SHORT COMMUNICATIONS

Ochlerotatus taeniorhynchus: A Probable Vector of Dirofilaria immitis in Coastal Areas of Yucatan, Mexico

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ABSTRACT Mosquito collections were done on microfilaremic dogs, positive for Dirofilaria immitis (Leidy), for 15 consecutive nights in Celestun, Yucatan, southeastern Mexico, during January 2007. In total, 275 mosquitoes (3 ♂ and 272 ♀) of five species were collected: Ochlerotatus taeniorhynchus (Wiedemann), Ochlerotatus sollicitans (Walker), Culex quinquefasciatus Say, Culex interrogator (Dyar & Knab), and Aedes aegypti (L.). Oc. taeniorhynchus was the species most frequently collected, and it had the highest rate of feeding success and the highest attack rates. First (L1) and third (L3) instars of Dirofilaria were observed in all mosquito species collected except for Ae. aegypti: 23 of 223 Oc. taeniorhynchus, three of 40 Cx. quinquefasciatus, and one of six Oc. sollicitans and one of Cx. interrogator were infected with Dirofilaria (10.3% of total examined mosquitoes). This is the first report of Dirofilaria (presumably D. immitis) isolation from wild-caught mosquitoes in Mexico. Results imply that D. immitis can develop from microfilaria to infective L3s in Oc. taeniorhynchus, Cx. quinquefasciatus, and Oc. sollicitans, but L3s (infectious) were only recovered in heads of Oc. taeniorhynchus. Thus, Oc. taeniorhynchus can be considered a potential vector of dirofilariasis in Celestun, because infective L3 Dirofilaria were found in the vicinity of the mouthparts, and this mosquito has a strong association with microfilaremic dogs in this study area.

KEY WORDS Ochlerotatus taeniorhynchus, Dirofilaria immitis, dogs, microfilaremia, Mexico

Dirofilaria immitis, responsible for canine heartworm disease, is a mosquito-borne parasitic disease of dogs that can be accidentally transmitted to humans. D. immitis infection in dogs is widespread in many countries, including Mexico (Labarthe and Guerrero 2005). Reports of D. immitis prevalence in stray dogs in the Mexican state of Yucatan range from 1 to 17% within Merida, the state capital (Rodríguez-Vivas et al. 1994, Bolio et al. 2005), but prevalences can reach up to 30% in coastal areas (unpublished data).

Nearly 70 species of mosquitoes have been associated with the transmission of D. immitis worldwide (Ludlam et al. 1970); but to our knowledge, no mosquito species had been found infected with Dirofilaria in Mexico. Here, we report field-based evidence of canine-attracted mosquitoes naturally infected with Dirofilaria in Mexico, and we suggest that Ochlerotatus taeniorhynchus (Wiedemann) is a potential vector of canine heartworm in the peridomestic environment of Celestun, an area of high prevalence of canine dirofilariasis on the coast of the Peninsula of Yucatan (PY).

Materials and Methods

Mosquito Collections in Dog-Baited Traps. As part of a wider project studying the epidemiology of heartworm disease, blood samples were collected from November to December 2006 from domestic dogs in the locality of Celestun for parasitological diagnoses of D. immitis infection. Blood samples were examined using two diagnostic procedures: thick smear technique and the modified Knott’s technique (Knott 1939, Atkins 2005). Characteristics considered for D. immitis identification were size (length) and shape. Average prevalence of microfilaremic infection was 33% in domestic dogs (unpublished data). Ten individual dogs identified as infected were selected for further studies based on the owners’ acceptance during a personal visit of our team members. Once informed consent for the study was granted from the responsible household, each dog was introduced into a trap where mosquito collections were carried out for 15 consecutive nights (from 1800 hours to 0600 hours) during January 2007. Traps consisted of iron cages (1.60 by 0.60 m in length by 1.00 m in height) covered with wire mesh and enclosed with a fine cloth net, allowing for airflow. Mosquitoes collected from the dog-baited traps were removed at the 0600 hours and held alive within mosquito-cages in a laboratory at room temperature, with a 10% sucrose solution until they eventually died. Mosquitoes from each trap and day were...
counted, and they were individually identified and sexed.

**Mosquito Dissections and Detection of Filarial Larval Stages.** Immediately after death, all female mosquito specimens were individually dissected. Individual heads, thoraxes, and abdomens were teased apart in independent saline droplets, and preparations were examined at 100-1,000× magnification under a coverslip for the presence of worms (particularly first [L1] and third [L3] instars, which are extracellular stages of the larval cycle). Filarial larvae found in the mosquitoes were identified as *Dirofilaria* based on morphological characteristics described by Taylor (1960) and identified as *D. immitis*, because it is the only *Dirofilaria* species known from the study area (Rodríguez-Vivas et al. 1994).

