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Authors: SAMUEL, W. M., and TRAINER, D. O.

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## PHARYNGEAL BOTFLY LARVAE IN WHITE-TAILED DEER\*

W. M. SAMUEL,\*\* D. O. TRAINER

Department of Veterinary Science, University of Wisconsin, Madison, and

W. C. GLAZENER, Welder Wildlife Refuge, Sinton, Texas

**Abstract:** Pharyngeal botfly (*Cephenemyia* spp.) larvae were found in 76 (17%) of 446 white-tailed deer (*Odocoileus virginianus*) from the Welder Refuge, San Patricio County, coastal south Texas (1961-1968). Seventy-one of the 76 infections by 2nd- and 3rd-stage larvae occurred in deer collected during fall and winter, suggesting a winter generation of approximately 6 months. The highest prevalence occurred in deer from brushy plant communities with a high, relatively continuous canopy. A higher prevalence in mature males (74%) compared with females (29%) during winter was correlated with behavioral differences between sexes during the breeding season.

### INTRODUCTION

Botfly larvae of the genus *Cephenemyia* are common and geographically widespread parasites of white-tailed deer,<sup>1,2,6,10</sup> but documentation of infection in deer from Texas is limited.<sup>7,12</sup> Also limited is factual information on the epizootiology of pharyngeal bots in deer.<sup>1</sup> During a cooperative deer disease-ecology study conducted by the University of Wisconsin and the Welder Wildlife Foundation at the Welder Refuge, San Patricio County, in south Texas, 446 deer were examined for pharyngeal botfly larvae from 1961 through 1968. Because pathologic changes can result from infection,<sup>1</sup> and mortalities of deer have been attributed to infections of botfly larvae,<sup>6,8,14</sup> the objective was to determine which segment of the host population was at risk to infection over time. The prevalence (percent infected) and numbers of larvae were compared between samples stratified according to the time of year, age and sex of the host, and landscape features of the host's habitat.

### METHODS

Deer 2 months to 9 years of age were collected by shooting from August 1961 to September 1968, according to procedures described previously.<sup>13</sup> Methods of collection were consistent throughout, but did not provide a completely random sample of the population. The aim of harvest was to approximate the adult sex ratio (males make up about a third of the total population), therefore, selection by sex was made occasionally. Fawns were selectively collected in the summer and fall to ascertain the rate of parasite acquisition. Numbers of deer examined for larvae in the different years were 26, 40, 49, 64, 72, 40, 53 and 102.

Each deer collected was given an identification number and the date, sex, and location of the kill was recorded. General vegetative type and density of vegetative cover at the collection site were determined later using descriptions of Box and Chamrad<sup>3</sup> and a vegetation density map.<sup>13</sup> Ages of deer were determined in the laboratory according to tooth eruption and wear of the lower molars.

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\*\*Presently, Department of Zoology, University of Alberta, Edmonton.

The retropharyngeal pouches, upper trachea and oral cavity were examined for 2nd- and 3rd-stage larvae. These areas were exposed during removal of the lower jaw for aging or by means of a mid-sagittal section of the skull.

Medians (Mann-Whitney U test, Kruskal-Wallis test), rather than means (t test) were used as a measure of central tendency because they are not overly influenced by the skewed nature of the numbers data.<sup>1</sup>

## RESULTS

Larval *Cephenemyia* could not be identified to species reliably due to variation in the diagnostic characters used in the keys of Bennett and Sabrosky;<sup>2</sup> third instars were particularly difficult to separate. Representative specimens were submitted to R. Gagné, Systematic Entomology Laboratory, USDA, Washington, D.C. Three species of *Cephenemyia* were tentatively identified: *C. pratti* Hunter, *C. jellisoni* Townsend, and *C. phobifer* (Clark). Results in this study refer to *Cephenemyia* spp. only.

Second- and third-stage larvae were found in 17% of 446 deer. By season, 70% of all infections occurred during winter (= December-February) (Table 1). Fall (=September-November) and winter prevalences were 21 and 37% compared to 2 and 3% during spring and summer. Median numbers of larvae (winter through fall collections) were similar: 3.0, 2.0, 2.0 and 2.0, respectively.

