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Article

Survey for ticks on feral swine within a cattle fever tick-infested landscape in Texas, U.S.A.

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Abstract

We collected ticks from feral swine, *Sus scrofa* L., during 1–3 September 2015, in pastures known to be infested by southern cattle ticks, *Rhipicephalus* (*Boophilus*) *microplus* (Canestrini), at the Laguna Atascosa National Wildlife Refuge in Cameron County, Texas, U.S.A. All 81 examined feral swine were infested by ticks, but none was infested by *R. microplus*. Tick species collected were *Amblyomma maculatum* Koch, *Amblyomma mixtum* Koch, *Amblyomma tenellum* Koch, *Dermacentor halli* McIntosh, and *Dermaentor variabilis* (Say). This is the first formal report of *A. tenellum* infesting feral swine.

Key words: *Amblyomma mixtum*, *Amblyomma tenellum*, *Dermacentor halli*, *Dermacentor variabilis*, *Rhipicephalus* (*Boophilus*) *microplus*, cattle fever tick

Introduction

Cattle fever ticks, *Rhipicephalus* (*Boophilus*) *annulatus* (Say) and *Rhipicephalus* (*Boophilus*) *microplus* (Canestrini), were introduced to the New World in the early 1500s (Anderson *et al*. 2010), and by the early 1900s, they were widespread in California, Texas, and across the southeastern United States. In 1906, the United States established the Cattle Fever Tick Eradication Program (CFTEP, Cotton 1908), and by 1943, the ticks had been eradicated from the U.S.A., except for an area in Florida, and in the Tick Eradication Quarantine Area (TEQA), a buffer area at the United States-Mexico border in South Texas (USDA 1962). The ticks were eradicated from Florida by 1961 (Pound *et al*. 2010). The United States Department of Agriculture (USDA) and Texas Animal Health Commission currently maintain CFTEP activities in the permanent TEQA because ticks are still present along this part of the border in Mexico.

Cattle fever ticks are able to complete their life cycle on domestic cattle (*Bos primigenius* Bojanus), horses (*Equus ferus* Boddaert), donkeys (*Equus africanus* Heuglin and Fitzinger), white-

tailed deer (*Odocoileus virginianus* [Zimmermann]) (Pound *et al*. 2010), nilgai (*Boselaphus tragocamelus* [Pallas]) (Davey 1993) and other ungulates (Pound *et al*. 2010), but swine (*Sus scrofa* L.) have been reported as infested only three times, twice on domestic swine in Panama (Fairchild *et al*. 1966) and Bangledesh (Islam *et al*. 2006), respectively, and once on feral swine in Brazil (do Nascimento Ramos *et al*. 2014). Various other mammals, including the Brazilian cottontail (*Sylvilagus brasiliensis* [L.]) (Evans *et al*. 2000), crab-eating fox (*Cerdocyon thous* [L.]) (Labruna *et al*. 2005), sloth bear (*Melursus ursinus* [Shaw]) (Liyanaarachchi *et al*. 2015), domestic dog (*Canis lupus familiaris* L.) (Evans *et al*. 2000), ocelot (*Leopardus pardalis* [L.]) (Labruna *et al*. 2005), and small Asian mongoose (*Herpestes javanicus* [É. Geoffroy Saint-Hilaire]) (Corn *et al*. 1994), also have been reported as infested outside of the U.S.A., but not as hosts through the entire life cycle of the ticks.

Cattle fever ticks (*R. microplus*) were detected in Cameron County, Texas, outside of the TEQA in May of 2014 (USDA unpublished report). In October 2014, after additional infested premises were identified, a Temporary Preventative Quarantine Area (TPQA) was established in the area. White-tailed deer and free-ranging nilgai at Laguna Atascosa National Wildlife Refuge (LANWR), within the TPQA, were both subsequently found to be infested by *R. microplus* during the open public hunts there in 2014–2015 and 2015–2016 (infestation rates: November 2014–January 2015, 6/15 [40%] on nilgai, and 37/67 [55%] on white-tailed deer; November 2015–January 2016, 36/50 [72%] on nilgai, and 51/66 [77%] on white-tailed deer) (USDA-APHIS-VS unpublished data). Nilgai are native to India, Nepal, and Pakistan (Leslie 2008), were released into Texas during 1924–1949, and are established in South Texas (Sheffield *et al.* 1983). Feral swine are abundant in South Texas, including at the LANWR. White-tailed deer, nilgai, and feral swine all are hunted on LANWR. The purpose of this survey was to determine if feral swine in this cattle fever tick-infested landscape were hosts for *R. microplus*.

Materials and Methods

We collected ticks and other ectoparasites from feral swine at the LANWR in Cameron County, Texas. Feral swine were acquired by aerial shooting, as part of an Invasive Species Management Action conducted 1–3 September 2015. Although our opportunity to collect ticks from LANWR swine in September was seasonally earlier than previous fever tick collections from sympatric deer and nilgai in November to January, the results are still comparable because all feeding stages of both *R. microplus* and the other encountered important tick species occur on hosts in South Texas throughout all months of the year (Strickland *et al.* 1976; Beck *et al.* 2011). The singular and brief sampling period may have failed, however, to detect some other non-target tick species in the area, e.g, blacklegged ticks, *Ixodes scapularis* Say, that could infest feral swine but have more restricted temporal occurrences.

