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IXODID TICKS FROM PANTHERS AND BOBCATS IN FLORIDA

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ABSTRACT: Ixodid ticks were present in all 189 samples examined from 53 Florida panthers (*Felis concolor coryi*, 104 collections) and 85 bobcats (*Felis rufus floridana*) in Florida (USA) between 1974 and 1991. We identified 3,251 ticks from panthers and 918 from bobcats. Specimens of *Dermacentor variabilis*, *Ixodes scapularis*, *I. affinis*, *Amblyomma maculatum*, and *A. americanum* were present on 49, 39, 17, seven, and two of the 53 Florida panthers, respectively, and comprised 36%, 55%, 7%, 1%, and <1% of the 3,251 ticks collected from panthers. *Ixodes scapularis*, *D. variabilis*, and *I. affinis* were present on 61, 56, and 11 of the 85 bobcats respectively, and comprised 58%, 39%, and 2% of the 919 ticks collected. *Amblyomma americanum* and *A. maculatum* were found infrequently and comprised <1% of the total ticks collected from bobcats. Only adult ticks were found on the cats, except for one *D. variabilis* nymph and three *A. americanum* nymphs that were found on bobcats.

Key words: Bobcat, *Felis rufus*, Florida panther, *Felis concolor*, Ixodid ticks, Florida, *Amblyomma*, *Ixodes*, *Dermacentor*, *Cytauxzoon*.

INTRODUCTION

Tick infestations present many problems for animals. Ticks can cause anemia due to their blood sucking behavior and can also act as vectors. Additionally, ticks can cause tick paralysis, allergic reactions, alopecia, and predispose the host to secondary bacterial infections (Sonenshine, 1991). Not only are bobcats (*Felis rufus floridana*) and Florida panthers (*Felis concolor coryi*) subjected to these problems, but they also share a number of infectious diseases (Forrester, 1992) of which some, such as *Cytauxzoon felis*, may be transmitted by ticks (Blouin et al., 1984). Since the number of Florida panthers estimated to be living in the wild is considered to be so low (Forrester, 1992), it is important to analyze information that affects the disease status of these animals.

Five species of ticks (*D. variabilis*, *A. americanum*, *A. maculatum*, *I. scapularis*, and *I. affinis*) are known to infest both bobcats and panthers in Florida (Forrester, 1992). However, very little information exists examining the prevalence and intensity of these ticks on the bobcat and panther in Florida (USA). Our objective was to determine the prevalence and intensity of the tick fauna of Florida panthers and bobcats from Florida.

MATERIALS AND METHODS

Collection of ticks from bobcats and Florida panthers was conducted as part of the Florida Panther Recovery project from 1983 to 1991. Tick collections were classified by season: winter (December through February), spring (March through May), summer (June through August), and fall (September through November). Ticks from Florida free-ranging panthers were collected from Highlands, Hendry, Palm Beach, Collier, Dade, and Monroe Counties; ticks from Nassau and Alachua Counties were from captive panthers (25°40′ to 30°40′N, 80°00′ to 84°30′W). Ticks from bobcats came from Bradford, Flagler, Alachua, Lake, Polk, Highlands, Hendry, Lee, Collier, and Dade Counties (25°40′ to 30°00′N, 80°00′ to 84°30′W). Fifty-three individual panthers were examined from 1983 to 1991. Of 104 samples collected from panthers: 90 were from captured and released panthers and 14 were from necropsied individuals. Efforts were made to collect all ticks present with forceps and fingers from the live-captured animals while they were anesthetized. All ticks were removed from the haircoat of the necropsy specimens. Seventy-two bobcat samples were from necropsy specimens and 13 were live captures. Ticks removed from bobcats were ob-

tained in a similar manner to the panther samples during 1974 to 1990.

Identification of the ticks was conducted by the authors with the aid of several taxonomic keys (Cooley and Kohls, 1945; Strickland et al., 1976; Keirans and Clifford, 1978) Mated pairs of ticks were separated for identification. All tick samples were stored in 70% ethanol with 5% glycerine. One hundred thirty-three individual *Ixodes* spp. from panthers were identified to genus only because they were frozen for attempted virus isolation. Intensity and prevalence of ticks were ascertained as to host species, season of collection, geographical location of the host, and year of collection. Prevalence data were analyzed statistically using Fisher's exact test ($\alpha = 0.05$), while intensity data (log transformed) were analyzed using the Student's t-test (Marks, 1982). Specimens of all tick species from both hosts were deposited in the Institute of Arthropodology and Parasitology, Georgia Southern University, Statesboro, Georgia (USA) (Accession numbers RML 120929 to 120940).

