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SURVEILLANCE FOR LEPTOSPIROSIS IN AN ILLINOIS DEER HERD

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Abstract

Serologic tests for leptospiral antibodies were conducted on 3236 sera from white-tailed deer killed in Pope County, Illinois from 1957 through 1968. Antibodies were detected to *Leptospira pomona* in 162 (5.0%) samples. The percentage of reactors was significantly less in female deer and in fawns of both sexes. The distribution of reactors in the county showed a reactor incidence (reactors/1000 deer tested) of 103 in areas with lower deer densities and higher cattle densities. The incidence in areas with more deer and fewer cattle ranged from 14 to 44.

Introduction

Native populations of the white-tailed deer *(Odocoileus virginianus)* in Illinois were exterminated shortly after the turn of the century.[1,4] Restocking by the Illinois Department of Conservation and the U.S. Forest Service resulted in re-establishment of deer to a level that has supported hunting in many parts of the state since 1957. Deer hunting in Illinois is on a permit basis for specific counties; deer of either sex and of any age can be killed; and all successful hunters are required to check their deer at stations maintained for each county. This program has provided an ideal means of investigating leptospirosis and other diseases since all deer killed can be examined, the kill represents all segmens of the population, and data on the population can be collected to correlate with disease studies.

Leptospirosis has been studied in one county in southern Illinois, Pope County, every year since the first hunting season in 1957. Some of these findings have been reported. The results of serologic tests of sera collected during the 1957 season were included in a state-wide report of brucellsois and leptospirosis in cattle and deer.[6] The 1958, 1959, and 1960 serologic findings were also included in a state-wide comparison of brucellosis and leptospirosis in deer.[7] Serologic results from 1957 through 1962 were compared with the incidence and distribution of leptospirosis in cattle in Pope County,[2] and characteristics of the deer herd, population densities and distribution of deer kills, for the 1957-1966 period have been examined.[3] Each of these papers included only segments of the data available on the deer herd over the 12 years it has been studied. This report integrates these papers with unpublished data to summarize the most inclusive study of leptospirosis yet reported in a wild deer population.

Methods

Pope County is an area of about 364 square miles in southeastern Illinois. The region is beyond the limit of glaciatin, and the topography is dominated by the Shawnee Hills in the north and the Ohio River floodplain in the south. Soil and climatic conditions of the area are best suited to timber and livestock production. Approximately 58% of the county is forested, but forested and nonforested land is interspersed throughout the county. There is a limited amount of cultivation, primarily corn and soybeans.

A shotgun hunting season has been held for three to six days in October, November or December each year since 1957. All successful hunters were required to check their deer at a station main-

tained in the county. All deer checked were sexed, aged,[15] weighed and examined for general physical condition. The location of deer killed each year from 1960 was recorded to the nearest square mile. Accession numbers were assigned each deer examined to permit correlation of age, sex and kill location with the results of serologic investigations.

Blood samples were collected by the hunters in plastic tubes from 1957 through 1960[6,7] and in 1965. Blood samples were collected all other years at the check station from non-dressed and freshly dressed deer.

Serum was extracted from the blood samples at the University of Illinois, Dixon Springs Agricultural Center in Pope County and frozen for shipment to the College of Veterinary Medicine, University of Illinois, Urbana. Microscopic agglutination tests[15] were conducted on the sera with the following live antigens: *Leptospira pomona, L. grippotyphosa, L. ballum, L. canicola, L. icterohaemorrhagiae, L. sejroe, L. hyos, L. hardjo, L. autumnalis,* and strain 3055, an isolate from the urine of an Illinois bull. All antigens were not used each year. Titers of 1:100 or higher were considered indicative of infection.

TABLE 1. *White-tailed deer shot in Pope County, Illinois, and tested for leptospiral antibodies.*

		Sera tested	
Year	Deer killed	Number	Percent
1957	108	30	41
1958	269	153	53
1959	338	224	66
1960	477	214	45
1961	811	198	24
1962	1358	300	22
1963	1274	662	52
1964	1626	320	20
1965	1997	675	34
1966	1444	174	12
1967	1013	152	15
1968	852	134	16
Total	11,567	3,236	28

Bacteriologic cultures were made from deer kidneys collected at check stations in 1958, 1959 and 1960[7] and in 1961.

The chi-square method was used for all statistical analyses reported in this study.

Results

A total of 11,567 deer were examined at Pope County check stations from 1957 through 1968 (Table 1). No leptospires were isolated from 500 kidneys cultured in 1958, 1959, and 1960[7] or from 156 kidneys cultured in 1961.

