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IXODID TICKS ON FERAL SWINE IN FLORIDA

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ABSTRACT: More than 99% of the 645 feral swine (*Sus scrofa* L.) in southern Florida harbored ixodid ticks. *Dermacentor variabilis* (American dog tick) was present on 99.6% of the swine and comprised 82.5% of the ticks collected. *Amblyomma maculatum* (Gulf Coast tick) occurred on 85.9% of the hosts and 17.4% of the collections were of this species. *Amblyomma americanum* (Lone Star tick) and *Ixodes scapularis* (Black-legged tick) were found infrequently and together constituted <0.1% of the ticks. Pigs were infested by 7–22 days of age and 95% carried ticks by 6 wk of age. Only adult ticks were found on swine from southern Florida, but immature stages of *A. americanum* were present from a small sample of swine from northern Florida. Each species had a different pattern of distribution on the feral swine. No *Ornithodoros* species were found among the 36,616 ticks collected from feral swine during this survey.

INTRODUCTION

The presence of African swine fever (ASF) in the Caribbean (Wilkinson, 1981) poses a threat of introduction of this disease into the United States. The high volume of legal and illicit human traffic between Florida and this region increases the probability that ASF might enter the U.S. through Florida. Florida also has a large population of feral swine which is distributed throughout the state (Degner et al., 1983). Many domestic swine are raised on pasture in Florida and are thus exposed to feral animals. Feral swine also enter the domestic swine industry through feeder pig sales when pork prices are elevated (Degner et al., 1983). McVicar et al. (1981) infected feral pigs from Florida with ASF virus and all of these pigs became moribund and either died or were euthanized. Therefore, there is a convenient avenue for entry of ASF virus into the domestic swine industry within Florida. Most domestic pigs raised in Florida are sent to bordering stages for processing, thus, the disease could easily spread into the general swine industry of the U.S. Furthermore, feral hogs are sold to hunting clubs in other states making possible yet another route for dispersal of infected swine (Degner et al., 1983).

African swine fever virus can be transmitted by direct contact, through swine eating garbage which includes contaminated uncooked pork, and by *Ornithodoros* (soft) ticks which serve as biological vectors and reservoirs of the virus (Wilkinson, 1981). Plowright (1977) has reviewed the transmission of African swine fever virus by *Ornithodoros moubata* (Murray) in Africa and *O. erraticus* (Lucas) has been proven to be a biological vector in Spain (Botija, 1963). Groocock et al. (1980) demonstrated that *O. coriaceus* Koch (Pajaroella tick) from California was susceptible and they were able to transmit experimentally ASF virus with this tick. They also examined the susceptibility of the hard ticks—*Amblyomma americanum* (L.) (Lone Star tick) and *A. cajennense* (Fabricius) (Cayenne tick)—but were unable to show either transtadial or transovarial transmission with them. Plowright (1977) examined the vector potential of two hard ticks (*Rhipicephalus simus* (Koch) and *Amblyomma variegatum* (Fabricius)) that regularly infest warthogs (*Phacochoerus aethiopicus*) on

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TABLE 1. Prevalence of ticks on feral swine by year of collection at Fisheating Creek, Florida.

Year	No. of swine examined	No. of swine with ticks	No. infested (% infested)			
			Dermacentor variabilis	*Amblyomma maculatum*	*Amblyomma americanum*	*Ixodes scapularis*
1979	111	106 (95%)	104 (94%)	80 (72%)	0	4 (4%)
1980	453	452 (100%)	447 (99%)	408 (90%)	3 (<1%)	1 (<1%)
1981	81	81 (100%)	81 (100%)	69 (85%)	0	1 (1%)
Total	645*	639 (99%)	632 (98%)	557 (86%)	3 (<1%)	6 (1%)

* Discrepancy between total swine examined in Tables 1 and 2 versus Table 4 is because ages were not determined for 12 swine.

the African continent and was unable to detect natural infections of ASF virus in them nor transmit the virus experimentally with them.

Hanson and Karstad (1959) reported *Dermacentor variabilis* (Say) (American dog tick), *A. americanum*, and *A. maculatum* Koch (Gulf Coast tick) from feral swine in Georgia, but gave no further information. Henry and Conley (1970) described fluctuations in seasonal and annual prevalences of *D. variabilis* on feral swine in Tennessee. Barrett (1978) reported *Dermacentor* sp. from feral swine in California. Smith et al. (1982) reported briefly on the prevalence of *D. variabilis, A. americanum, A. maculatum* and *Ixodes scapularis* Say (Blacklegged tick) on feral pigs in the southeastern states.

