

Validity of morphological characters used to distinguish *Culex restuans* and *Culex pipiens*

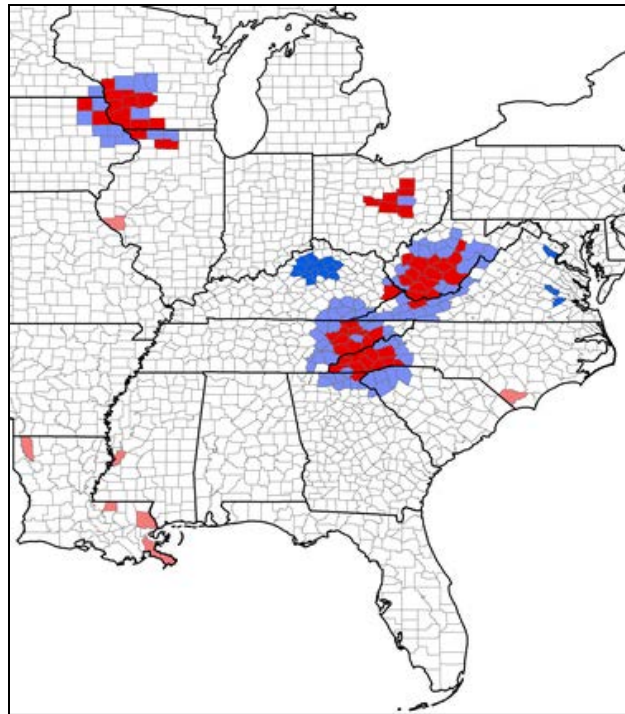
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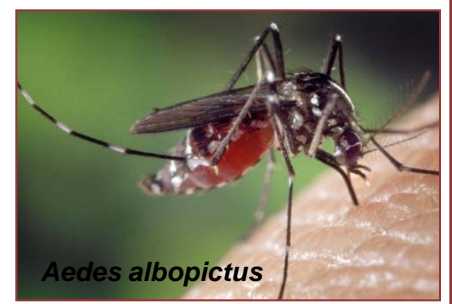
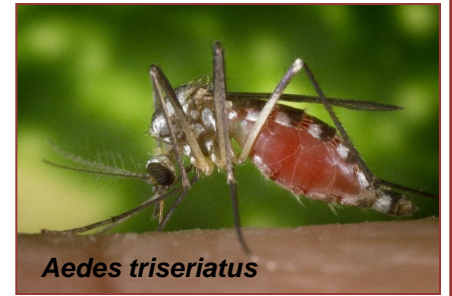
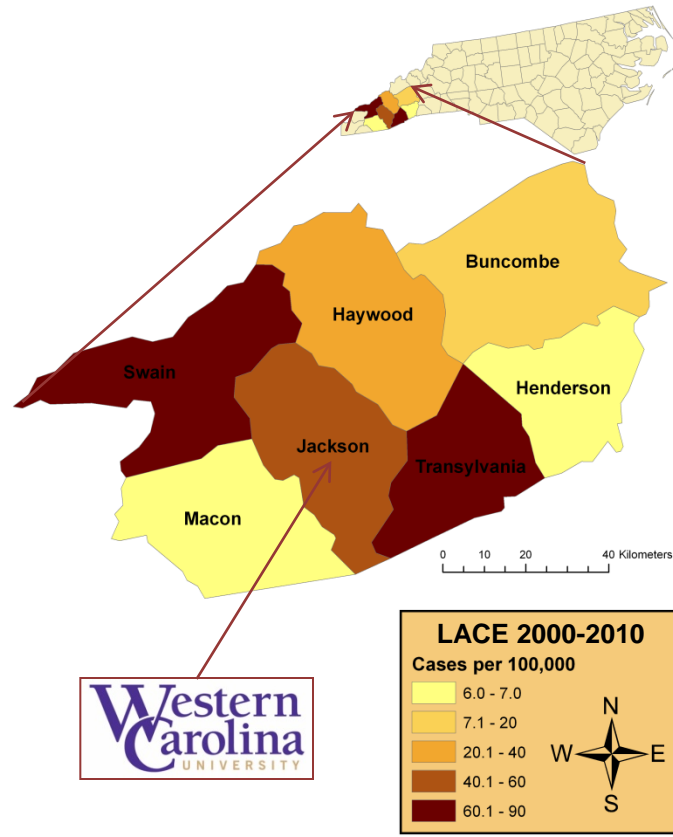
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Haddow AD and Odoi A, The incidence risk, clustering, and clinical presentation of La Crosse virus infections in the eastern United States, 2003-2007. *PLoS One*. 2009 Jul 3;4(7):e6145.