Sera from 3236 (28%) were tested for leptospiral antibodies. Antibodies were detected to all of the 10 antigens used. Seven serotypes were positive in 1% or less of the sera examined (Table 2). Two serotypes, *L. autumnalis* and strain 3055, were positive in higher percentages, but these antigens were not used throughout the study period. Reactors to *L. pomona* were detected each year (Table 3) and the total number of reactors, 162 or 5.0%, was considered large enough for further analysis.

Comparison of the age structure of the deer killed,[8] deer tested and deer with titers to *L. pomona* (Figure 1) indicated that there was little difference in the three sample populations for any age group except ½ year. The percentage of ½ year old deer tested was significantly less than the percentage killed, and the percentage of reactors was significantly less than the percentage tested.

Within the sample populations of deer tested and reactor deer (Table 4) there were marked differences. As shown in figure 2, fewer females were tested than males, significantly less in the ½ and 1½ age classes. The percentage of reactors was significantly less than the percentage of deer tested in the ½ year deer of both sexes. In adult deer, 1½ years or older, the only significant variation between deer tested and reactor deer was in 3½ and 4½ year males and 1½ year females.

TABLE 2. *White-tailed deer sera from Pope County, Illinois with titers of 1:100 or higher to leptospiral antigens.*

Serotype	Years Tested	Sera Tested	Reactors	
			Number	Percent
L. pomona	12	3236	162	5.0
L. grippotyphosa	12	3236	31	1.0
L. ballum	11	3102	7	0.2
L. canicola	10	2928	6	0.5
L. icterohaemorrhagiae	10	2910	2	0.1
L. sejroe	9	2776	14	0.5
L. hyos	9	2776	2	0.1
L. hardjo	4	1281	6	0.5
L. autumnalis	4	1135	44	3.9
Strain 3055	2	849	100	11.4

The distribution of deer tested from 1960 through 1968 was plotted on a county map and compared with the distribution of *L. pomona* reactors (Figure 3). The reactor incidence (reactors/1000 deer tested) could not be correlated with the distribution of rivers and streams, private or U.S. Forest Service land or general topography. In general, areas with a high incidence of reactors (103/1000) were the parts of the county with the lowest deer densities,[3] the least wooded land and the highest density of cattle.[2] Conversely, areas with low indices of reactors had higher deer densities, more wooded land and lower cattle densities.

TABLE 3. *White-tailed deer sera from Pope County, Illinois with titers 1:100 or higher to* L. pomona.

Year	Tested	Reactors	
		Number	Percent
1967	30	3	10.0
1958	153	11	7.2
1959	224	8	3.7
1960	214	1	0.5
1961	198	21	10.6
1962	300	35	9.7
1963	662	26	3.9
1964	320	4	1.1
1965	675	31	4.6
1966	174	9	5.2
1967	152	6	4.0
1968	134	7	5.2
Total	3,236	162	5.0

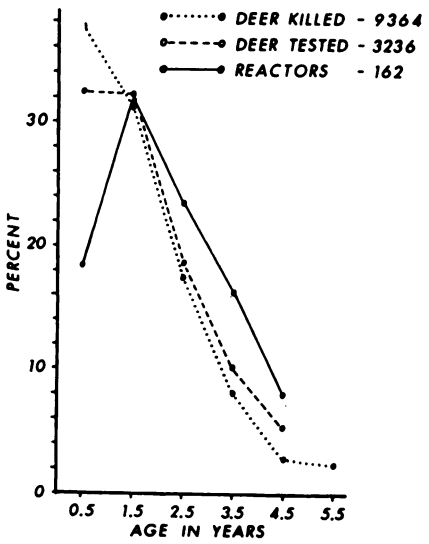

FIGURE 1. *Age structure of three sample populations of white-tailed deer from Pope County, Illinois. The sample of deer killed is from 1957-1966;[4] the other two samples are from 1957-1968.*