The present study was undertaken to determine the tick fauna associated with feral swine in Florida in order to assess the potential vectors of ASF virus in the state.

MATERIALS AND METHODS

Tick sampling from feral swine was conducted from 1979 to 1981 in the 3,240 ha Hackle-trap sector of Lykes' Fisheating Creek Wildlife Refuge near Palmdale, Glades County, Florida. The study area was characterized by low, flat terrain (8–17 m above sea level) with live oak/cabbage palm hammocks, slash pine flat woods, cypress swamps, bayheads, palmetto flats and grassy glades. Rainfall averaged 125 cm annually. At the time of this study the population density was estimated to be one hog/4 ha. Most of the swine were examined during July, August and September and smaller samples were surveyed on a quarterly basis in 1980 and 1981. On the basis of climatic condition and changes in vegetation, the four seasons were: spring = March, April, May; summer = June, July, August; autumn = September, October, November; and winter = December, January, February. An ongoing study of the biology of feral swine was conducted by the Florida Game and Fresh Water Fish Commission and provided live-trapped swine. The 2.5-m-square portable live traps (Belden and Frankenberger, 1977) were baited by laying 600-m trails of whole kernel corn in various directions from the traps. The doors of the traps were tied open and corn was provided free choice for 1 wk prior to the day of trapping. The doors were set on the evening of the "trap night" and the trap was rebaited. The following morning the hogs were removed from the trap and their legs were tied with nylon cord. The sex of each animal was recorded and its age was estimated from tooth eruption and wear. The swine were either released back onto the study area or moved to other areas.

While the animals were restrained, they were examined for ticks visually and by running a hand along the body opposite to the direction of the hair to feel for ticks. A pen-light flashlight was used to examine the deeper recesses of the ear. Ticks were removed by grasping them with fingers or blunt-tipped forceps. All ticks from each host were placed into individually labeled vials.

Prevalence data were analyzed by contingency table analysis using a Hewlett Packard HP-41C Programmable Calculator ($\alpha = 0.05$). Representative ticks were deposited as follows: *Ixodes scapularis* No. RML 115974 and RML 115975 in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560, USA and *Dermacentor variabilis, Amblyomma americanum* and *A. maculatum* in

TABLE 2. Mean and range of intensity of infestations of ticks on feral swine from Fisheating Creek, Florida. Numbers in brackets represent the range in intensities of infestation. Numbers in parentheses represent the percentages of the total catch comprised of that species.

Year	No. of swine examined	Total no. of ticks	Mean no. of ticks/ host	*Dermacentor variabilis*	*Amblyomma maculatum*	*Amblyomma americanum*	*Ixodes scapularis*
1979	111	2,734	25	18 [0–58] (74%)	6 [0–37] (26%)	0	1 [0–1] (<1%)
1980	453	29,704	66	55 [0–307] (85%)	10 [0–61] (16%)	1 [0–1] (<1%)	1 [0–1] (<1%)
1981	81	4,178	52	38 [2–148] (74%)	13 [0–63] (26%)	0	1 [0–1] (1%)
Totals	645	36,616	57	47 [0–307] (82%)	10 [0–63] (17%)	1 [0–1] (<1%)	1 [0–1] (<1%)

the Florida State Collection of Arthropods, Florida Department of Agriculture and Consumer Services, Gainesville, Florida 32602, USA.

RESULTS

During the 3-yr study, nearly 100% of the 645 swine examined from Fisheating Creek were infested with at least one of four species of hard ticks (Table 1). The prevalence of *D. variabilis* was highest followed by *A. maculatum*, and then *I. scapularis* and *A. americanum* (Table 1). Annual prevalence did not differ significantly for *D. variabilis*, but did for *A. maculatum*. *Ixodes scapularis* was found on only a few hosts each year, whereas *A. americanum* was detected only in one year (Table 1). All ticks collected from swine in southern Florida were adults.