Feral swine were immediately scratch-inspected (visual and tactile examination) for ticks, and representative samples of all ectoparasites seen were collected from individual animals into coded vials, stored in 70% ethanol, and identified by standard morphological methods at the USDA-APHIS-VS-National Veterinary Services Laboratories (NVSL), Ames, Iowa, U.S.A. Representative voucher specimens for each ectoparasite species collected are deposited in the parasitology reference collection at the NVSL.

Results

We found ticks on all 81 of the feral swine examined during this survey (Table 1). Tick species collected and the overall prevalence of each were as follows: Gulf Coast ticks, *Amblyomma maculatum* Koch (42/81, 51.9%), *Amblyomma mixtum* Koch (81/81, 100%), *Amblyomma tenellum* Koch (26/81, 32.1%), *Amblyomma* sp. (22/81, 27.2%), *Dermacentor halli* McIntosh (1/81, 1.2%), and American dog ticks, *Dermaentor variabilis* (Say) (53/81, 65.4%). We also found one species of flea, *Pulex porcinus* Jordan and Rothschild, on these animals (7/81, 8.6%). Immature stages of certain resident *Amblyomma* spp. in South Texas presently are not reliably distinguishable from one another based on morphology, and we encountered some nymphs and larvae of these. Our *Amblyomma* sp. larval collections (two individual ticks) consisted of either *A. mixtum*, *A. tenellum*, or lone star ticks, *Amblyomma americanum* L., although *A. americanum* is relatively uncommon in Cameron County, and nymphs (22 ticks) definitely were either *A. mixtum* or *A. tenellum*. For purposes of data analysis and discussion, we treated all of our immature *Amblyomma* ticks at the generic level only.

TABLE 1. Ticks collected from 81 feral swine examined in Cameron County, South Texas, U.S.A., 1–3 September 2015, and their prevalences (%).

Tick species	Number of tick-infested hosts (%)			
	Larvae	Nymphs	Males	Females
Amblyomma maculatum	0	0	29 (35.8)	35 (43.2)
Amblyomma mixtum	0	0	80 (98.8)	78 (96.3)
Amblyomma tenellum	0	0	8 (9.9)	22 (27.2)
Amblyomma sp.	2 (2.5%)	22 (27.2)	0	0
Dermacentor halli	0	0	1 (1.2)	0
Dermacentor variabilis	0	0	25 (30.9)	50 (61.7)

Discussion

The CFTEP has successfully kept the U.S.A. north of the South Texas border area free of cattle fever ticks, but increasingly, outbreaks along the United States-Mexico border since the 1970s have been related to the abundance of white-tailed deer and other free-ranging wild ungulates (Pound *et al*. 2010). Specific concerns arose when cattle fever ticks were reported on nilgai and white-tailed deer during November 2014–January 2015 in the LANWR, north of the TEQA in Cameron County, Texas. Feral swine also are abundant in this area, but they had never been identified as hosts for fever ticks during the history of the CFTEP; however, a survey of feral swine in a heavily infested area had never been conducted. Although populations of both white-tailed deer and nilgai at LANWR were heavily tick-infested, and observed infestation rates grew between two successive hunting season samples (2014–2015 and 2015–2016, USDA-APHIS-VS unpublished data), we found no cattle fever ticks on sympatric feral swine in our survey. Based on these data, we think that feral swine are not an important host for cattle fever ticks in South Texas.

All of the feral swine examined in this survey were infested by ticks, however, all but one of the tick species collected in our survey, i.e., *A. tenellum*, have been reported previously from feral swine in North America. Tick surveys in Georgia (Hanson and Karstad 1959) and Florida (Greiner *et al*. 1984; Allan *et al*. 2001) both reported *A. maculatum* and *D. variabilis* on feral swine. Henry and

Conley (1970) found only *D. variabilis* on feral European swine in Tennessee. *Dermacentor variabilis* was reported on feral swine in Texas, along with *A. maculatum* and *A. mixtum* (as *A. cajennense* [Fabricius], Coombs and Springer 1974). Sanders *et al*. (2013) also reported *A. mixtum*, *A. maculatum*, *D. halli*, and *D. variabilis* on feral swine in Texas. In addition, Guzmán-Cornejo *et al*. (2011) reported historical collections of *A. mixtum* (as *A. cajennense*) on *S. scrofa* from three Mexican states, i.e., Quintana Roo, Tamaulipas, and Yucatan.