Prevalence and numbers of *Cephenemyia* spp. from deer collected during fall and winter were compared between samples stratified according to several landscape features. Prevalence of botflies in deer from different plant communities with vegetation designated "dense," "moderate," and "sparse" (according to previous descriptions)<sup>18</sup> were 43, 34 and 21%, of 44, 92 and 57 deer, respectively ( $X^2_{diff} = 5.78$ ,  $P > 0.05$ ). Median numbers of larvae in deer from these areas (2.5, 3.0, 4.5) were not significantly different ( $P > 0.05$ ) by the Kruskal-Wallis test.<sup>4</sup>

Most (75%) of the deer collected in fall and winter were from five extensive

plant communities with varying tree cover and canopy types. Three of these communities (Live oak-chaparral, Huisache-bunchgrass, Chaparral-bristlegrass) had high (10-15 ft.), intermittent to thick canopies. The Mesquite - buffalo-grass community was comprised of low (< 10 ft.), intermittent chaparral mottes while the Bunchgrass-annual forbs community was almost treeless (Table 2). Differences in the prevalence of *Cephenemyia* spp. in deer from the three designations were not significant ( $X^2_{diff} = 5.47$ ,  $P > 0.05$ ). The difference between the sample medians was not statistically significant (Kruskal-Wallis test,  $P > 0.10$ ).

During winter 53% of 49 males and 28% of 95 females ( $X^2 = 10.56$ ,  $P < 0.005$ ) were infected (Table 3). Median values for the numbers of larvae in males and females were 4.0 and 3.0 ( $P > 0.05$ ). There were differences in prevalence in fawns, yearlings, and mature deer among males ( $X^2_{diff} = 9.63$ ,  $P < 0.005$ ), but not among females ( $X^2_{diff} = 0.084$ ). There were significant differences in prevalence between adult males and females ( $X^2 = 14.26$ ,  $P < 0.001$ ), but not between male and female fawns and yearlings ( $P > 0.25$ ). There were no significant differences in median numbers of larvae between any of these samples (Mann-Whitney U test,  $P > 0.05$ ).<sup>4</sup>

The youngest infected animal was 4 months of age (Table 4). Prevalence in host age groups up to 5 years of age was similar. Prevalence in older adult deer ( $\geq 5$  years) was significantly higher than prevalence for deer aged 1-4 years ( $X^2 = 7.38$ ,  $P < 0.01$ ) or fawns ( $X^2 = 8.84$ ,  $P < 0.005$ ) (Table 4). There were no significant differences in the prevalence of *Cephenemyia* spp. between the sexes in the older deer ( $X^2 = 1.57$ ,  $P > 0.05$ ) and no differences between the sample medians in any of these comparisons ( $P > 0.10$ ). The percentages of older deer in the four seasonal collections were similar ( $X^2_{diff} = 3.51$ ,  $P > 0.10$ ).

## DISCUSSION

The development and/or activity of *Cephenemyia* larvae in deer of south Texas is obviously coordinated with

Table 1. Monthly prevalence and numbers of 2nd- and 3rd-stage botfly larvae in Welder deer from 1961-1968.

	Months (1961-1968)											
	J	F	M	A	M	J	J	A	S	O	N	D
No. deer examined	118	20	73	36	31	0	32	45	26	44	15	6
No. deer infected	43	7	3	0	0	0	0	2	6	10	2	3
% deer infected	36	35	4	0	0	0	0	4	23	23	13	50
Median no. larvae	7.0	1.0	2.0	0	0	0	0	2.0	3.0	2.0	4.5	28
Mean air temp. ° C*	13	13.5	18.5	23.5	25.5	28.5	30	29.5	28	22	20	14.5

\*Compiled from climatological data of the U.S. Weather Bureau, Sinton, Texas, 7 miles southwest of the Welder Refuge.

Table 2. Prevalence and numbers of *Cephenemyia* spp. compared to canopy characteristics of vegetation from which deer were collected.

	Canopy		
	High Thick	Low Broken	None
No. deer examined	95	49	27
No. deer infected	36	14	4
% deer infected	38	28	15
Median no. larvae*	2.0	4.0	6.5
Range	1-30	1-16	1, 12

\*Sample size = 18, 10, 2 for high, low, none.

Table 3. Comparison of winter prevalence and numbers of *Cephenemyia* spp. in aged male and female deer.