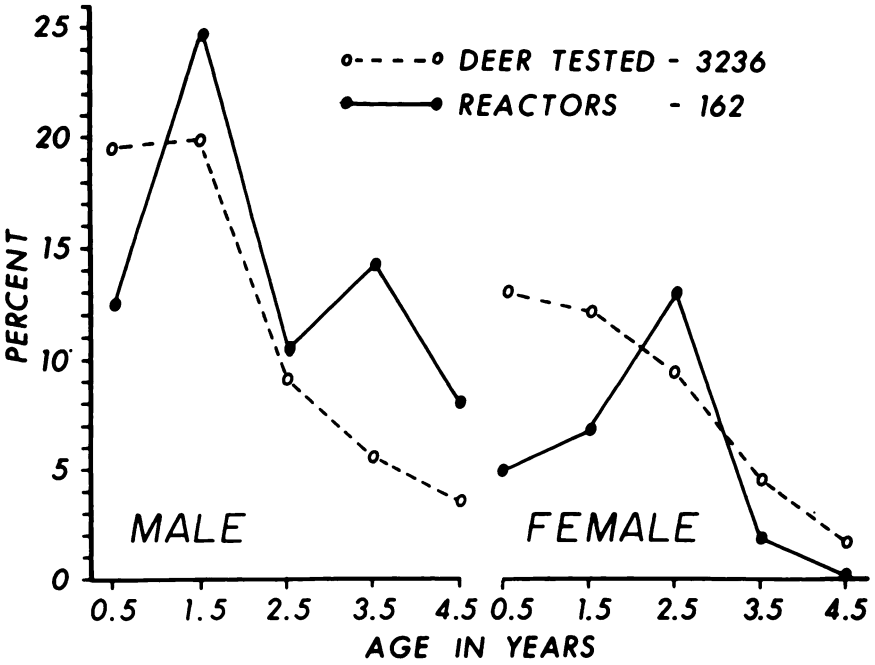

FIGURE 2. *Age structure of male and female white-tailed deer from Pope County, Illinios tested for leptospiral antibodies and* L. pomona *reactors, 1957-1968.*

TABLE 4. *Age and sex of white-tailed deer killed in Pope County, Illinois from 1957-1968 with serologic titers to* L. pomona.

Age in Years	Deer Tested						*L. pomona* Reactors					
	Male		Female		Total		Male		Female		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
½	628	19.4	423	13.0	1051	32.4	22	13.5	8	4.9	30	18.4
1½	642	19.9	395	12.2	1037	32.1	40	24.7	11	6.8	51	31.5
2½	293	9.1	306	9.5	599	18.6	17	10.5	21	13.0	38	23.5
3½	181	5.6	147	4.5	328	10.1	23	14.2	3	1.9	26	16.1
4½ +	118	3.6	56	1.7	174	5.3	13	8.0	0	—	13	8.0
Unknown	26	0.8	21	0.7	47	1.5	0	—	4	2.5	4	2.5
Total	1888	58.4	1348	41.6	3236	100.0	115	70.9	47	29.1	162	100.0

Discussion

Serological studies have shown that leptospirosis is present in white-tailed deer throughout most their range and that *L. pomona* is the principle serotype involved.[1,2,3,6,7,8,11,12,14,17,19,21,22] Isolations of *L. pomona* from deer in New York,[14] Ontario[1,12] and Louisiana[17] have confirmed the serologic findings. Serologic reactors to other serotypes were detected in this study and by others[6,7,8,11,14,21] but generally at much lower percentages and often as cross reactors with *L. pomona*.

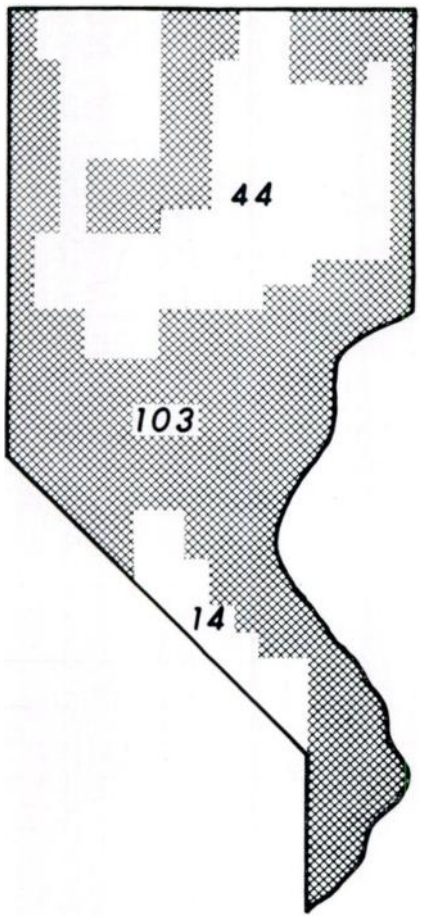

FIGURE 3. *Distribution of* L. pomona *reactors in white-tailed deer from Pope County, Illinois, 1957-1968, expressed as the number of reactors per 1000 deer tested.*

The percentage of *L. pomona* reactors has varied greatly between regions. Low reactor rates, from 2% to 7%, have been reported in 10 southeastern states,[19] from the state-wide deer harvest in Illinois in 1958-1960[7] and in this study of Pope County deer from 1957 through 1968. Reactor rates ranging from 10% to 12% have been reported in Minnesota,[1,22] New York[11] and in Illinois in 1957.[6] Higher rates (26% - 27%) have been reported in Wisconsin[21] and Ontario.[11]

There is little information on the importance of leptospirosis in wild deer populations. Experimental infections with *L. pomona* produced a clinically inapparent disease in nonpregnant deer,[5,20] but did result in abortions in 4 of 5 pregnant does.[20] The abortions, as the workers pointed out, were not typical of infection in wild deer since they were the result of massive inoculations by an abnormal route. It is difficult to determine if low rates of infection, as seen in Pope County, cause abortions and decrease the productivity of the herd. There was no evidence that the rate of population increase of the Pope County herd was influenced by any factor when the ratio of fawns per doe in the kill from 1957 through 1962 was examined.[2] It must be kept in mind, however, that a low rate of fawn loss due to leptospirosis would be difficult, if not impossible, to determine from analysis of deer-kill data.