RESULTS

The prevalence of ticks found on the Florida panther was ranged from 3% for *A. americanum* to 92% for *D. variabilis* (Table 1). Geographical distribution of these ticks varied (Fig. 1). The more common ticks infesting panthers were *D. variabilis* and *I. scapularis*. *Ixodes affinis* was present in all years, but less prevalent. All of the Florida panthers examined were infested with at least one of these three species.

The prevalence of *Ixodes scapularis* was significantly higher in 1986 than in 1991 ($P = 0.02$) as was *I. affinis* in 1988 versus 1989 ($P = 0.04$). *Dermacentor variabilis* was significantly more prevalent than *I. scapularis* during 1987 ($P = 0.02$) and 1991 ($P = 0.002$), and more prevalent than *I. affinis* during 1987 to 1991 ($P \leq 0.03$). *Ixodes scapularis* was significantly more prevalent than *I. affinis* during 1986 ($P = 0.03$), 1989 ($P < 0.001$), and 1990 ($P = 0.002$).

No significant differences ($P \geq 0.05$) occurred in seasonal prevalence of ticks within individual years except in two instances. In 1987 ($P = 0.02$) and 1991 ($P = 0.009$), the prevalence of *I. scapularis* was higher in the winter as compared to the summer, and in the winter as compared to the spring, respectively. Most ticks were collected during the winters, but there were no differences in prevalence between the winters of succeeding years from 1984 to 1991.

Even though tick intensity for all Florida panthers was not analyzed statistically, some general comments can be made. Across the years, *I. scapularis* contributed the highest percentage of ticks during years 1983, 1984, 1986, 1989, and 1990, in contrast to 1985, 1987 and 1991 when *D. variabilis* was the most common tick. The mean intensities (range) of ticks from all panthers were 17 (0–218) for *I. scapularis*, 2 (0–37) for *I. affinis*, 11 (0–94) for *D. variabilis*, 0.1 (0–6) for *A. americanum* and 0.4 (0–18) for *A. maculatum* (Table 2). Of the regularly occurring ticks, *Ixodes affinis* was found in the lowest numbers. Tick intensities on living panthers, followed that of collections from all panthers except in 1985 when *D. variabilis* had the highest intensity. Two particular locations within Collier County, Fakahatchee Strand State Preserve (FSSP) and Northern Fakahatchee Strand (NFS), when compared to all other counties had a higher intensity of *I. scapularis* ($P = 0.04$) whereas no difference was noted for *D. variabilis*. When tick infestations from dead panthers were compared to those for living panthers, a mean tick intensity of 31.0 (1 to 114) was found among dead panthers compared to 72.2 (1 to 261) for living panthers.

Ticks from bobcats were the same species found on the panthers. Similarly, *I. scapularis* and *D. variabilis* had the highest prevalence (72% and 66%, respectively) with *I. affinis* (13%) being present less often and *A. americanum* found rarely (2%) (Table 3). *Amblyomma maculatum* (1%) was found on one live bobcat. All but two bobcats were infested with at least one species of ixodid tick.

Ixodes scapularis was found throughout the state on bobcats whereas *D. variabilis* and *I. affinis* were found in the northern and southern portions of the state. *Am-*

TABLE 1. Prevalence of ixodid ticks on 53 Florida panthers, 1983 to 1991.

Number of samples	Number of panthers with				
	Ixodes scapularis	*Ixodes affinis*	*Dermacentor variabilis*	*Amblyomma maculatum*	*Amblyomma americanum*
104[a]	76 (73%)[b]	33 (32%)	96 (92%)	15 (14%)	3 (3%)

[a] Includes 90 samples from living panthers, as well as samples from 14 dead panthers (n = 53 panthers).
[b] Number of samples positive (percent positive).

blyomma americanum was found on one bobcat each in Flagler and Highlands Counties while *A. maculatum* was found on one bobcat in Dade county (Fig. 2).

There were no statistical differences between prevalence of ticks during the four seasons for the year 1985. In 1984, *I. scapularis* was more prevalent in the winter than in the spring season. Other years were not analyzed in this way due to lack of samples. Between 1984 to 1988, *Dermacentor variabilis* and *I. scapularis* were significantly more prevalent than *I. affinis* in the spring (P = 0.006 and 0.002, respectively) and *I. scapularis* was more prevalent than *I. affinis* in the winter ($P < 0.001$).

Tick intensity on all bobcats was highest in 1986. However, *I. scapularis* had the highest intensity in 1985, 1986, 1987 and 1990. *Dermacentor variabilis* was highest in 1984. Fewer *I. affinis* were collected than any other species of those regularly collected. Tick intensity on dead bobcats differed from that above; *I. scapularis* had highest intensities in 1985, 1986, and 1988. The mean (range) intensities of ticks from all bobcats were 7 (0–72) for *I. scapularis*, 0.2 (0–3) for *I. affinis*, 5 (0–53) for *D. variabilis*, 0.3 (0–2) for *A. americanum*, and 0.1 (0–1) for *A. maculatum*. Overall, the mean (±SE) tick intensity for live bobcats was greater (21.4 ± 4.6) than that of dead bobcats (10.3 ± 1.5).

