VECTOR STUDIES AT LA CROSSE ENCEPHALITIS CASE SITES, TRANSYLVANIA COUNTY, NC - 2005

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WHAT IS LA CROSSE (LAC) ENCEPHALITIS?

- It is an infection caused by a virus named for the city of La Crosse, Wisconsin, where it was discovered in the 1960s.
- It primarily affects children, in which infections are more severe.
- The virus is transmitted to humans by certain species of mosquitoes that bite primarily during daylight hours and at dusk.
- The virus occurs naturally in small mammals, and humans are accidental and dead-end hosts for the virus.

LA CROSSE VIRUS TRANSMISSION ROUTES

1. HORIZONTAL:
   A. Between mosquito and vertebrate amplifying hosts or to dead end hosts
   B. Venereal, from infected male mosquitoes to female mosquitoes
2. VERTICAL*: from female mosquito to her offspring = filial transmission

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*Mechanism for vertical transmission in Bunya-viruses is transovarial, i.e., the virus infects the ovarian tissue and developing ova are infected before oviposition.

KNOWN VERTEBRATE AMPLIFYING HOSTS FOR LAC

- Chipmunk
- Eastern gray squirrel
- Western fox squirrel
- Red squirrel
- Cottontail rabbit
- Red fox
- Gray fox
- Woodchucks (ground hogs)