Western NC



La Crosse virus is endemic in Western North Carolina and is the major focus of our research. In particular, we are interested in the local scale ecology of three mosquitoes: the principal vector (*Aedes triseriatus*) and other potential vectors (*Ae. albopictus* and *Ae. japonicus*). Photo Credits: CDC



**Western
Carolina**
UNIVERSITY

Undergraduate Education (Environmental Health and Biology)

Background

Culex pipiens and *Culex restuans* are primary vectors of West Nile virus in the eastern US

- Enzootic (avifaunal) transmission and magnification
- Primary vectors in epidemic transmission of WNV in many regions, but roles in transmission are complex and variable (Apperson 2002; Apperson 2004)
- *Cx. pipiens* is a more important vector than *Cx. restuans*



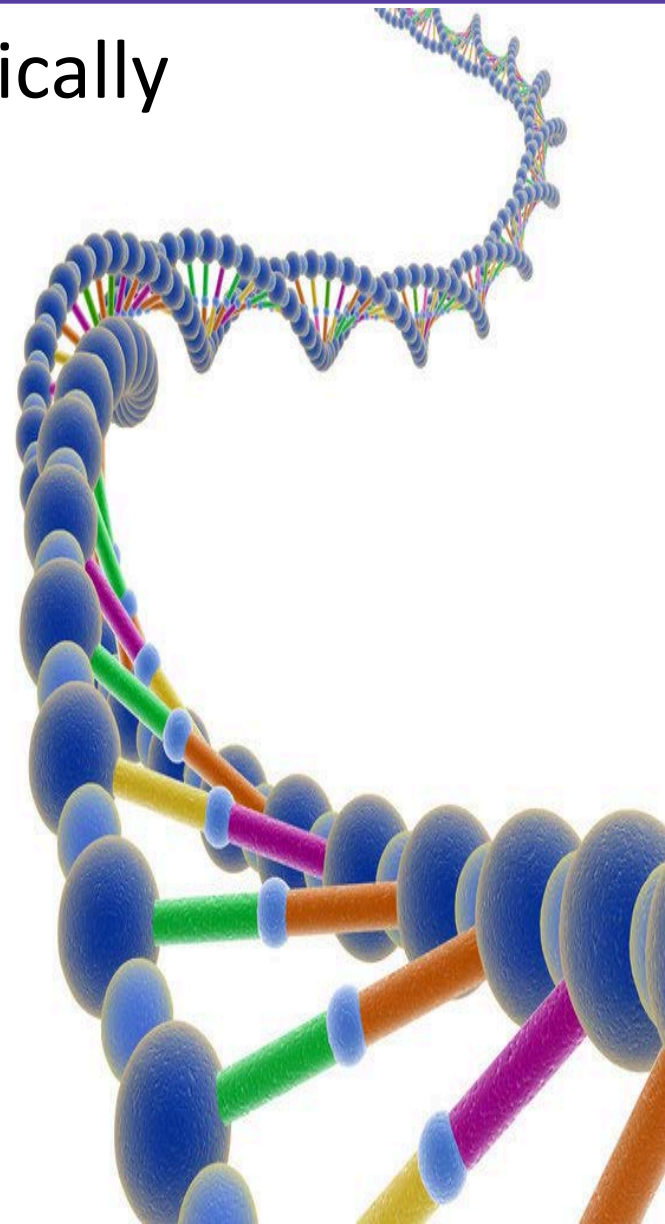
Background

Difficult to differentiate morphologically

- (NY) Harrington and Poulson 2008

Molecular ID by PCR more accurate

- Requires molecular techniques
- Resource intensive
- Contamination an issue

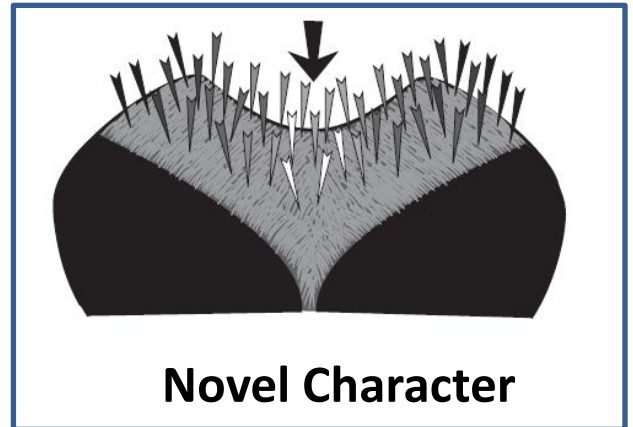
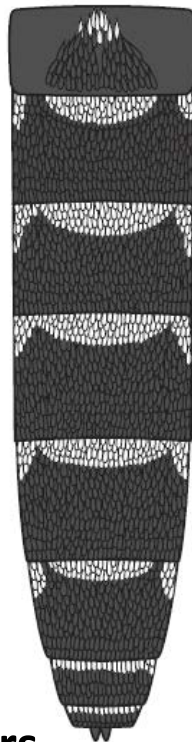


Research Purpose

To determine the validity of 3 morphological characters used to identify *Cx. pipiens* and *Cx. restuans*



Traditional Characters



Top of head with erect forked scales on median, and lateral areas of vertex and occiput black (Fig. 232); scutum with fine dark brown scales and usually 2 small round white spots (Fig. 233). *Cx. restuans*

Top of head with several erect forked scales on median area of vertex and/or occiput light tan or pale, lateral erect forked scales dark brown (Fig. 234); scutum with coarse light tan scales, without small pale spots (Fig. 235). *Cx. pipiens*

“*Cx. pipiens* complex”

Cx. quinquefasciatus

(See Note 9)