**Results and Discussion**

In total, 275 mosquitoes (3♂ and 272♀) of five species were collected from dog-baited-traps in Celestun (Table 1): *Ochlerotatus sollicitans* (Walker), *Oc. taeniorhynchus*, *Culex quinquefasciatus* Say, *Culex interroga
tor* (Dyar & Knab), and *Aedes aegypti* (L.). *Oc. taeniorhynchus* was the species most frequently collected and represented 81% of the total females collected.

Dogs seemed to be significantly more attractive to *Oc. taeniorhynchus* and *Cx. quinquefasciatus* (Table 1). Feeding success rates (the percentage of the total catch for each species that was blood fed) was 33% (Table 1), from which the highest rates were observed in *Oc. taeniorhynchus* (78.9%) and *Cx. quinquefasciatus* (16.7%). Attack rate (the number of mosquitoes trapped in 1,800 dog per h of mosquito exposure, i.e., 10 dogs × 15 consecutive nights × 12 h per night) was 0.15 mosquito per dog per h with the highest rate from *Oc. taeniorhynchus* (0.12). Attack rates were very low, and it was possible that many more mosquitoes may have attacked but then escaped the trap, as observed by our collectors.

Nevertheless, filarial worms were observed in all mosquito species collected except for *Ae. aegypti*. After examining 272 female mosquitoes, we observed filarial larvae in 23 *Oc. taeniorhynchus*, three *Cx. quinquefasciatus*, and one *Oc. sollicitans* and *Cx. interroga
tor* (10.29% of total examined mosquitoes) (Table 2). Natural infections in mosquitoes were relatively high, because it was not necessary to dissect numerous specimens to obtain specimens positive for worms.

**L3 infection rates found in mosquitoes collected at other areas of the Western Hemisphere are variable, but in general lower than 3% (Christensen and Andrew 1976, Arnott and Edman 1978, Pingier 1982, Sauerman and Nayar 1983, Hribar and Gerhardt 1985, Parker 1986), with the exception of those reported for *Anopheles punctipennis* Say (10.43%) and *Aedes vexans* (Meigen) (7.14%) in Alabama (Tolbert and Johnson 1982). L3 infection rates found in *Oc. taeniorhynchus* in Celestun were much higher than reported from North Carolina (0.72%) (Parker 1986) and Florida (1.14%) (Sauerman and Nayar 1983); infection rates found by the same authors for *Cx. quinquefasciatus* and *Oc. sollicitans* were also lower (0.5 and 0.39%, respectively).

As far as we know, this report represents the first report of natural infection of mosquitoes with *Dirofilaria* in Mexico. Presently, it would be impossible to state with certainty whether the parasite was *D. immitis*, but it is likely, because it is the only *Dirofilaria*
species recognized from the study area. In-progress studies in our laboratory should soon confirm the identification of the Dirofilaria in this study. However, these results from Celestun imply that *D. immitis* can develop from microfilaria to infective L3s in *Oc. tenuiorhynchus*, *Cx. quinquefasciatus*, and *Oc. sollicitans*, but L3 (infectious) were only recovered from heads of *Oc. tenuiorhynchus*.

We hypothesized that the abundance of *Oc. tenuiorhynchus* at coastal areas of Yucatan is likely to explain the differences in the canine dirofilaria prevalence observed between inland and coastal canine populations. If also confirmed in upcoming studies, *Oc. tenuiorhynchus* is expected to be the principal vector of *D. immitis* in other coastal areas of the PY where salt marshes regularly produce a number of generations of mosquitoes per year. These mosquitoes could easily disperse from the breeding area to feed on infected dogs. *Cx. quinquefasciatus* seems likely to be, at most, a secondary vector in this area, but it could be the principal vector in inland localities of the PY, where *Oc. tenuiorhynchus* is rare or nonexistent.

*Oc. tenuiorhynchus* is considered a vector of *D. immitis* in Florida (Sauerman and Nayar 1983) and North Carolina (Parker 1986, 1993), and it has been found with infected stages of *Dirofilaria* in Brazil (Lourenço de Oliveira and Deane 1995, Labarthe et al. 1998). However, more studies are needed to incriminate this mosquito species, because the finding of infective larvae, and even their migration to the mosquito proboscis, does not demonstrate the actual potential to infect dogs and for these larvae to develop to maturity. In addition, *Oc. tenuiorhynchus* is an aggressive and persistent blood seeker strongly attracted to humans in Celestun; hence, humans are exposed to mosquitoes infected with *Dirofilaria*. It would not be surprising that future studies would report evidence for human pulmonary dirofilariasis in this locality.

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