La Crosse amplifier hosts Chipmunk, Squirrels

Transmission of LACV to Humans

Mosquito feeds / acquires virus

Mosquito refeeds / transmits virus

Extrinsic incubation period

Intrinsic incubation period

Viremia

Viremia

0 5 8 12 16 20 24 28

DAYS

Illness

Squirrel/Chipmunk

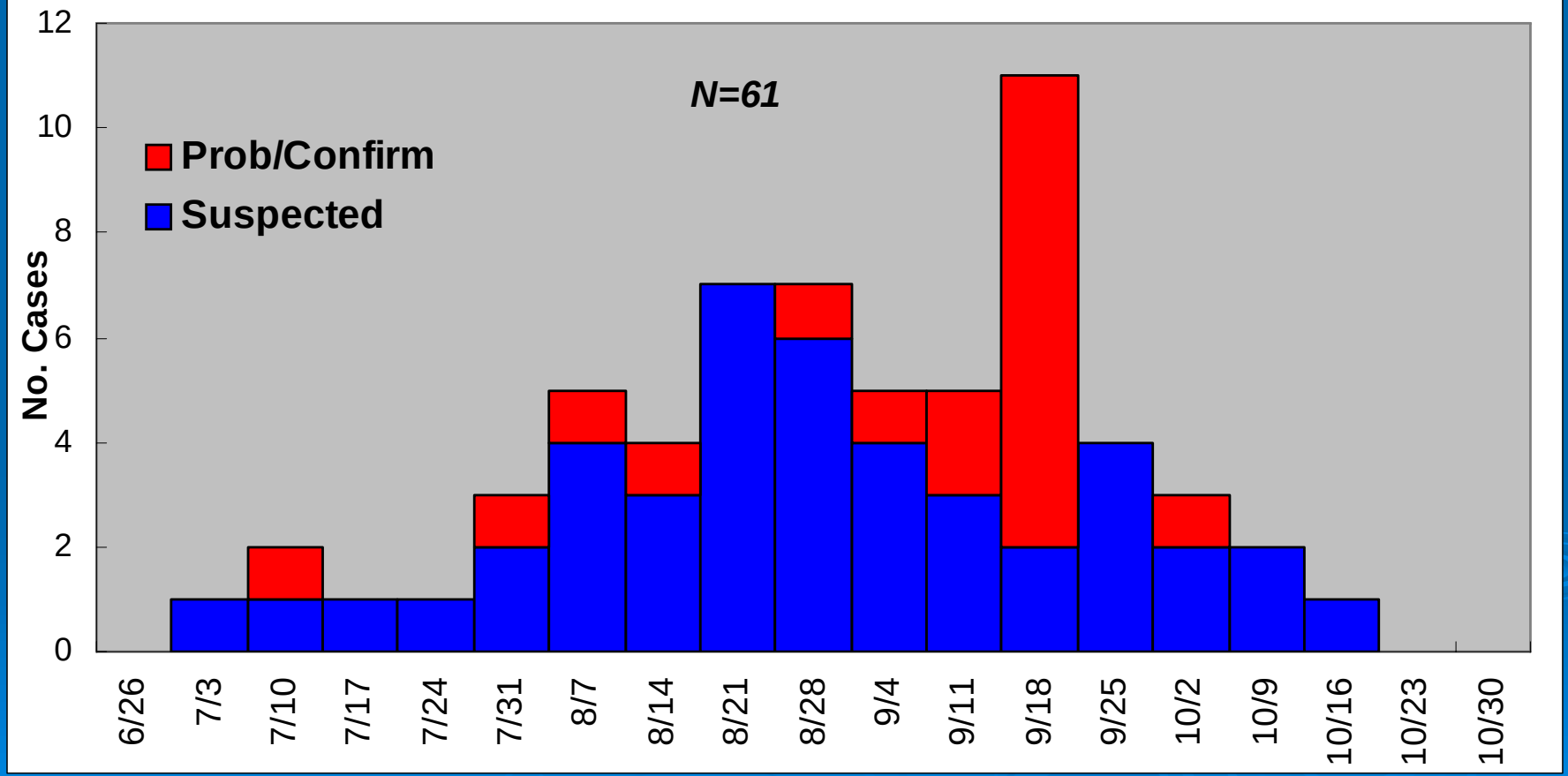