Dermacentor variabilis comprised most of the ticks collected, followed by *A. maculatum* and the minor species (Table 2). The mean intensities of infestation were highest in 1980, which was the only year in which all four ticks were collected (Table 2). Males of *D. variabilis* and *A. maculatum* were more numerous than females in all years, but only female *A. americanum* and *I. scapularis* were found.

Quarterly collections of ticks indicated that only *D. variabilis* was present

TABLE 3. Mean and range of intensity of infestation of ticks from quarterly on-host collections from Fisheating Creek, Florida. Numbers in brackets represent the range of intensities of infestation. Figures in parentheses are the percentages of the quarterly collections comprised of that species.

Season	No. of swine examined	Total no. of ticks	Mean no. of ticks/ host	*Dermacentor variabilis*	*Amblyomma maculatum*	*Amblyomma americanum*	*Ixodes scapularis*
Summer* 1980	31	2,341	76	66 [6–223] (88%)	9 [1–31] (12%)	0	0
Fall* 1980	25	950	38	28 [0–186] (74%)	10 [0–54] (26%)	1 [0–1] (<1%)	0
Winter 1981	16	62	4	1 [0–2] (8%)	1 [0–5] (10%)	0	3 [0–19] (82%)
Spring 1981	30	362	12	12 [0–73] (100%)	0	0	1 [0–1] (<1%)

* These data were based on the first 31 and 25 swine sampled in August and September, respectively.

throughout the year, but the lowest prevalence occurred during winter. This was the numerically dominant species, except in winter when *I. scapularis* was most common (Table 3). The intensity of infestation of *D. variabilis* was highest during the summer and lowest during the winter.

The data on three of these seasons (spring, summer and winter) were further analyzed with reference to location of the ticks on the host (Fig. 1). Nearly all of the *A. maculatum* were found in the ears. *Dermacentor variabilis* preferred the ventral surface of the pig (venter) during the spring, but were more evenly distributed over the body during the summer. Most *I. scapularis* were situated on the head, neck and in the ears. While *A. maculatum* was located in the deeper recesses of the ear, *D. variabilis* was located on the pinna. The heavily haired parts of the hosts yielded the fewest ticks.

Tick prevalences by host age class are summarized in Table 4. Significant differences in the prevalences of *D. variabilis* and *A. maculatum* occurred by host age. The youngest pigs infested with ticks were 7–22 days old. By 6 wk of age, more than 95% of the hosts harbored ticks (Table 4). *Amblyomma americanum* was not detected in pigs less than 6 mo of age, whereas *D. variabilis* and *A. maculatum* were found on animals in the youngest through the oldest age classes.

Three hunter-killed hogs from northern Florida (near Lochloosa) were examined in November, 1981. These hogs were not in ideal condition as they had been dragged from the site of the kill to the hunters' vehicles. However, all four species of ticks were recovered, but due to the condition of the swine, counts were not attempted. A significant finding was the presence of nymphs and larvae of *A. americanum* on all three animals.

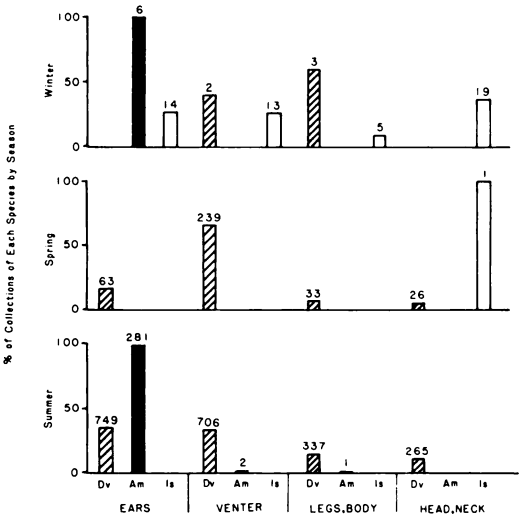

FIGURE 1. Distribution of ticks on four regions of the host. Numbers above bars represent the numbers of each species of tick recovered from that region of the host during that season. Dv = *Dermacentor variabilis*, Am = *Amblyomma maculatum* and Is = *Ixodes scapularis*.

DISCUSSION

The four species of tick recovered from feral swine have been reported previously from this host, but little information on pig–ixodid tick interactions is known. All four species are three-host ticks and can complete their life cycles within a year in southern U.S. (Strickland et al., 1976). The adults of these species infest a variety of large mammals, whereas the immature stages prefer birds and small mammals.