Investigations of the population dynamics of the Pope County herd indicated that the population density increased about 650% from 1957 to 1964 and then declined about 20% during 1965 and 1966 as a result of overhunting.[3] The percentage of *L. pomona* reactors has not fluctuated accordingly but has remained relatively stable (Table 3). These data suggest that the reactor rate in this herd is not density dependent but rather is related to density independent environmental factors. These findings are in contrast to those of Trainer[21] who found that a decline in *L. pomona* reactors

from 30% in 1957 to 22% in 1960 in Wisconsin was correlated with a decline in the deer population.

There was no relationship between the percentage of *L. pomona* reactors and either sex or age when the Pope County data for the first six years, 1957 through 1962, were examined.[2] Similar findings have been reported in deer from northwest Illinois,[5] Minnesota[22] and New York.[14] In Wisconsin, however, Trainer[21] found that reactor rates were lower in male than female fawns, and in adult deer they were higher in males than females. Trainer's speculation that venereal transmission was involved was based, in part, on these data since female fawns breed at six months of age while males do not breed until 1½ years. The 1957-1968 Pope County data show a higher percentage of reactors in male fawns while females had significantly lower reactor rates through 1½ years (Figure 2). These data suggest that venereal transmission was not involved in this deer herd.

Reactor rates in deer from Ontario,[11] Wisconsin[21] and in this study were higher in adults of both sexes than in fawns. Trainer attributed this to a longer chance of exposure through time and age. Higher reactor rates in adult males than in adult females are more difficult to explain unless males are more motile, thus increasing their chance of exposure.

The source of infection of Pope County deer is unknown. Rather than venereal transmission, deer are probably exposed through contact with contaminated surface water. Streams and ponds are found throughout the county; many of the streams are reduced to a series of pools most of the year. Infections in deer using a contaminated pond or pool would be restricted to a limited area. Such localizations were observed in *L. pomona* reactors in six of the nine years that deer-kills were mapped.[2] That is, when a reactor was located in one section (square mile) there was a 60% chance that another reactor would be located in the same section or in a contiguous section. The reservoir host contaminating the waters is not known. Experimentally infected deer shed leptospires in their urine, although the period of leptospiruria is short and of low magnitude.[20] Livestock have been considered as a possible reservoir host for deer infections.[5] Cattle are found in all parts of the county and *L. pomona* is present in the herds.[10] If cattle were the reservoir host, the chance of deer exposure would be greatest in the less heavily wooded parts of the county where cattle were most common. This premise is supported by the distribution of *L. pomona* reactors from 1957 through 1968 (Figure 3). The reactor incidence was 103/1000 deer tested in regions where cattle were most numerous. In parts of the county where cattle were less numerous the incidence ranged from 14 to 44/1000 deer tested.

Other wildlife species might also be involved. *Leptospira pomona* has been isolated from the urine of striped skunks *(Mephitis mephitis)* in Pope County, and free moving skunks periodically live-trapped shed leptospires for as long as 77 days.[9] Skunks in captivity have shed *L. pomona* for as long as 354 days.[19] Skunks are most numerous in the more open parts of the county, the same areas with the highest density of cattle and the highest incidence of reactors in deer. Skunks, therefore, may be responsible for infections in both cattle and deer.

The role of the white-tailed deer in the epizootiology of leptospirosis has not been adequately defined. Many of the previous reports have been on a limited number of deer, often collected over a large area. These findings have shown the presence of leptospirosis in deer, but they have not defined the influence of the disease on deer populations. Intensive work has also been done with deer collected in small areas around outbreaks of leptospirosis in livstock.[1] In such cases *L. pomona* has been isolated and a high percentage of the deer are serologic reactors. These data, however, must not be considered indicative of the entire population, since, as suggested in this report, leptospiral reactors are localized and not distributed throughout the population. In the Pope County herd

leptospirosis is apparently enzootic and deer are probably of little importance in transmission of leptospires to other species. Further work is necessary to determine if the disease does become epizootic in localized areas in the county and of the influence of such infections of productivity.

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