Human

The cost of doing nothing…

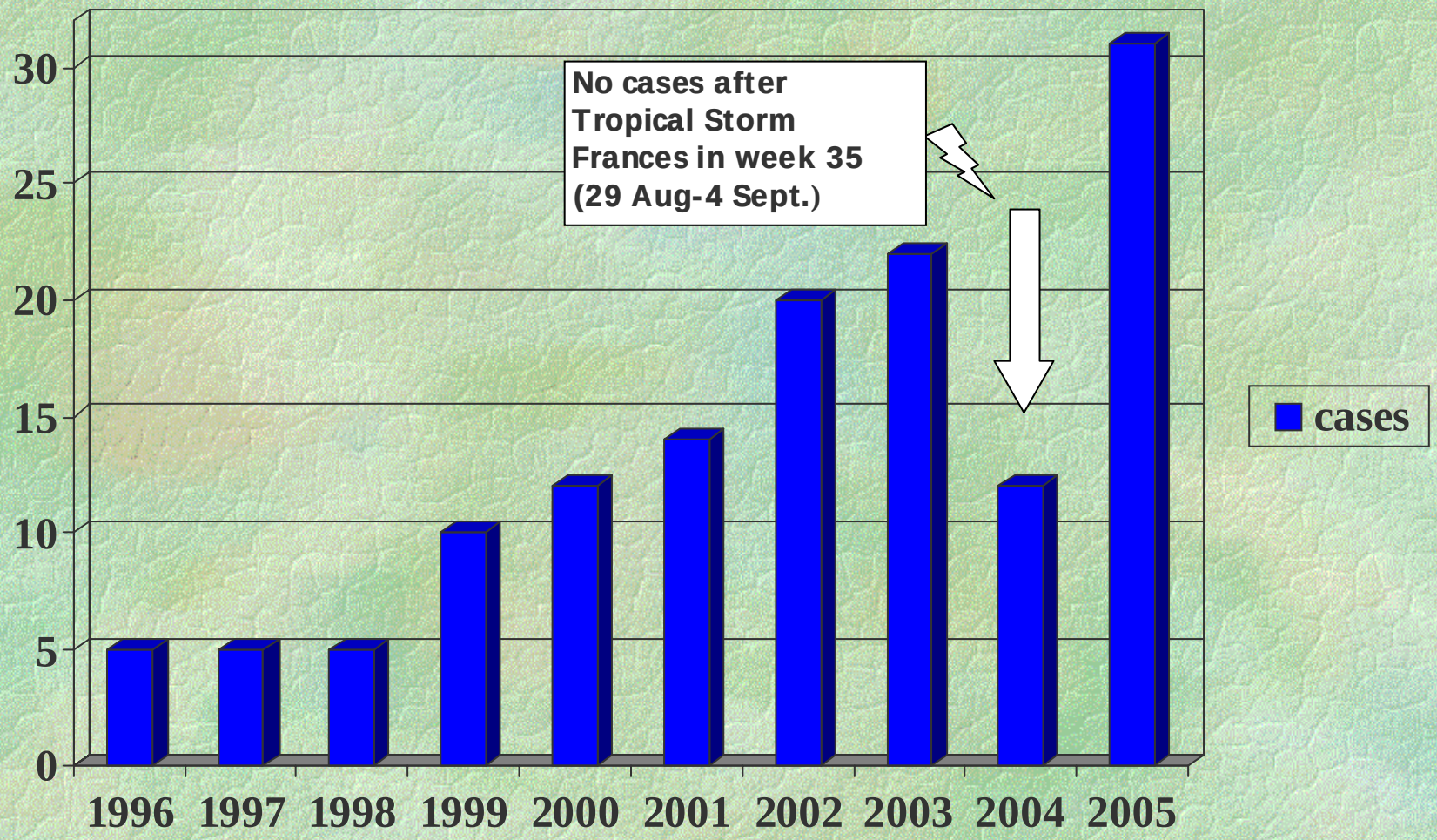
- Direct and Indirect Medical Costs
  - Avg. $32, 974 (n=24)
  - Range: $7,521- $175,586
- Lifelong Neurologic Sequelae Costs
  - $48,775 - $3,098,798 (n=5)
- Social Impacts
  - Differ by sequelae (NS, IS, LS)
  - IQ and academic performance