There were ticks found which were only identified to genus because they were damaged and these comprised 42 ticks from the panther samples and eight ticks from the bobcat samples. Another interesting finding from these identifications was the presence of mismated pairs of ticks among the panther collections. For four pairs of 170 *Ixodes* spp. pairs examined, the female was *I. scapularis* and the male attached to her was *I. affinis*.

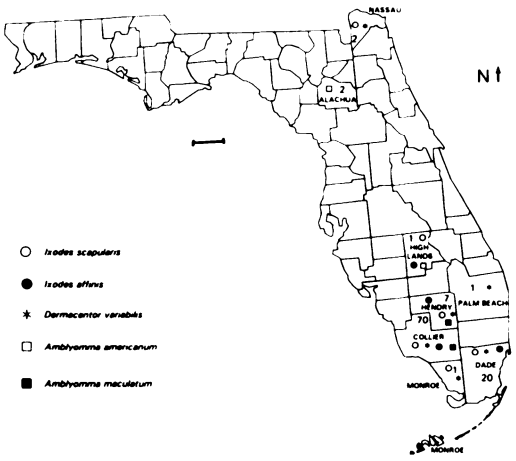

FIGURE 1. Geographical distribution of ticks on Florida panthers, 1983 to 1991. The number in each county represents the number of cats examined. The symbols represent the particular ticks recovered from that county. Scale bar = 60 km.

DISCUSSION

All five species of ticks recovered from the Florida panther have been reported previously (Forrester, 1992). These species are three-host ticks and complete their life cycles within a year in the southern U.S. (Strickland et al., 1976). Adult ticks were recovered from the panther, a large mammal, which is consistent with this part of these ticks' life cycles. The immature stages of these ticks prefer smaller mammals and birds (Strickland et al., 1976). This may explain why nymphal stages were recovered from bobcats and not panthers; bobcats are much smaller. Another reason for

TABLE 2. Intensity of infestations of ticks on 53 Florida panthers, 1983 to 1991.

Year	Number of samples[a]	Total number of ticks	Mean number of ticks/host	*Ixodes scapularis*	*Ixodes affinis*	*Dermacentor variabilis*	*Amblyomma americanum*	*Amblyomma maculatum*
1983	2	53	26	22 (8–37), 85%[b]	2 (0–3), 6%	2 (2–3), 9%	0	0
1984	6	113	19	10 (0–39), 53%	2 (0–8), 9%	5 (0–18), 27%	0	0.2 (0–1), <1%
1985	5	185	37	15 (2–36), 41%	6 (0–21), 15%	16 (1–40), 43%	0	0
1986	9	335	37	28 (1–97), 76%	0.7 (0–3), 2%	8 (0–23), 21%	0	0
1987	14	299	21	5 (0–40), 25%	1 (0–8), 5%	14 (2–78), 66%	0	0.2 (0–1), 1%
1988	15	679	45	19 (0–177), 42%	4 (0–37), 10%	19 (0–94), 42%	0.5 (0–6), 1%	2 (0–18), 5%
1989	12	383	32	23 (0–160), 72%	1 (0–13), 3%	7 (0–26), 22%	0.4 (0–1), 1%	0.2 (0–1), <1%
1990	18	842	47	32 (0–218), 68%	3 (0–27), 6%	9 (0–29), 19%	0	0.1 (0–1), <1%
1991	23	537	23	7 (0–56), 28%	1 (0–22), 6%	12 (1–73), 51%	0	0.3 (0–2), 2%
Totals and means	104[a]	3,426	33	17 (0–218), 52%	2 (0–37), 6%	11 (0–94), 34%	0.1 (0–6), <1%	0.4 (0–18), 1%

[a] Includes 90 samples from living panthers and samples from 14 dead panthers ($n = 53$ panthers).
[b] Mean intensity per host for this tick species (range in intensity), percent this tick composed of all ticks collected from panthers for this year.

this finding could be that most bobcats were dead and the search for ticks was less rushed. However, nymphal stages were not recovered from panthers which were necropsied and therefore it is more likely that body size was more important. Forrester et al. (1985) reported the mean intensity and prevalence of the ticks found on 12 Florida panthers. Of these, seven were necropsy specimens and five were live captures; they came from some of the same counties (Collier, Dade, and Glades) as the panthers in our survey. *Dermacentor variabilis* was reported as being most prevalent and *I. scapularis* being less prevalent by Forrester et al. (1985), whereas in our survey, *D. variabilis* was the most prevalent tick in some years and *I. scapularis* in other years. *Ixodes scapularis* was reported by Forrester et al. (1985) as having a higher mean intensity than *D. variabilis*; this also was the case in five of the eight years of our study. *Dermacentor variabilis* had the highest tick intensity in 1987 and 1991. The other three ticks were reported as less prevalent and with less intensity by Forrester et al. (1985); this coincides with our survey. *Dermacentor nitens* was not found in our survey of Florida panthers as was reported by Forrester et al., (1985); *D. nitens* is a one-host horse tick (Strickland et al., 1976).