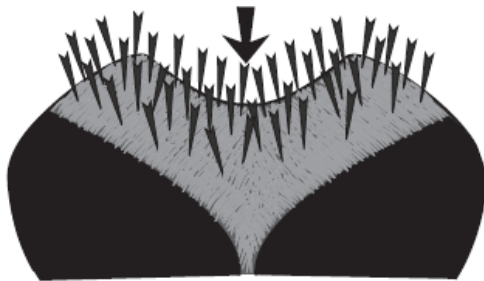


Fig. 232

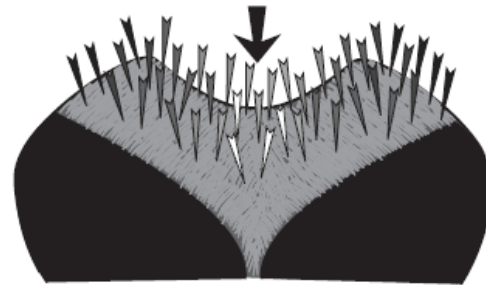


Fig. 234

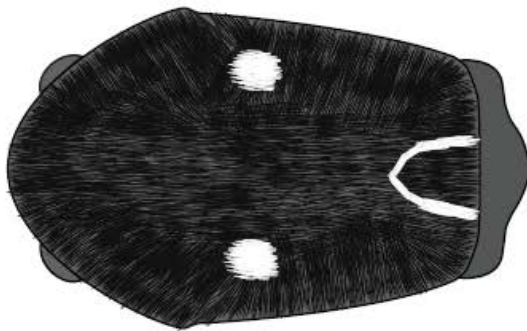


Fig. 233

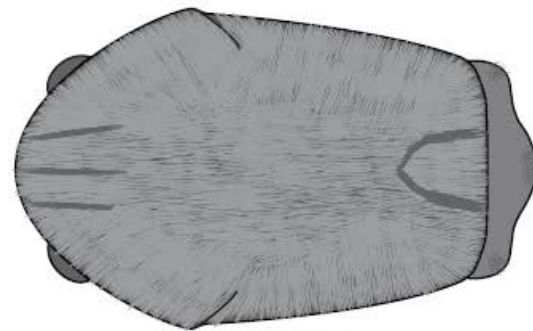
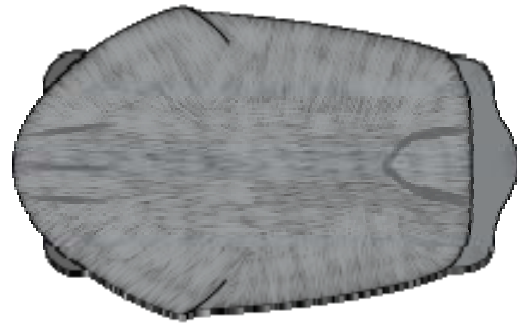


Fig. 235

Scutal Spots Character



Culex restuans