Economic and Social Impacts of La Crosse Encephalitis in Western North Carolina
Utz et al. *American Journal of Tropical Medicine and Hygiene*. 69 (5) 2003.

Epidemic Curve of Suspected and Positive LAC Case-Patients by Week, Mission Memorial Hospital, 7/1 to 10/21, 2005



EVIDENCE FOR LA CROSSE ENCEPHALITIS RISK IN N.C.



OBJECTIVES FOR 2005

- Conduct studies at 7 case residences
- Survey environmental factors that enhance risk at or near each case residence
- Determine the abundance of known and suspected mosquito vectors of LACE at case residences
- Determine and develop best collecting methods for adult mosquito vectors of LAC virus
- Confirm LAC virus in mosquitoes at or near case residences
- Determine the abundance and collect mammal amplifying hosts at or near residences
- Confirm LAC virus antibodies in mammals at or near case residences

RESULTS OF HABITAT EVALUATION SURVEYS AT CASE RESIDENCES

Site #	Distance to forest	Treeholes visible	Squirrels Chipmunks	Containers Perm:Disp		Mosq. Larvae*
1	10 m	yes	yes	9	34+	yes
2	5 m	yes	no	7	94	yes
3	70 m	yes	yes	7	16	no*
4	25 m	no	yes	8	7	no*
6	5 m	yes	no	14	12	no*
8a**	5 m	yes	no	18	17	yes
8b**	5 m	yes	yes	28	18	no*

*Containers disposed of or water dumped 2 weeks before survey

**Site 8 had two residences

WHERE DO YOU FIND LARVAE OF MOSQUITOES THAT TRANSMIT LA CROSSE ENCEPHALITIS IN NC?

