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AVIAN POX INFECTIONS IN SOUTHEASTERN BOBWHITES: HISTORICAL AND RECENT INFORMATION¹

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Abstract: Historic and recent information on the occurrence of avian pox, an infectious viral disease, in southeastern bobwhite quail (*Colinus virginianus*) is summarized. An apparent long-term (> 50 year) low-level (< 2 percent) rate of infection occurred prior to an outbreak with a 12-fold increase in prevalence in 1978-1979. Post-outbreak monitoring during the two succeeding years disclosed that the regional prevalence of infection declined to near the pre-outbreak rate. The significance of avian pox as a regional and local mortality factor is discussed.

Avian pox is a viral infection of birds, characterized by discrete proliferative (wart-like) lesions on the skin and/or mucous membranes of the mouth and upper respiratory tract. There are several strains of avian pox viruses, many of which are of varying virulence, but all of which are infective only to birds. Some strains of the virus are host specific and infect only certain species of birds, whereas other strains are less host specific and may infect many species. The virus may be transmitted by several routes, including (1) contact with or ingestion of infectious scabs, (2) inhalation of viral particles in dust, or (3) by blood-feeding arthropods, particularly mosquitoes (Cunningham 1978). Mosquito-borne infection is generally considered to be the most important means of transmission among wild birds, and several species of mosquitoes have been shown to be natural vectors of pox viruses in wild game birds in the Southeast (Akey et al. 1981). Avian pox may occur in two forms. The cutaneous form involves lesions which develop primarily on the unfeathered portions of the skin (legs, feet, eyelids, head) and, unless vision is impaired, is not usually a serious disease. The moist or wet form involves lesions which develop on the mucous membranes of

the mouth, nasal passages, and upper respiratory tract and often leads to a serious disease due to impairment of feeding and/or respiration. In birds which survive, avian pox lesions generally regress spontaneously 6 to 12 weeks after infection. Morbidity and mortality rates from pox infection are influenced by a variety of factors and may range from near zero to over 50 percent of a population (Cunningham 1978).

Reports of avian pox in wild bobwhite quail have been infrequent, although this disease has been a sporadic problem in captive bobwhites (Morley 1933, Shillinger and Morley 1937, Poonacha and Wilson 1981). This situation changed abruptly in 1978-1979 in the southeastern United States when an outbreak of avian pox occurred in wild bobwhites (Davidson et al. 1980). This report (1) summarizes published accounts of avian pox in bobwhites prior to the 1978-1979 outbreak, (2) reviews the 1978-1979 outbreak in the Southeast, (3) presents the results of region-wide avian pox surveillance conducted during two years following the 1978-1979 outbreak, (4) evaluates available epizootiologic information, and (5) discusses the implications of avian pox for wild bobwhites in the Southeast.

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of Veterinary Medicine, The University of Georgia, graciously assisted with laboratory support.

METHODS

Information on the occurrence of avian pox in wild bobwhites prior to the 1978-1979 outbreak was obtained by a review of the literature and from unpublished records of the Southeastern Cooperative Wildlife Disease Study (SCWDS). Data on the 1978-1979 outbreak were obtained from the description of the outbreak (Davidson et al. 1980) and were supplemented by additional unpublished records of the SCWDS and by a follow-up questionnaire distributed by Tall Timbers Research Station.

Post-outbreak surveillance was conducted during bobwhite hunting seasons in 1979-1980 and 1980-1981. Requests for assistance with surveillance were channelled through state fish and wildlife agencies in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia and through Tall Timbers Research Station, Tallahassee, Florida. Via this system, hunters were asked to retain and freeze the head, wings, and the unfeathered portion of the legs and feet of bobwhites for examination. Additional data requested were the specific location, county, state, and date of collection. Samples generally were limited to < 100 per location. All bobwhites handled during bobwhite management studies by the SCWDS at Tall Timbers Research Station during February 1979, 1980, and 1981 also were examined. Age and sex of birds were determined by plumage characteristics (Stoddard 1931). Pox infection of these samples was determined on the basis of gross lesions and was accompanied by histologic confirmation of questionable lesions.

RESULTS AND DISCUSSION

Pre-outbreak Data

A review of the literature revealed only four published reports of avian pox in wild bobwhites prior to the 1978-1979 outbreak (Table 1). Collectively these reports suggest that avian pox has existed in wild southeastern bobwhite populations at least since the 1920s and probably prior to that time. Such infections typically appeared to be mild and transient with only occasional birds reaching a debilitated condition due to pox infection. The single report by Gallagher (1916) of large scale mortality involved wild-caught birds crowded into cages. The confinement conditions undoubtedly were related to increased transmission and high infection rates. In the 15 years prior to 1978, only a single bobwhite with avian pox had been submitted to the SCWDS diagnostic laboratory.