Culex pipiens

	<i>Culex restuans</i> (PCR ID)	
	+	-
Scutal Spots Present	30	0
Scutal Spots Absent	28	58

Sensitivity: 100% (95% CI: 88%-100%)

Specificity: 67% (95% CI: 56%-77%)

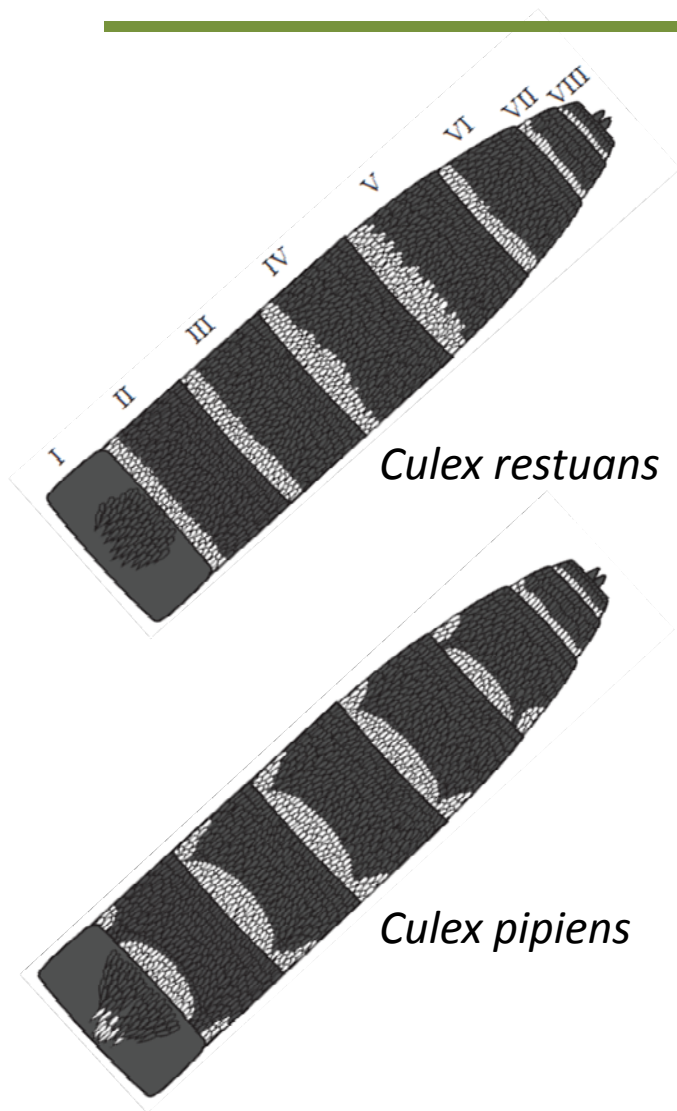
Although the specificity is low (67%), the sensitivity is perfect at 100%.