- **Only in artificial and natural containers !***

*** This means they <u>DO NOT COME FROM</u> the creek, stream, ditch, pond, swamp, lake, puddles, and ground pools near your home. Only from items that collect water outside and inside your home and from tree holes.**

Residence 01

TWO KNOWN AND ONE SUSPECTED MOSQUITO VECTORS

***Ochlerotatus triseriatus*, the tree hole mosquito**

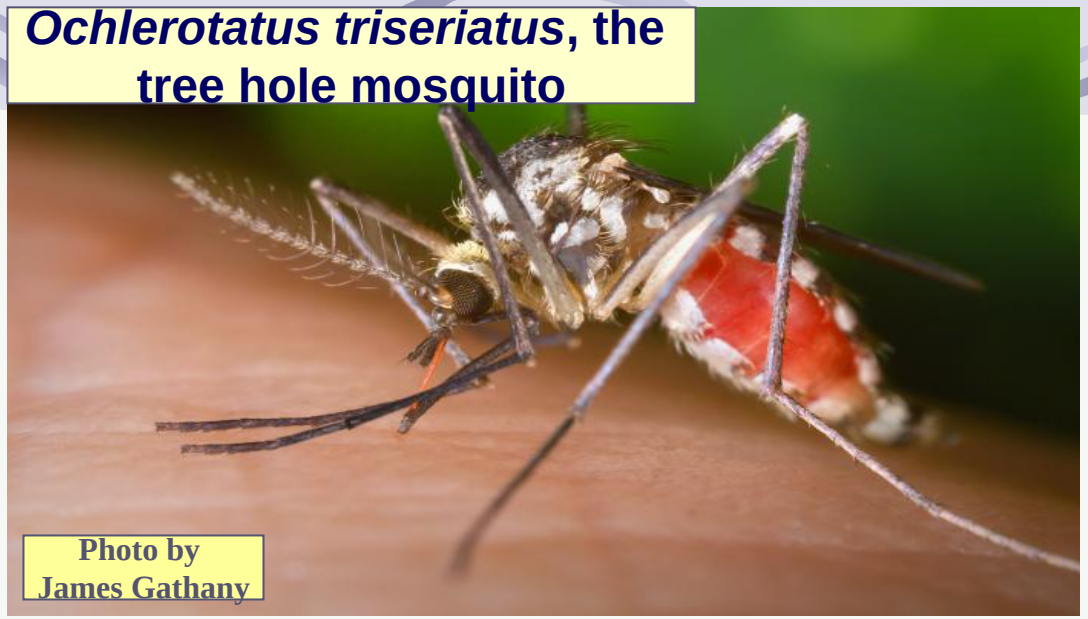


Photo by James Gathany

SUSPECTED VECTOR
Ochlerotatus japonicus

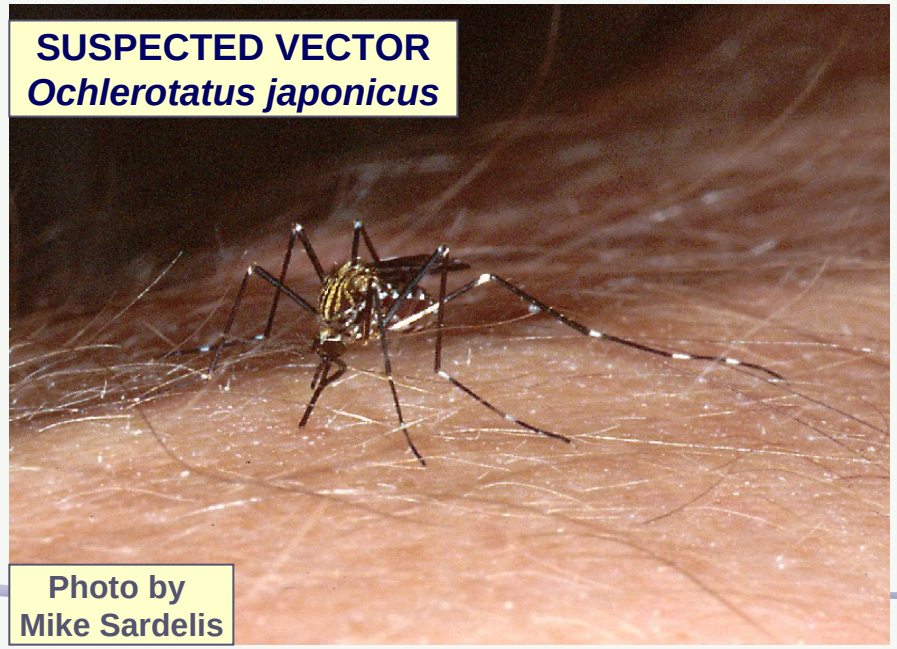


Photo by Mike Sardelis

***Aedes albopictus*, the Asian Tiger mosquito**

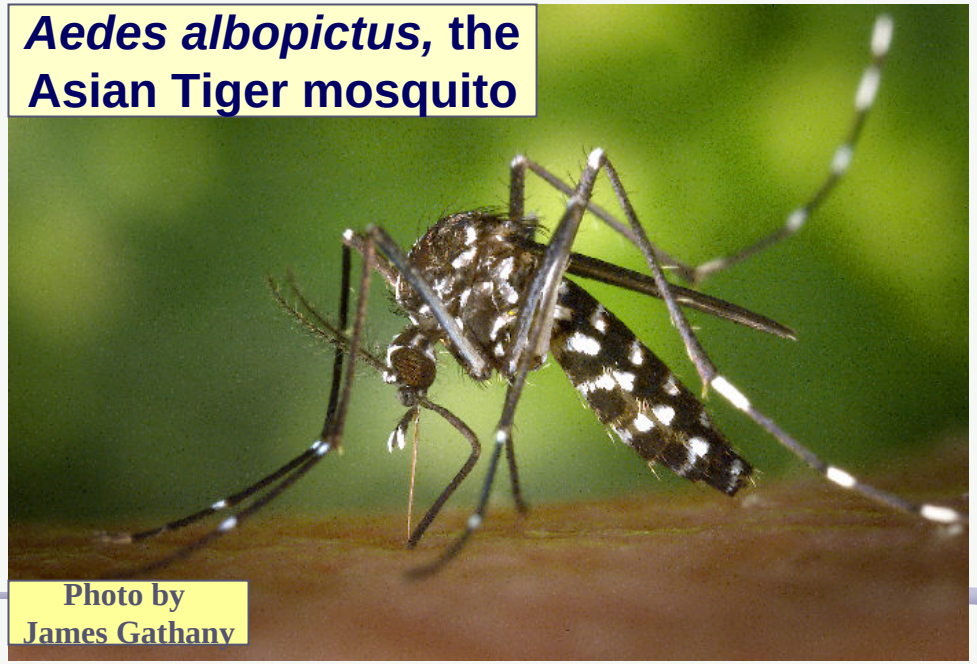


Photo by James Gathany

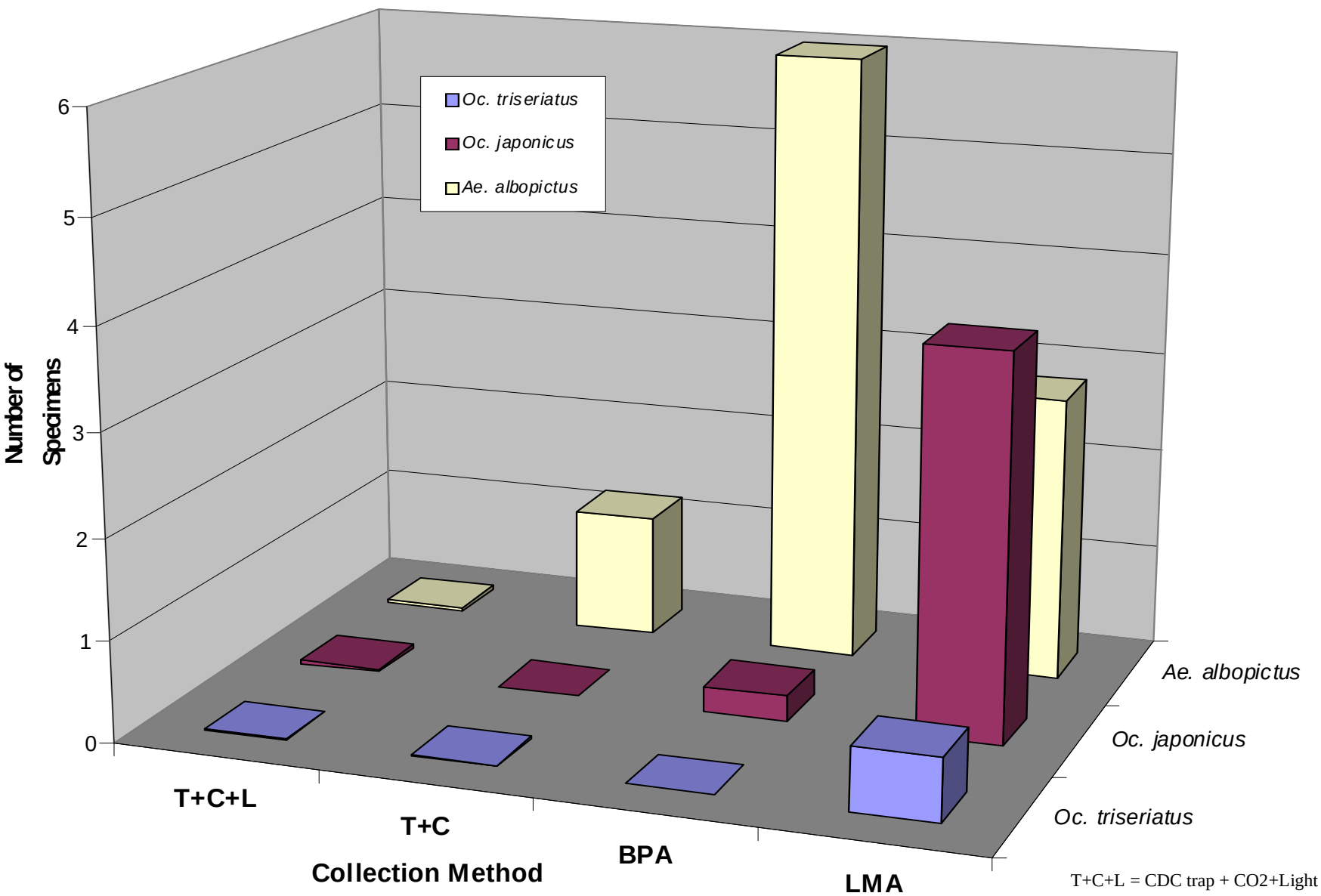
CONTAINERS POSITIVE FOR LARVAE

DATE	CONTAINER	*Ae. albopictus*	*Oc. japonicus*	*Oc. triseriatus*
27 Sept	truck liner	-	+	-