Outbreak Data

The 1978-1979 outbreak of avian pox was described in detail by Davidson et al. (1980). From July 1978 through March 1979, 26 separate unsolicited clinical case accessions involving 43 wild bobwhites from southeastern Georgia/northcentral Florida were diagnosed as avian pox by the SCWDS. A survey of 2,586 hunter-killed bobwhites from Florida, Georgia, North Carolina, South Carolina, Tennessee, and West Virginia conducted during January and February, 1979, disclosed an overall rate of infection of 12 percent (312 birds). Most (77 percent) of the 312 infected birds had only mild lesions on the legs and feet with the remaining birds (23 percent) having more extensive lesions of the eyes, nares, and oral cavity. The prevalence of infection varied greatly among

Table 1. Reports of the occurrence of avian pox in wild bobwhites prior to an outbreak of pox in 1978-1979.

Source	Date	Location	Circumstances
Gallagher (1916)	1916	Kansas City	Severe disease developed in a group of 400 wild-caught bobwhites imported from Mexico; 85 percent mortality
Stoddard (1931)	1924-1929	"Southeast"	Pox lesions observed on legs and feet of <2 percent of several thousand bobwhites; in some coveys the majority were infected; two cases with lesions on head reported (GA, SC)
Kellogg and Doster (1972)	1972	Baker Co., GA	Single sick bird caught by hand; lesions on legs and around nares ^a
Davidson et al. (1980)	1969-1978	Leon Co., FL	Mild pox lesions observed on legs and feet of less than one percent of over 8,300 bobwhites; no mortality reported

^aCircumstances from unpublished SCWDS case records.

Table 2. Results of avian pox surveillance in wild bobwhites in the Southeast during three successive hunting seasons, 1978-1979, 1979-1980, 1980-1981.

State/County	Number Infected/Number Examined		
	1978-79	1979-80	1980-81
Arkansas			
Conway			0/8(0)
Izard			0/25(0)
Logan			0/40(0)
Pope			0/30(0)
Stone			1/115(1)
Yell			2/53(4)
"Southwest AR"			2/74(3)
			<u>5/345(1)</u>
Florida			
Charlotte		5/44(11)	5/104(5)
Citrus	0/18(0) ^a	0/64(0)	0/26(0)
Jefferson	4/114(4)		0/13(0)
Leon	80/902(9)	2/829(<1)	21/925(2)
Osceola	0/3(0)	1/58(2)	
Santa Rosa			2/23(9)
Not Given			0/59(0)
	<u>84/1037(8)</u>	<u>8/995(1)</u>	<u>28/1150(2)</u>
Georgia			
Baker			1/63(2)
Brooks	6/24(25)	10/68(15)	1/53(2)
Bullock		1/7(14)	
Burke		5/50(10)	0/26(0)
Decatur	40/308(13)	9/125(7)	7/57(12)
Dougherty	56/493(11)		10/49(20)
Grady			13/44(30)
Jackson			0/2(0)
Jefferson		3/21(14)	0/1(0)
Lee	0/6(0)		
Mitchell		10/68(15)	
Oglethorpe		0/6(0)	1/14(7)
Putnam			0/9(0)
Screven	13/34(38)	2/13(15)	2/52(4)
Sumpter	0/6(0)		
Thomas	88/413(21)	17/216(8)	19/259(7)
Toombs	8/23(35)		
Truetlan	7/18(39)	2/7(29)	
Washington	1/12(8)		
Wheeler		6/9(67)	0/6(0)
Worth			0/100(0)
	<u>219/1337(16)</u>	<u>65/590(11)</u>	<u>54/735(7)</u>
Louisiana			
Caldwell			0/13(0)
Catahula			0/4(0)
East Carrol			0/6(0)
Ouachita			0/1(0)
Union			1/38(3)
			<u>1/62(2)</u>

Table 2. (Cont.)