30 of 58 (52%) of the PCR confirmed *Culex restuans* had the dorsal spots on the scutum.

No *Culex pipiens* had these spots.

n=116

Abdominal Band Character



	<i>Culex restuans</i> (PCR ID)	
	+	-
Character Present (Straight Bands)	45	9
Character Missing (Centrally Enlarged)	21	70

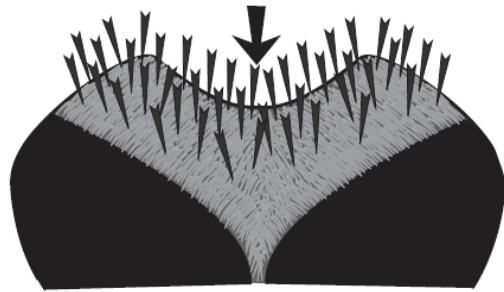
Sensitivity: 83% (95% CI: 71%-92%)

Specificity: 77% (95% CI: 70%-85%)

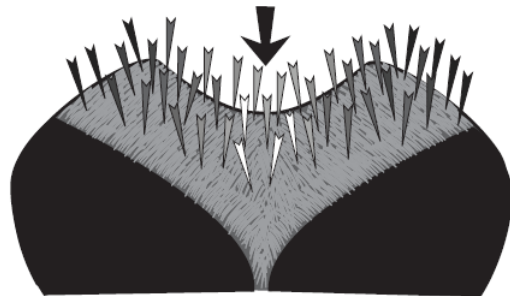
45 of 66 (68%) of PCR confirmed *Culex restuans* were identified with straight bands on the abdomen.

However, 70 of 79 (89%) *Culex pipiens* were identified correctly by the presence of a centrally enlarged band on the abdomen.

Head (Vertex) Character



Culex restuans



Culex pipiens

ONLY PRESENT ON 72%
OF SPECIMENS

	<i>Culex restuans</i> (PCR ID)	
	+	-
Character Present (Dark, erect, forked scales)	52	2
Character Missing (Pale, erect, forked scales)	3	55

Sensitivity: 96% (95% CI: 87%-99%)

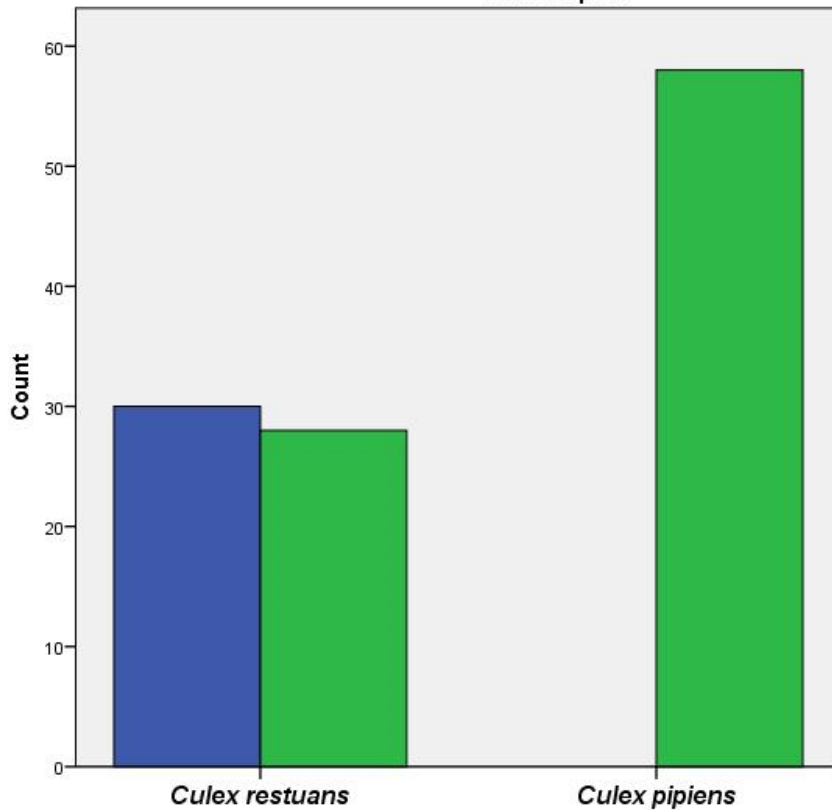
Specificity: 95% (95% CI: 86%-99%)