"	x-mas tree holder	-	+	-
"	bowl	-	+	-
"	bucket	+	+	+
"	black-gum treehole	+	+	+
17 Oct	tarp on boat	+	-	-
"	tarp on ground	+	-	-
"	old sink	+	+	-
18 Oct	top of propane tank	+	+	+
19 Oct	pet dish	+	-	-
"	metal trough	+	-	-
"	plastic garbage can	+	-	-
"	plastic garbage can	+	+	-
	used tires	+	+	-
	14	11	9	3

MOSQUITO COLLECTIONS DURING AND AFTER TRANSYLVANIA CO. LA CROSSE OUTBREAK - 2005

- **Collection days = 10** (23, 27- 29 Sept., 4-5, 17-20 Oct.)
- **Sites Collected = 7**
- **Collection methods = 5**

	# of coll.	unit-hrs of collection	specimens per unit-hr
Trap + CO_2 + light	12	290 trap-hrs	0.1/trap-hr
Trap + CO_2 - no light	8	62 trap-hrs	1.3/trap-hr
Back-Pack Aspirator	3	4 man-hrs	6.3/man-hr
Landing-Mouth Aspirator	28	34 man-hrs	7.6/man-hr
Larval (positives only)	15	No Count	No Count
Total collections	66	390 unit-hrs	