Amblyommma mixtum and *A. tenellum* are reported by these names on feral swine here for the first time, but previously, these two species names were treated as synonyms of *A. cajennense* until their recent resurrections (Nava *et al*. 2014 a, b). Geographically, both species occur in the U.S.A. only in South Texas, and the range of each also includes much of east-central Mexico, but *A. mixtum* further occupies southern Mexico, all of Central America, and northeastern coastal South America as far south as Ecuador (Estrada-Peña *et al*. 2014; Rivera-Páez *et al*. 2016), whereas the singular, disjunct, and southern-most record for *A. tenellum* is from Honduras (Becklund 1959). Within this geographic area, all previous references to *A. cajennense* on feral swine probably refer to *A. mixtum*, although some limited confusion with *A. tenellum* ticks cannot be ruled out entirely.

Conventional wisdom among tick taxonomists generally did not recognize ticks now known as *A. tenellum* as a distinct entity until they were redescribed and named *Amblyomma imitator* Kohls in the 1950s (Kohls 1958). Thus, any *A. tenellum* ticks from feral swine in South Texas or Mexico before 1958 would have been identified as *A. cajennense*. However, after 1958, such ticks might have been distinguished as *A. imitator*, although we can find no published accounts of such collection records. To our knowledge, only Coombs and Springer (1974) and Sanders *et al*. (2013) have studied and reported on ticks from feral swine in South Texas since 1958, and six of the eight localities they sampled lie north of the known occurrence of *A. tenellum* in Texas. More than 50 years of records at the NVSL (unpublished data) indicate that most Texas collections of *A. tenellum* from all hosts are concentrated in the southern-most tip of the state, i.e., Cameron, Hidalgo, and Starr Counties, but sporadic and scattered collections have come from 10 more northerly counties as far north as Karnes County. Hilburn *et al*. (1989) surveyed for *A. tenellum* in six South Texas counties but found them in only Cameron and Hidalgo Counties. The collective studies of Coombs and Springer (1974) and Sanders *et al*. (2013) in Aransas and San Patricio Counties were both within the sporadic range of *A. tenellum* in Texas, and the latter report actually remarked on the absence of *A. tenellum* in sampled ticks, even though many hundreds of *A. mixtum* were present. Given the preceding observations and the fact that our survey evidently is the first to collect ticks from feral swine in the southern-most counties of Texas, we believe our report is the first for *A. tenellum* – under any of its three names—from this host species.

In order to be conclusive on this subject, however, we searched the NVSL parasitology archives for other records of *A. tenellum* ticks collected from feral swine, and we found three complete, older records, all from Cameron County animals. The first (NVSL accession no.93-10528) consisted of 2 females and 1 male from a road-killed swine near Bayview, Texas, on 11 November 1992; the other two collections contained 4 females and 2 males, 22 April 1996 (NVSL 96-24217), and 1 female and 2 males, 6 May 1996 (NVSL 96-26372), respectively, both from near Rio Hondo, Texas (and both probably from hunter-killed animals in LANWR). In addition, we found one partial record listed in the 1973 annual report for the USDA National Tick Surveillance Program (NTSP), which is centered at the NVSL and has operated continuously since 1962. These annual reports were issued and circulated on a limited basis every year through 1989, and each briefly summarized the tick identification activities of the NTSP during the preceding calendar year. Exact collection dates and localities of included tick identifications were not given, only the host, year, and state of origin for the tick specimens. *Amblyomma tenellum* (as *A. imitator*) tick submissions from Texas were identified and reported in every annual report of the series, save for 1966 and 1967, but only for

calendar year 1973 was there an entry reporting one submission of *A. tenellum* from a Texas swine (USDA 1974). No other paperwork or voucher specimens are extant at the NVSL to support or expand upon this obscurely published and previously unnoticed record. Although the published details in the NTSP annual report on the 1973 collection are minimal and sketchy, it is a genuine record and, together with the 1992 and 1996 collections, these samples considerably precede our recent collections, thus becoming the earliest known *A. tenellum* specimens from feral swine.

The *Amblyomma* sp. larvae and nymphs we collected from feral swine probably were mostly *A. mixtum*, based upon the composition of the adult tick fauna in our survey; however, it is most likely that these immature ticks represented a mixture of both *A. mixtum* and a few *A. tenellum* individuals. Currently, immature stages of these two species are morphologically indistinguishable. Keirans and Durden (1998) provided a key morphological character for separation of nymphs of the two species, but we find the distinction to be difficult and unreliable to use in practice. Like both Coombs and Springer (1974) and Sanders *et al*. (2013), who also surveyed ticks on feral swine in the Texas Gulf Coast Prairies and Marshes ecoregion, we found no *A. americanum* on our Cameron County animals, an observation supported by decades of identification records at the NVSL (unpublished data) suggesting that lone star ticks are present but uncommon to rare in this region. At present, *A. americanum* larvae are morphologically indistinguishable from those of both *A. mixtum* and *A. tenellum*, but given the absence of both adults and nymphs of this species in our survey, we believe that no larvae were present, either. *Dermacentor halli* typically infests the collared peccary, *Pecari tajacu* (L.), but where the peccary's range overlaps with that of feral swine, this tick also may use the latter as hosts (Sanders *et al*. 2013).

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