	Fawns		Yearlings		Adults	
	M*	F	M	F	M	F
No. deer examined	11	4	15	19	23	72
No. deer infected	2	1	7	5	17	21
% deer infected	18	25	47	26	74	29
Median no. larvae	—	—	2.0	3.0	9.0	2.0

\*M = male, F = female.

Table 4. Comparison of the prevalence and numbers of larval *Cephenemyia* to age of Welder deer (1961-1968).

Host Age	No. Deer Examined	No. Deer Infected	% Deer Infected	Number of Larvae	
				Median	Range
1-6 months	15	1	7	2.0	—
7-11 months	35	2	6	13.5	11-16
1 year	102	14	14	2.5	1-16
2 years	90	13	14	3.0	1-30
3-4 years	106	16	15	1.0	1-8
≥ 5 years	94	26	28	7.0	1-28
Total	442	73	16	3.0	1-30

changes in the external environment. Deer lose infections in early spring (March-April) and presumably do not become infected again until late summer or early fall (August-September). Thus, the winter cycle in deer from the Welder Refuge is approximately 6 months. A similar generation time was recorded for *C. phobifer* in Ontario<sup>1</sup> but the cycle was out of phase with the one in south Texas. Infections in Ontario whitetails peaked in April and June compared to highs in Texas in December and January. Few or no 2nd- or 3rd-stage larvae were found in Ontario between September and February compared with similar lows in Texas between April and July. Bennett<sup>1</sup> accepted in theory the proposal by Hadwen<sup>9</sup> that 1st-stage larvae infecting animals in late fall are inhibited from developing due to the inhalation of cold winter air. Rising spring temperatures, through a decrease in the differential in temperatures between the inspired air and the host's body, result in development of the larvae. Similar causes of inhibited larval growth would not be expected in the much warmer climate of south Texas (Table 1). Yet a 6-month fall-winter generation was found, the onset of which corresponded to dropping, but high, air temperatures and which terminated with rising air temperatures (10° C, February to April).

The pooling of data for several species of *Cephenemyia* may mask important seasonal features of individual species. The ecology of related botflies in deer may be as different seasonally as has been shown for ticks of the genus *Amblyomma* on deer from the Welder Refuge.<sup>13</sup>

The differences in prevalence of larvae in deer from various plant community cover types are interpretable only if deer normally live and become infected in areas with the assigned vegetative characteristics. Long distance travels by Welder deer are relatively rare and home ranges seldom exceed one square mile.<sup>11</sup> Deer

were usually shot during their early morning feeding period and, except for shifting of feeding sites during periods of limited or extensive rainfall, were spending most of their time in similar plant communities (see <sup>18</sup> for further discussion). Results suggest that areas of high, unbroken canopies are utilized most by adult botflies. These areas are comparable in canopy characteristics to the second-growth forest in Ontario, where the prevalence of *C. phobifer* larvae in deer was high,<sup>1</sup> and add to the results of Catts,<sup>5</sup> who found adult *Cephenemyia* aggregated on taller clumps of hilltop vegetation in coastal California.

Older deer at Welder are apparently more susceptible to infection than younger deer. This age-specific difference may be due in part to a physical or behavioral inability of older deer to effectively avoid larvipositing female flies. This explanation remains untested.

Similar phenomena may explain the higher rate of infections in adult bucks during winter. Social behavior associated with the breeding season of deer on the Welder Refuge occurs from October through January.<sup>11</sup> During this period adult males lose weight and by January are in their poorest physical condition of the year. Females are in the best of condition in late fall and early winter.<sup>14</sup> During the peak of the rut (November-December) bucks spend considerable time "thrashing" the brush as well as pursuing receptive does.<sup>11</sup> There is no data to indicate that bucks at Welder utilize a larger area than does during the breeding season,<sup>11</sup> but extensive wandering by males is common.<sup>12</sup> This period of marked activity and deteriorating condition may be characterized by lack of a behavioral response or increased exposure to female botflies larvipositing in late fall, apparently placing bucks at greater risk to infection. The fact that significant differences occurred only between sexually mature male and female deer strengthens this theory.

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age. M. White, F. F. Knowlton, and R. S. Cook, University of Wisconsin, Green Bay, assisted in collecting deer and larvae from 1961 to 1966. E. P. Catts, University of Delaware, contributed valuable suggestions during the study.

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