sp. To these may be added, *Acuaria anthuris, Diplotriaena tricuspis* and *Splendidofilaria* sp., where specimens belonging to these 3 families had been previously collected from this host but were unidentified as to species. Cestodes and acanthocephalans have not previously been reported for the blue jay but both are represented as unmounted specimens in the Helminthological Collection, each having been collected on 1 occasion. The single tapeworm (#39719) proved similar to 1 of the 2 recovered in the present study and identified as *Culcitella* sp.? The tentative identification of the acanthocephalan as *Plagiorhynchus formosus* has been confirmed.

8. The incidence of parasitism in the blue jay is discussed and compared with published findings in the crow and starling (Table IV).

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EXPLANATION OF FIGURES

FIGS. 1–9. Eggs of the three species of Mallophaga drawn in lateral view with the aid of a camera lucida.

FIGS. 1–3. *Degeeriella eustigma* Kell.; 1, under surface of breast feather with egg in situ; 2, cap area; 3, portion of edge of cap.

FIGS. 4–6. *Philopterus cristata* Malcomson; 1, under surface of neck feather with egg in situ; 2, cap area; 3, portion of edge of cap.

FIGS. 7–9. *Menacanthus persignatus* Kell. and Chap.; 1, upper surface of back feather with egg in situ; 2, cap area; 3, portion of edge of cap.

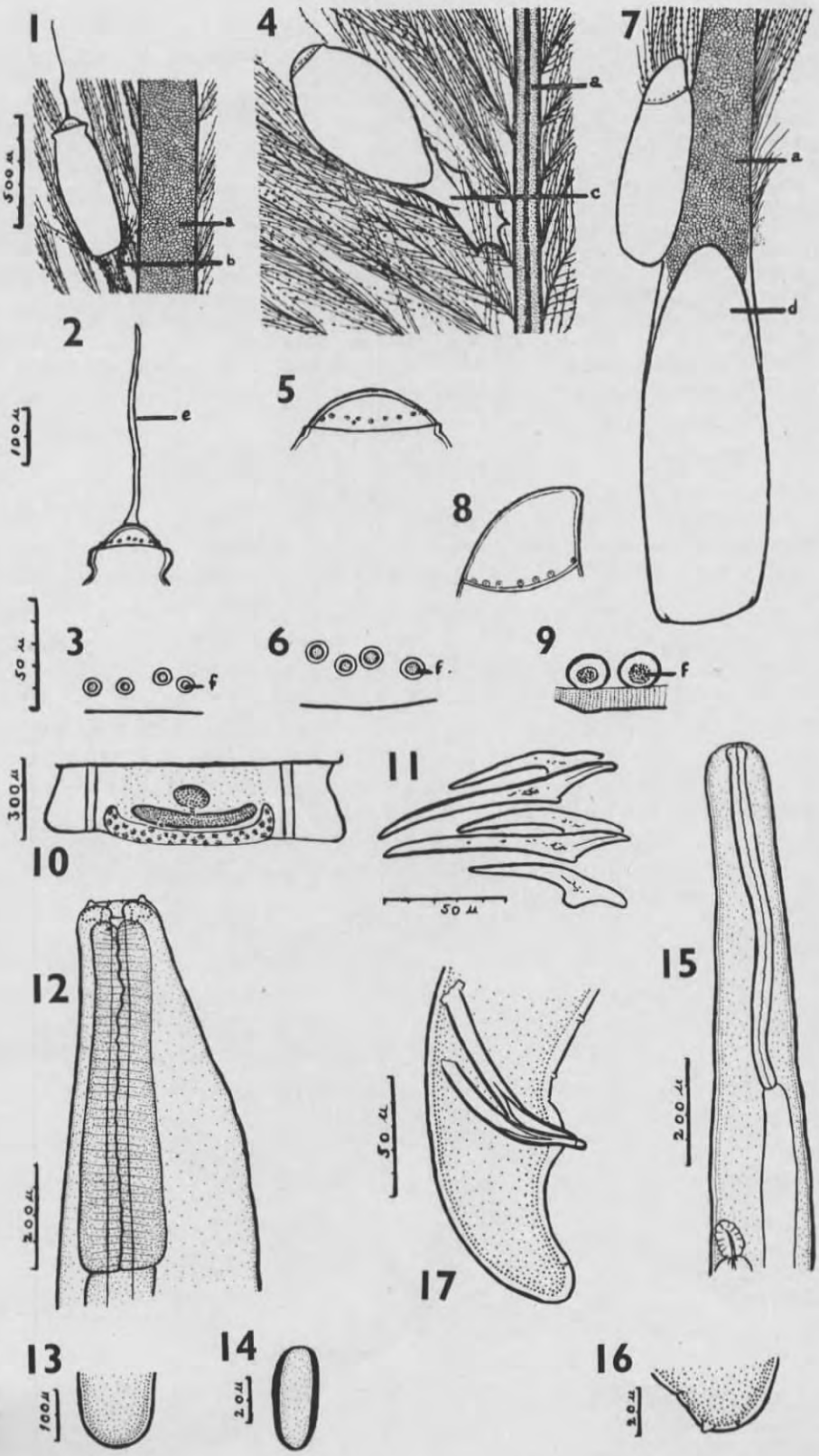
Abbreviations: a, rachis; b, barbules; c, secretory material; d, calamus; e, filament; f, micropyle.

FIGS. 10, 11. *Culcitella* sp. ? 10, mature proglottid of cestode from blue jay #63. 11, Hooks on scolex of cestode #39719 Helminthological Collection, U. S. D. A.

FIGS. 12–14. *Pseudaprocta* sp. Female. 12, anterior end. 13, posterior extremity. 14, egg.

FIGS. 15–17. *Splendidofilaria* sp. 15, anterior end female. 16, posterior tip female. 17, posterior region of male to show spicules and tail.

PLATE I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