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Researching West Nile Virus

My professional interest in arbovirus ecology has been excited by the recent activity of West Nile Virus (WNV) in the U.S., which has created opportunities to learn more about the relationship between this flavivirus and its mosquito vectors and vertebrate hosts. WNV was first recognized in the U.S. in 1999 when it was discovered in the New York City area, as well as in Louisiana in 2001. The first human cases of WNV in Louisiana were reported in 2002.

West Nile Virus is a zoonotic pathogen (communicable to humans) that is maintained in an enzootic cycle (constantly present), primarily through the viral transmission between birds and ornithophilic (bird-feeding) mosquitoes. Human or equine disease may occur when mosquitoes that have fed on infected birds then take a subsequent blood meal on a human or equine, which are considered dead-end hosts and can not become part of the WNV cycle. While this basic cycle occurs throughout the U.S., WNV has now spread throughout the country and there are significant differences in the ecology of the virus in different regions. This relates to the fact that different species of *Culex* mosquitoes serve as the primary vectors in different areas and there are also variations in the passerine (members of the Order Passeriformes containing over one-half of all birds) bird species that serve as the primary reservoirs. While the populations of some bird species, such as blue jays and crows, have been significantly affected by mortality associated with WNV, many reservoir bird species are not known to be negatively affected by WNV. It is important to note that experimental studies have shown the various *Culex* mosquitoes that occur in different regions of the country vary significantly in their efficiency to transmit WNV. Further, different bird species vary in their capacity to manufacture virus and serve as viral reservoirs for mosquitoes. The geographic distribution of passerine bird species contributes to regional differences in WNV ecology as do the distribution and abundance of the *Culex* mosquitoes in different regions of

the U.S. These differences in large part help to explain the distribution of the reported U.S. human cases of WNV.

It should not be surprising that the largest number of human WNV cases in the U.S. have occurred in the Great Plains and in the West, where *Cx. tarsalis*, the most efficient mosquito vector species in the U.S., occurs in large numbers in rural areas where it may be associated with wetlands and canal-based irrigated agriculture. It is also important to note that in many of these areas there are not organized mosquito control efforts. In most areas of the South, *Cx. quinquefasciatus* appears to be the most important vector, and while this mosquito is not as efficient in vectoring WNV as *Cx. tarsalis* in the West, the mosquito season is significantly longer, year round in some areas. Large local populations can be produced from the highly organic larval development sites preferred by ovipositing *Cx. quinquefasciatus* mosquitoes.

LSU entomologists are actively involved in ongoing research programs targeting WNV. Research conducted by recent LSU Medical Entomology Ph.D. graduate, Dr. Andrew Mackay, has shown that *Culex quinquefasciatus* does serve as the primary vector of WNV in East Baton Rouge Parish, La. Blood meal identification studies conducted on bloodfed *Cx. quinquefasciatus* collected throughout the parish has yielded important information about the feeding patterns of this mosquito species in Louisiana. Analyzing the blood meal hosts of more than 1,000 *Cx. quinquefasciatus* mosquitoes collected over a three-year period showed that these mosquitoes fed on at least 41 different species of birds and 15 species of mammals with an overall division of 60% feeding on avian hosts and 40% feeding on mammalian hosts. *Cx. quinquefasciatus* mosquitoes were also confirmed feeding on man, as 7% of all blood meals (17.5% of all mammalian meals) contained human blood. The most utilized avian host species was the Northern Cardinal, *Cardinalis cardinalis*, comprising 15% of all and 25% of all of the avian blood meals taken

by *Cx. quinquefasciatus* mosquitoes. Mosquito blood meals were analyzed using two molecular techniques: TRFLP and sequencing.

Field work conducted by current Medical Entomology M.S. student, Jessica Brauch, has shown WNV activity in a wide variety of Louisiana bird species including spring and summer breeding birds as well as winter residents and other migrant species. This study as well as an earlier one by Dr. Mackay identified the Northern Cardinal as the bird most often trapped and as having the highest WNV viremias and antibodies of all birds trapped. These results are complimentary to Dr. Mackay's earlier work and are consistent in confirming the importance of Northern Cardinals as reservoirs of WNV, as well as the role of *Culex quinquefasciatus* as vectors of WNV and utilizing Northern Cardinals as a primary host based on their abundance at sites throughout Louisiana.

While much attention has been focused upon the role of birds in the transmission of WNV, mammals and reptiles can often be involved as well. Interestingly, a field project conducted by Dr. Islik Unlu, recent LSU Medical Entomology Ph.D. graduate, has shown that *Cx. quinquefasciatus* mosquitoes feed on alligators based on blood meal identification studies. This is significant because losses of alligators due to WNV have been experienced by Louisiana alligator farmers in some years. There appears to be economic effects on the alligator hide quality even in those animals that have been infected with WNV and survived. While this work leads us to believe *Cx. quinquefasciatus* mosquitoes may be responsible for the initial introduction into alligator houses, there may be additional mechanisms responsible for the movement of WNV from alligator to alligator within the rearing houses.

As West Nile Virus continues to pose a public health threat, our team constantly strives to understand the reasons for its varying effects throughout the regions of the U.S.