The prevalences of these ticks were markedly different from the figures presented from feral swine from 20 different locations in the southeastern U.S. by Smith et al. (1982). They reported that *A. americanum* was present on 35% of their feral swine, followed by *D. variabilis* (14%), *I. scapularis* (7%), and *A. maculatum* (2%). This was in contrast to <1%, 98%, 1% and 86% from our Florida sample, respectively. Their collections were made during the same time as our study, but their collection sites in Florida were all north of Palmdale. They did not recover *A. americanum* from their Florida sample and recovered *D. variabilis* from two sites and *A. maculatum* and *I. scapularis* from only

TABLE 4. Prevalence of ticks on feral swine by host age at Fisheating Creek.

Age class	No. of swine examined	No. of swine with ticks	No. infested (% infested)			
			Dermacentor variabilis	*Amblyomma maculatum*	*Amblyomma americanum*	*Ixodes scapularis*
0–6 wk	7	6 (86%)	6 (86%)	1 (14%)	0	1 (14%)
6 wk–6 mo	111	111 (100%)	110 (99%)	81 (73%)	0	2 (2%)
6 mo–12 mo	85	85 (100%)	83 (98%)	75 (88%)	1 (1%)	0
12–26 mo	230	230 (100%)	228 (99%)	204 (89%)	1 (<1%)	0
26 mo	200	199 (100%)	197 (99%)	190 (95%)	1 (<1%)	3 (2%)
Totals	633	631 (100%)	624 (98%)	551 (87%)	3 (<1%)	6 (1%)

a single location. The small sample sizes (6–14 animals/site) that they examined may not have given a true indication of the prevalence in southern Florida. These differences possibly reflect variations in the parasite fauna and prevalence at different locations and that the overall prevalence was influenced strongly by certain host populations being devoid of ticks and thus diluting the estimated prevalences at other sites. Differences in the tick fauna and prevalence through the range of feral swine evidently occur as Henry and Conley (1970) recovered only *D. variabilis* from feral hogs in Tennessee and noted that 30% of their swine harbored it.

Henry and Conley (1970) reported significant differences in the prevalences of *D. variabilis* by year, whereas no significant differences by year were detected for this species in our study. The prevalences of the other species found in our study did vary by year. Henry and Conley (1970) also detected significant differences in prevalence of *D. variabilis* by season as was the case in Florida. The highest prevalence and intensity of infestation occurred during the spring and summer in Florida. Our findings parallel those of Smith et al. (1946) who noted that peak populations of adult *D. variabilis* occurred during the summer.

Whereas the only ticks proven to be capable of transmitting ASF virus are argasids (soft ticks), only two studies have detailed unsuccessful attempts to transmit virus by ixodids (hard ticks) (Plowright, 1977; Groocock et al., 1980). Others have suggested that ixodid ticks might be involved (DeTray, 1963; Heuschele and Coggins, 1965).

The feeding behavior and nocturnal habits of argasids minimize the potential of finding them on swine during daylight collections. The absence of soft ticks from feral swine habitat in Palmdale, as determined by using standard tick collection procedures operated diurnally and nocturnally, was initially surprising (Greiner, unpublished data). By using newer techniques, the presence of *Ornithodoros turicata* (Duges) has been confirmed throughout much of Florida, but not at Palmdale (Butler and Gibbs, 1984; Butler et al., 1983).

Collections of ticks at Fisheating Creek were made from living hosts and it was not possible to treat the hides with potassium hydroxide (KOH), a procedure which would have increased the potential of finding larvae and nymphs of the ixodid ticks. However, these stages were found on the few swine carcasses examined from northern Florida without KOH treatment. Thus, with the large number of swine examined, if immatures occurred on swine with any frequency, they should have been detected. Because only adult ixodid ticks have been found feeding on swine in southern Florida, if they are capable of transmitting ASF virus, the virus would have to be transferred transovarially to the

next generation of ticks and be maintained through the larval and nymphal molts in order to be available for transmission to susceptible hogs. The likelihood of this occurring is remote, but until *D. variabilis* and *A. maculatum* have been examined, they should not be ruled out as having the potential to transmit the virus in the event ASF virus is introduced into the feral swine of Florida.

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