State/County	Number Infected/Number Examined		
	1978-79	1979-80	1980-81
North Carolina			
Bladen	1/21(5)		
Chatham	0/4(0)		
Craven	0/4(0)	1/17(6)	
Cumberland	0/11(0)		
Edgecombe	0/1(0)		
Green/Pitt	1/20(5)		
Halifax	0/2(0)		
Hoke/Moore		0/35(0)	0/5(0)
Harnet		1/20(5)	4/28(14)
Jones	0/8(0)		
Lenoir	5/53(9)		
Montgomery		1/20(5)	
Northhampton	2/32(6)		
Richmond	0/6(0)	3/29(10)	
Robeson	0/15(0)		
Scotland	0/3(0)		0/6(0)
Wake		0/2(0)	
	<u>9/169(5)</u>	<u>6/123(5)</u>	<u>4/50(8)</u>
South Carolina			
Allendale		2/11(18)	
Berkeley		0/20(0)	
Hampton	0/23(0)	0/56(0)	0/98(0)
Marlboro	0/3(0)		
Oconee			0/2(0)
Pickens			0/21(0)
Williamsburg		4/57(7)	0/64(0)
	<u>0/26(0)</u>	<u>6/144(4)</u>	<u>0/185(0)</u>
Tennessee			
Fayette	1/6(17)		
Henderson	0/9(0)		
	<u>1/15(7)</u>		
Virginia			
Accomack		7/39(18)	
Caroline		0/60(0)	0/40(0)
Culpepper		0/12(0)	0/13(0)
Dinwiddie/			
Nottoway		0/36(0)	0/68(0)
Essex			0/32(0)
King and Queen		1/28(4)	0/16(0)
King William		0/4(0)	
Madison			0/2(0)
Nelson			0/14(0)
Northumberland		2/26(8)	0/28(0)
Rappanhannock		0/33(0)	0/15(0)
Richmond			0/1(0)
Southampton			0/4(0)
Sussex		0/38(0)	
		<u>10/276(4)</u>	<u>0/233(0)</u>
West Virginia			
Mason	0/4(0)		
	<u>0/4(0)</u>		
Southeast			
Total	313/2588 (12.1)	95/2128 (4.5)	92/2760 (3.3)

^aPercent infected in parenthesis.

specific locales with the highest detected rate being 39 percent. The 12 percent prevalence was estimated to represent approximately a 12-fold increase in prevalence. Based on clinical case and survey data, morbidity and mortality rates of approximately 2 percent and 1 percent, respectively, were estimated for a 13,000 km² area of Georgia and Florida during the interval of January and February 1979. No differences in infection rates were noted among different age or sex categories, and it was concluded that all segments of the population were affected equally.

Post-outbreak Data

The results of region-wide surveillance activities conducted during the hunting seasons of 1979-1980 and 1980-1981 are presented in Table 2 along with similar information from 1978-1979 for comparative purposes. On a region-wide basis, post-outbreak surveillance showed lower overall rates in 1979-1980 (4.5 percent) and 1980-1981 (3.3 percent) than during the outbreak (12.1 percent). Sufficient data were available from nine specific locations in each of the three years for annual comparisons (Table 3). The prevalence of pox on these areas exhibited varying trends, although similar trends were detected on five of the seven areas where infections occurred. The pattern in these cases was a decline in prevalence from 1978-1979 to 1979-1980 followed by a slight increase in prevalence in 1980-1981. One of the remaining areas was highest in 1979-1980, and the other declined in both 1979-1980 and 1980-1981. The annual mean prevalence for data from these nine areas (adjusted for unequal sample sizes) was highest (13.2 percent) in 1978-1979 and approximately equal in 1979-1980 (5.6 percent) and 1980-1981 (4.8 percent). Collectively these data indicate that during the two years following the outbreak, the prevalence of pox generally declined to approximately one-third the rate during the outbreak although marked local differences in prevalence existed as were noted during the outbreak (Davidson et al. 1980).

Fewer accessions of clinically affected bobwhites were received by the SCWDS in the two years following the outbreak. During 1979-1980, three accessions involving four bobwhites were diagnosed as pox infections, and in 1980-1981 there were 12 accessions involving 15 bobwhites. These data also indicate a decline in the occurrence of clinical pox infections especially considering that general awareness of the disease was much greater than in 1978-1979.

Related Epizootiologic Data

A questionnaire distributed in November 1979, among individuals cooperating in surveillance activities provided one particularly interesting fact. In response to the question of whether they had observed avian pox in bobwhites prior to 1978, two respondents, one in Brooks County, Georgia, and one in Colquitt County, Georgia, indicated that they had observed infected bobwhites in 1977. These reports suggest that avian pox may have begun to increase in 1977, a year before the outbreak was generally recognized.