52 of 55 (95%) of the *Culex restuans* had dark erect forked scales on the vertex. Only 2 of 57(3.5%) of the *Culex pipiens* were misidentified by this character.

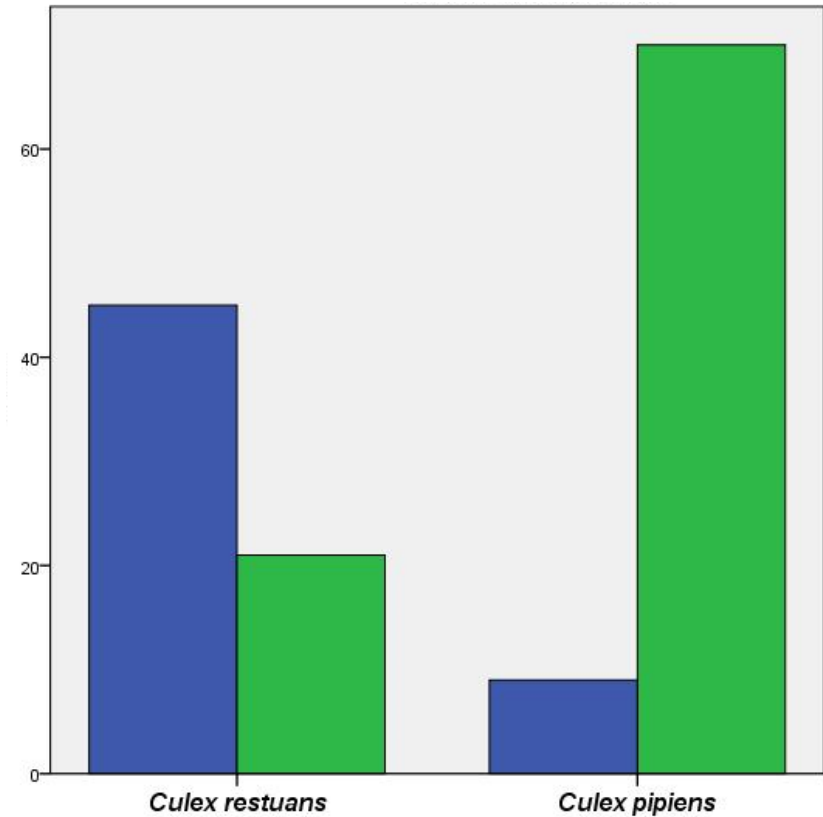
This character is highly sensitive and specific when present. However, of the 158 mosquitoes with PCR confirmed identities, this character was only present on 112 specimens (71%).



