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BLOOD HOSTS OF *AEDES ALBOPICTUS* IN THE UNITED STATES

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ABSTRACT. Bloodfed *Aedes albopictus* were collected during 1989–91 by vacuum aspirator from rural and urban study sites in Missouri, Florida, Indiana, Illinois, and Louisiana. Blood hosts identified by ELISA and precipitin tests were rabbit (n = 91), *Rattus* sp. (n = 69), dog (n = 14), unidentified mammal (n = 14), cow (n = 13), human (n = 10), deer (n = 10), sciurid (n = 7), turtle (n = 5), murid other than *Rattus* sp. (n = 4), raccoon (n = 3), passeriform bird (n = 3), and cat (n = 2). As an opportunistic bloodfeeder, *Ae. albopictus* may be a potential vector of domestic arboviruses and a nuisance pest where infestations occur.

The blood hosts of wild *Aedes albopictus* (Skuse), a relatively new vector in the United States, were investigated as part of a comprehensive study on the adult ecology and potential health threat of this mosquito in its new range. Initially, this study focused primarily on the role of *Ae. albopictus* as a nuisance pest and potential vector of La Crosse (LAC) virus (Grimstad et al. 1988). Recent arbovirus isolations (Francy et al. 1990, Mitchell et al. 1992, Niebylski et al. 1992) increased concerns that *Ae. albopictus* may be a potential vector of other domestic arboviruses including eastern equine encephalomyelitis (EEE) virus.

Mosquito host-feeding studies conducted in rural Hawaii (Hess et al. 1968, Tempelis et al. 1970) and rural Thailand (Sullivan et al. 1971) found that wild *Ae. albopictus* bloodfed opportunistically on a variety of hosts. Similarly, in the initial stage of this comprehensive research project, *Ae. albopictus* collected at Potosi, MO, during 1989 and over the entire 1990 field season were determined to have fed on an array of hosts including birds (16.9%, n = 29) (Savage et al. 1993). To provide further insight on this mosquito's blood hosts, particularly birds and those in urban areas, field studies were expanded to 10 sites in 5 states including continued collections at Potosi.

Adult mosquitoes were collected from scrap tire yards, private dumps, and surrounding vegetation by vacuum aspirator (Nasci 1981) operated for 10-min intervals. Collections were made during May–August 1991 at rural study sites in Potosi, MO; Polk County, FL; Gillespie, IL; Mounds, IL; and New Orleans, LA (site A) and urban sites in New Orleans (site B), and East St. Louis, IL (sites C, D, and E). A rural site in New Alsace, IN, was sampled in August 1989. Aspirators were operated for a cumulative period of 3 h, 10 h 10 min, 50 min, 1 h 20 min, 2 h, 3 h 30 min, 30 min, 40 min, and 1 h 30 min at Potosi, Polk Co., New Alsace, Gillespie, Mounds, New Orleans (site A), New Orleans (site B), E. St. Louis (site C), and E. St. Louis (sites D and E), respectively. A random sampling procedure, which proved effective for monitoring *Ae. albopictus* dispersal and survival, collected few bloodfed specimens. Greater collection success was achieved by preferentially sampling transition habitats such as forest edge ecotones. Even so, bloodfed specimens were difficult to collect at all sites (n = 128/1,370 min aspiration time) except E. St. Louis (site C) (n = 129/40 min). Mosquito samples were placed on wet ice in the field, sorted on a chill table, and stored individually at −70°C. Nonbloodfed specimens were pooled and stored separately for virus assay.

The capillary tube precipitin test was used for the identification of general avian, mammalian, opossum, squirrel, chipmunk, passeriform bird, columbiform bird, ciconiiform bird, quail, snake, and turtle blood meals (Tempelis and Lofy 1963, Savage et al. 1993). A direct-plate, enzyme-linked immunosorbent assay (ELISA) technique was used for the identification of human, rabbit, cat, dog, deer, cow, horse, swine, raccoon, *Rattus*, and murid other than *Rattus* blood meals (Savage et al. 1993).