Considering the Florida panther's diet is primarily white-tailed deer (*Odocoelius virginianus*) and feral swine (*Sus serofa*), it is important to consider which ticks if any infest these hosts. When comparing our study to Greiner et al. (1984), the only tick which panthers, bobcats and feral swine share in terms of high prevalence is *D. variabilis*. Forrester (1992) reported the most common ticks infesting white-tailed deer in Florida were *I. scapularis* (54%), *A. maculatum* (32%), and *A. americanum* (26%); *D. variabilis* and *I. affinis* were reported less commonly. *Ixodes scapularis* was the most commonly shared tick among bobcats, deer, and Florida panthers.

It was interesting that *I. scapularis* had a higher intensity in the NFS and FSSP

TABLE 3. Prevalence of ixodid ticks on 85 bobcats in Florida, 1974 to 1990.

Number of bobcats	Number of bobcats with				
	Ixodes scapularis	*Ixodes affinis*	*Dermacentor variabilis*	*Amblyomma maculatum*	*Amblyomma americanum*
85[a]	61 (72%)[b]	11 (13%)	56 (66%)	1 (1%)	2 (2%)

[a] Includes samples from 72 dead and 13 living bobcats.
[b] Number positive (percent positive).

when compared to other areas. These two regions contain the most dense breeding population of Florida panthers (M.E. Roelke, unpubl.). Our findings may be more representative of *I. scapularis* densities on panthers whereas *D. variabilis* did not have a similar elevated intensity in these areas. This difference in *I. scapularis* intensities in the two geographical locations may be related to the factors of habitat, weather conditions, and presence of other hosts. Forrester (1992) reported a difference in the prevalence on deer of *I. scapularis* from two different areas in southern Florida, Bear Island and Raccoon Point. These locations are only 48 km apart, but *I. scapularis* was much more prevalent on deer from Bear Island. Forrester (1992) also suggested that this difference may be due to habitat differences, weather conditions, and available hosts.

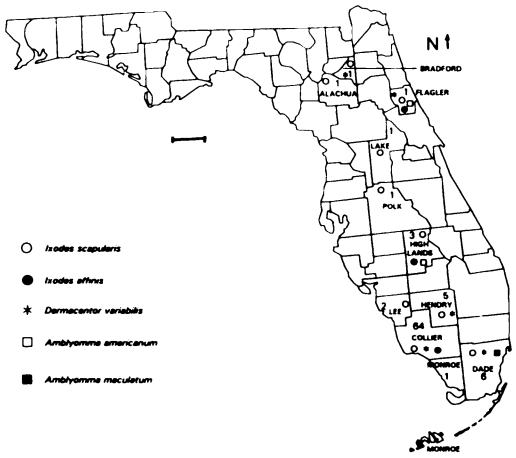

FIGURE 2. Geographical distribution of ticks on Florida bobcats, 1974 to 1990. The number in each county represents the number of cats examined. The symbols represent the particular ticks recovered from that county. Scale bar = 60 km.

Tick intensity data within Collier County for the bobcat were similar to the panther results in that *I. scapularis* was more abundant in the fall and winter than in the spring and summer. However, unlike the panther, there was evidence that *D. variabilis* had a lower intensity in this county, but there was no evidence that *I. scapularis* was more abundant in the NFS and FSSP.

Because 67% of the panther and 75% of the bobcat samples were collected in Collier County, the prevalence and intensity data from this county probably were a better indicator of the tick fauna of Florida panthers and bobcats. *Dermacentor variabilis* was the most prevalent and abundant tick on the Florida panthers in the spring and summer, whereas *I. scapularis* was the most prevalent and abundant tick in the fall and winter. On the bobcat, *I. scapularis* was more abundant in the fall and winter compared to spring and summer, and *D. variabilis* had a lower intensity in Collier county than the other counties.

Considering that *D. variabilis* can transmit *Cytauxzoon felis* (Blouin et al., 1984), this species seems likely to be the most important tick vector of this blood parasite due to its high prevalence and intensity during the spring and summer among panthers in Florida. However, *I. scapularis* should not be ruled out as a potential vector because it was the most abundant tick of both panthers and bobcats in the fall–winter season. Therefore, any efforts to eliminate *C. felis* from captive felids,

should be concentrated on controlling both species of ticks.

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