A widespread and rather severe problem due to avian pox occurred during the summer and fall of 1978 among pen-raised bobwhite operations in the Southeast, including Florida, Georgia, South Carolina, and North Carolina. Avian pox infections also had been noted in a breeder flock of bobwhites in Kentucky during the fall of 1977 (Poonacha and Wilson 1981). These occurrences raised the question of whether release of pen-raised bobwhites might be related to the pox situation in wild bobwhites. Review of available information did not provide evidence that the region-wide increase in avian pox infections in 1978 was related directly to the avian pox problem that occurred simultaneously in captive bobwhites. The occurrence of avian pox in increased levels at locations where pen-raised birds were not present, such as Tall Timbers Research Station, indicates that the outbreak probably arose from the naturally-occurring low level of pox in wild

Table 3. Comparison of the prevalence of avian pox in bobwhites from nine specific locations during three successive hunting seasons.

Location No.	County/State	Number Infected/Number Examined		
		1978-1979	1979-1980	1980-1981
1	Leon, FL	14/90(16) ^a	0/24(0)	3/105(3)
2	Leon, FL	47/324(15)	2/450(<1)	10/508(2)
3	Leon, FL	4/320(1)	0/322(0)	8/312(3)
4	Citrus, FL	0/18(0)	0/64(0)	0/26(0)
5	Thomas, GA	15/58(31)	1/46(2)	5/72(7)
6	Thomas, GA	10/219(5)	15/60(25)	14/115(12)
7	Decatur, GA	40/308(13)	9/125(7)	7/57(12)
8	Screven, GA	13/34(38)	2/13(15)	2/52(4)
9	Hampton, SC	0/23(0)	0/56(0)	0/98(0)
Total		146/1394(10.5)	29/1160(2.5)	49/1345(3.6)
Annual mean prevalence ^b		13.2%	5.6%	4.8%

^aPercent infected in parenthesis

^bAdjusted for unequal sample sizes

bobwhites. Conversely, there was circumstantial evidence that in some specific locations release of pen-raised bobwhites contributed to and intensified pox problems. For example, the high prevalence at location 6 (Table 3) in 1979-1980 apparently was related to release of pen-raised bobwhites. At another location, approximately 1,000 bobwhites were known to have been released while over 50 percent were experiencing clinical disease due to avian pox. Such cases clearly could contribute to the perpetuation of pox infections on these localized areas.

An additional point of interest with regard to the increased occurrence of avian pox in bobwhites was the host range of the virus and its ability to produce disease in other species such as domestic poultry and wild turkeys (*Meleagris gallopavo*). A series of laboratory tests and experimental infections were conducted in collaboration with the Poultry Disease Research Center, College of Veterinary Medicine, The University of Georgia (Dr. Pedro Villegas and Dr. Mark Dekich, unpubl. data). These studies provided the following basic findings: (1) viral neutralization and vaccination-challenge trials indicated that bobwhite isolates were immunologically different from the fowl pox strain of avian pox viruses; (2) isolates of pox virus from bobwhite field cases (wild and pen-raised) produced transient lesions in domestic chickens and turkeys but were not infective to coturnix quail (*Coturnix coturnix*); and (3) commercial fowl pox vaccines provided protection against challenge with bobwhite isolates, but bobwhite isolates did not protect against challenge with the fowl pox strain of avian pox virus.

SUMMARY AND CONCLUSIONS

Avian pox infections have occurred naturally in wild bobwhites in the Southeast for a long time (> 50 years) at a low prevalence (< 2 percent). For reasons that are not known, avian pox infections increased approximately 12-fold in the southwest Georgia/northcentral Florida region in 1978-1979. Mortality due to pox infection in this region was estimated to be approximately one percent during January and February 1979 but probably was considerably more during the period of July-December 1978, when environmental conditions were more favorable for arthropod vectors, primarily mosquitoes. A similar seasonal occurrence of avian pox and mosquito transmission of pox viruses have been demonstrated in wild turkeys in Florida (Akey et al. 1981, D. L. Forrester, pers.comm. 1981). During the two years following the outbreak, the regional prevalence of infection declined to near the pre-outbreak level. On a local basis, the prevalence of infection can vary markedly, and mortality in specific locales can be much greater or much lower than in the region as a whole. Although releases of infected pen-raised bobwhites were not known to initiate the 1978-1979 outbreak, use of pen-raised birds apparently did contribute to pox problems on local areas. Where releases are necessary, birds vaccinated with commercial fowl pox vaccines eight to ten weeks prior to arrival on release properties provide minimal risks. The trend that

avian pox infections in southeastern bobwhites will take in the future is entirely speculative; however, historical accounts and data obtained subsequent to the outbreak provide considerable indications that the disease will return to the relatively quiescent status maintained prior to 1978.

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