Blood meal extracts were first screened with general avian and mammalian antisera to determine the class of host. Samples positive in the avian screen were tested for quail, passeriform, ciconiiform, and columbiform birds. Samples positive in the mammalian screen were tested for human, rabbit, dog, cat, *Rattus*, and murid than *Rattus*. Mammal positives from Potosi, Polk Co., New Alsace, and New Orleans (Site A) were further tested for deer, cow, raccoon, squirrel, and chipmunk. Those from Polk Co. were also tested for opossum and swine. Mammal positives from Gillespie and Mounds were tested for deer, squirrel, and chipmunk. Deer positives were tested for horse and cow. Lastly, any blood meal

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Table 1. Blood hosts of wild-caught *Aedes albopictus* at 6 rural and 4 urban study sites in Missouri, Florida, Indiana, Illinois, and Louisiana as determined by ELISA and precipitin tests.

	Rural sites					Urban sites				
						New Orleans, LA	New Orleans, LA	East St. Louis, IL		
Blood host	Potosi, MO[1]	Polk Co., FL	New Alsace, IN	Gillespie, IL	Mounds, IL	Site A	Site B	Site C	Sites D & E	Total (%)
Rabbit	0	2	2	1	3	9	0	54	20	91 (35.4)
Rattus	0	0	0	0	0	0	0	69	0	69 (26.8)
Dog	0	0	0	12	0	0	2	0	0	14 (5.4)
Cow	0	13	0	—	—	0	—	—	—	13 (5.1)
Human	0	6	0	1	0	0	3	0	0	10 (3.9)
Deer	0	7	1	0	0	2	—	—	—	10 (3.9)
Sciurid[2]	5	0	2	0	0	0	0	0	—	7 (2.7)
Turtle	5	0	—	—	—	—	—	—	—	5 (1.9)
Murid[3]	0	0	0	0	0	4	0	0	0	4 (1.6)
Raccoon	0	3	0	—	—	0	—	—	—	3 (1.2)
Passeriform	0	1	—	0	—	0	1	1	—	3 (1.2)
Cat	0	0	0	0	0	0	2	0	0	2 (0.8)
Mammal[4]	0	10	0	2	0	2	0	0	0	14 (5.4)
Unknown[5]	5	0	0	1	0	1	0	5	0	12 (4.7)
Total	15	42	5	17	3	18	8	129	20	257

— = Not tested.

[1] Savage et al. (1993) determined that *Aedes albopictus* (n = 139) collected during 1989–90 in Potosi fed on rabbits (n = 27), unidentified mammals (n = 24), deer (n = 16), dogs (n = 15), unidentified birds (n = 15), humans (n = 9), sciurids (n = 8), passeriform birds (n = 7), opposums (n = 5), columbiform birds (n = 5), murids other than *Rattus* sp. (n = 4); raccoon, cow, ciconiiform bird, and quail, one each.

[2] All 5 Potosi specimens were collected in August 1991 and reacted strongly to anti-chipmunk and weakly to anti-squirrel antisera.

[3] Four specimens reacted moderately to anti-murid other than *Rattus* antisera and weakly to anti-*Rattus* antisera.

[4] Specimens tested positive for general mammalian but negative for all other taxa. No opossum, horse, swine, ciconiiform birds, columbiform birds, quail, or snake blood meals were identified.

[5] Specimens failed to react in all tests.

still unidentified to class or a lower taxon and with suspension remaining was selectively tested against squirrel, chipmunk, opossum, turtle, snake, or passeriform bird antisera not yet employed for the specimen. No tests were conducted for amphibian blood meals.

Overall, 92.2% (237/257) of the *Ae. albopictus* fed on mammals, 1.9% fed on turtles (5/257), 1.2% (3/257) fed on birds, and 4.7% (12/257) failed to react in all tests (Table 1). Blood hosts, ranked by number of positive feeds, were rabbit (n = 91), *Rattus* sp. (n = 69), dog (n = 14), unidentified mammal (n = 14), cow (n = 13), human (n = 10), deer (n = 10), sciurid (n = 7), turtle (n = 5), murid other than *Rattus* sp. (n = 4), raccoon (n = 3), passeriform bird (n = 3), and cat (n = 2) (Table 1). No specimens fed on opossum, swine, horse, columbiform bird, ciconiiform bird, quail, and snake. No multiple blood meals were detected.