“Traditional” Characters

Scutum



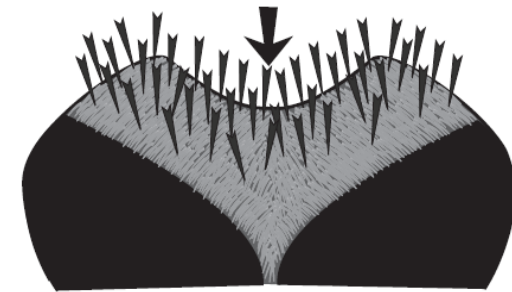
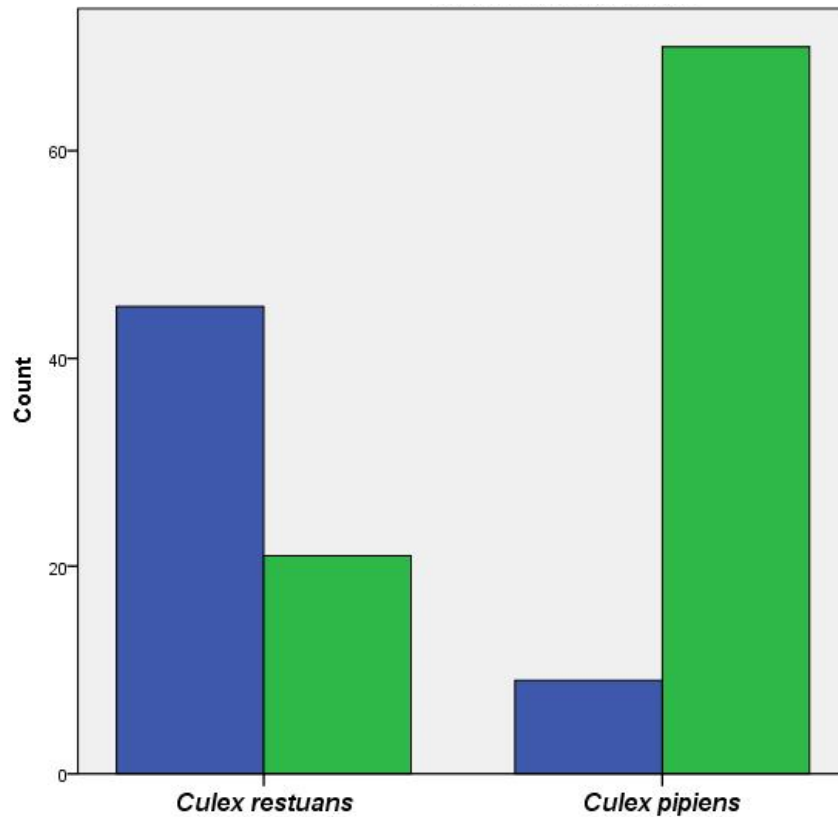
Abdomen



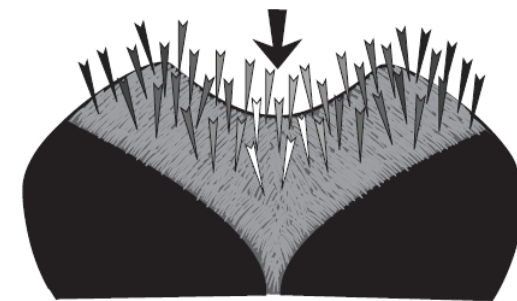
-  *Culex restuans* morphology (Character State)
-  *Culex pipiens* morphology (Character State)