Five sciurid positives from Potosi reacted strongly to anti-chipmunk and weakly to anti-squirrel suggesting that eastern chipmunks (*Tamias striatus*) were the hosts. Five turtle positives likely fed on eastern box turtles (*Terrapene carolina*), which were active the day collections were made in Potosi. Four blood meals from New Orleans (site A) reacted moderately to anti-murid other than *Rattus* and weakly to anti-*Rattus*. These may have fed on nutria (*Myocastor coypus*) or muskrats (*Ondatra* sp.), which were common at the site. The 69 *Rattus* positives likely fed on Norway rats (*Rattus norvegicus*), which were abundant at E. St. Louis (site C). Other notable blood hosts observed at study sites were as follows: domestic cattle (*Bos taurus*), domestic dogs (*Canis* sp.), white-tailed deer (*Odocoileus virginianus*), eastern cottontails (*Sylvilagus floridanus*) in Potosi and Polk Co., dogs in Gillespie and New Orleans (site B), and cottontails in E. St. Louis (sites C, D, and E).

Fourteen *Ae. albopictus* blood meals tested

positive to the mammalian screen but were not identified to a lower taxon. These specimens may have fed on amphibians or mammals for which antisera were not available such as the 9-banded armadillo (*Dasypus novemcinctus*), round-tailed muskrat (*Neofiber alleni*), striped skunk (*Mephitis mephitis*), woodchuck (*Marmota monax*), and bats (*Myotis* spp.). They may also have fed on unscreened taxa with available antisera. For example, 2 unidentified mammalian blood meals from Gillespie were not tested for raccoon. The 12 unknowns that failed to react in all tests may represent blood meals either too small or too digested for proper identification.

Few human bloodfeds were collected at urban sites despite high mosquito landing/biting rates (range = 1.2–35.4 females/min) and the availability of humans. *Aedes albopictus* may have fed on rats, dogs, and cats because these hosts were more susceptible or tolerant than humans to mosquito bites. Secondly, because urban bloodfed mosquitoes were collected predominantly near heavy vegetation rather than in or near households, humans may have been outnumbered by other potential hosts. If this was the case, *Ae. albopictus* may have fed on more common vertebrates in these areas, namely rats, rabbits, dogs, cats, and birds. The low degree of human bloodfeeding in urban areas may also be attributable to inadequate or biased sampling. For example, a large number of rat (n = 69) and rabbit (n = 54) bloodfeds at E. St. Louis (site C) were collected in only 40 min from bramble where both hosts and their burrows were encountered. Additional mosquito collections from vegetation surrounding an adjacent apartment complex may have revealed other blood hosts including humans.

Similarly, *Ae. albopictus* may selectively feed on an array of hosts depending on the season and microhabitat sampled. For example, at the Potosi study site, mosquitoes collected on August 29, 1990, from vegetation along the perimeter of a pond fed primarily on birds. Those collected at the site on June 22, 1991, from a forest-edge habitat adjacent to the tire yard fed on turtles and an unknown host. Those collected on August 21, 1991, from a brush pile beneath mature oak trees fed only on chipmunks. The broad host range of *Ae. albopictus* and the importance of sampling diverse habitats over an entire field season is apparent.

In summary, this study confirms that *Ae. albopictus* feeds opportunistically in its new range and supports the conclusions of Tempelis et al. (1970), Sullivan et al. (1971), and Savage et al. (1993). The bloodfeeding habits, coupled with the isolation of EEE, Potosi, and Keystone viruses from wild-caught *Ae. albopictus* (Francy et al. 1990, Mitchell et al. 1992, Niebylski et al. 1992), indicate that this mosquito may be exposed to and potentially vector a range of domestic arboviruses to include LAC virus and those with an avian reservoir. Vertebrate sources of viruses isolated from *Ae. albopictus* collected in Potosi and Polk Co. remain unknown.

This mosquito's broad host range may also provide an increased potential to locate blood hosts, feed, and become established following introduction to a site. From there, *Ae. albopictus* has the capacity to disperse, *via* short flight (max = 525 m), beyond an infestation focus and survive long enough to bloodfeed more than once as determined by mark-recapture trials at Potosi (Niebylski and Craig 1994). Together, this research on *Ae. albopictus* accentuates the need for continued surveillance, personal protection, and public awareness wherever its populations occur.

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