“Novel” Character



Vertex



Culex restuans



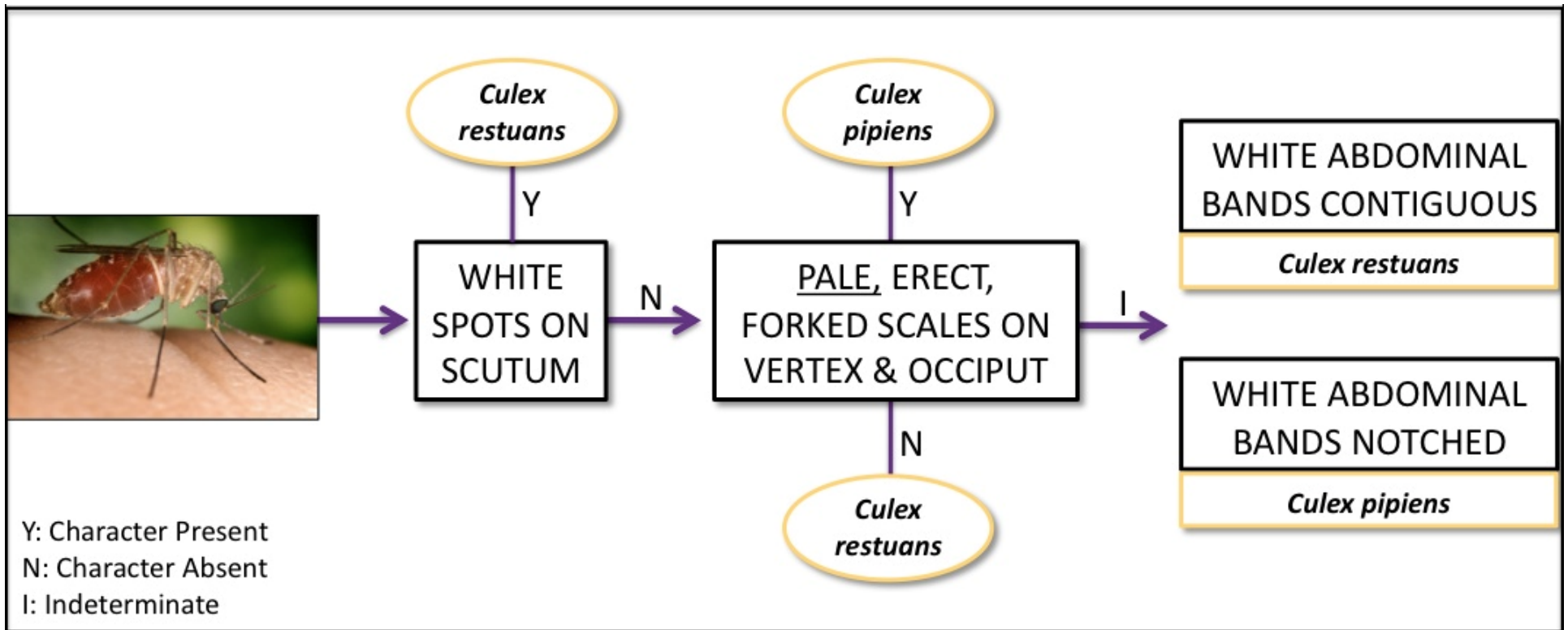
Culex pipiens

-  *Culex restuans* morphology (Character State)
-  *Culex pipiens* morphology (Character State)

Take Home Messages

- The novel vertex character (pale vs black scales) works very well
 - Sensitivity= 96% for *Cx. restuans*
 - Better than the abdominal character
 - However, not always present (missing ~30% of the time)
- Scutal spots, when present, are 100% sensitive for *Cx. restuans*
 - Of 58 *Culex restuans*, 28 (48%) were missing the pale scales.
 - Specificity is low (67%); absence does not identify *Cx. pipiens*
- The abdominal band character appears to be the least predictive
 - Perhaps does a better job at identifying *Cx. pipiens* than *Cx. restuans*
- **Public health professionals would be best served by a hierarchy of multiple characters**

Take Home Messages



Selected References

- Crabtree, M.B., Savage, H.M. and B.R. Miller. 1995. Development of a Species-diagnostic Polymerase Chain Reaction Assay for the Identification of *Culex* Vectors of St. Louis Encephalitis Virus Based on Interspecies Sequence Variation in Ribosomal DNA Spacers. *American Journal of Tropical Medicine and Hygiene*. 53(1): 105-109.
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- Apperson, C.S., Hassan, H.K., Harrison, B.A., Savage, H.M., Aspen, S.E., Farajollahi, A., Cranston, W., Daniels, T.J., Falco, R.C., Benedict, M., Anderson, M., McMillen, L., and Unnasch, T.R. 2004. Host Feeding Patterns of Established and Potential Vectors of West Nile Virus in the Eastern United States. *Vector-Borne and Zoonotic Diseases*. 4(1): 71-82.



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Questions?