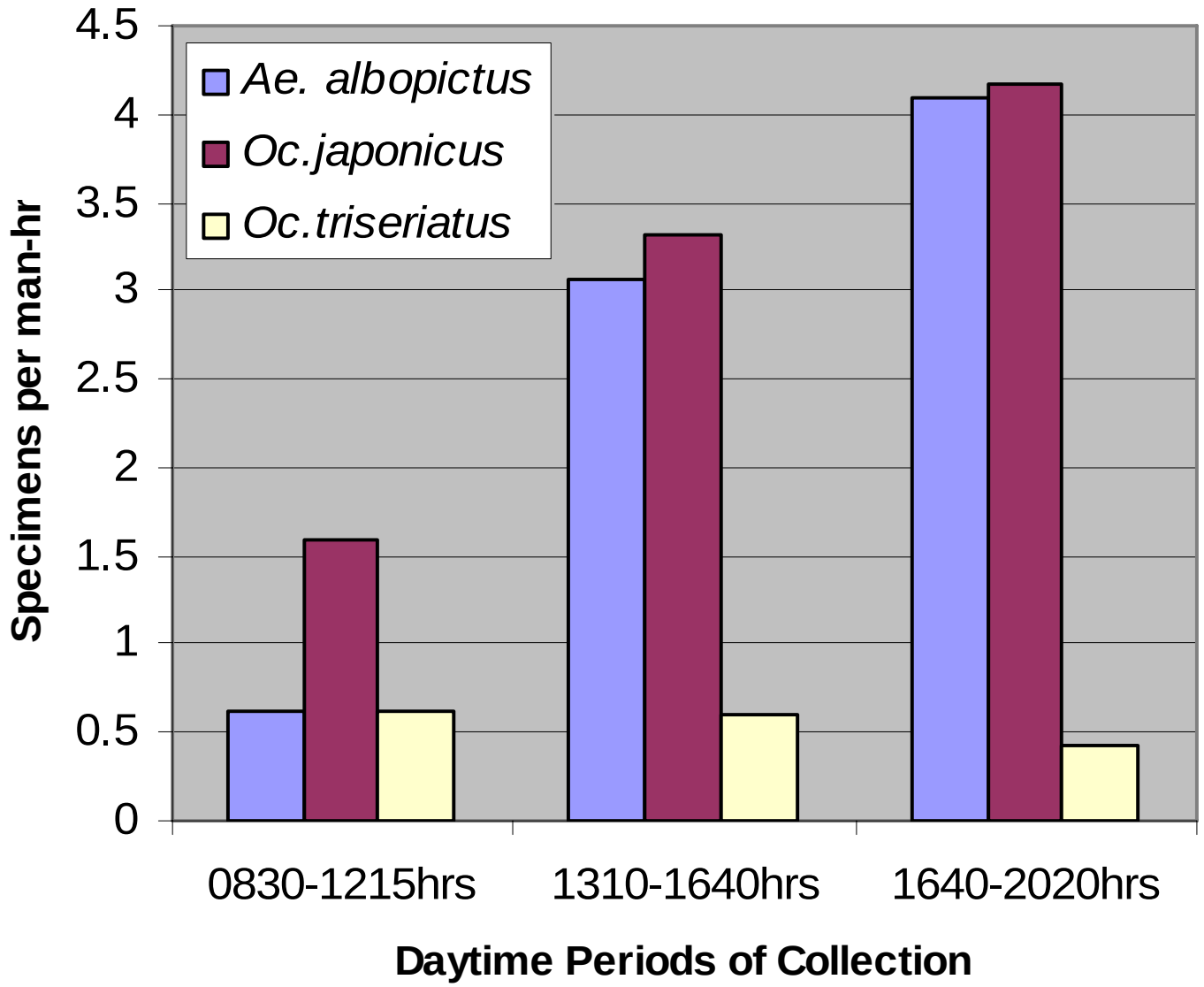
T+C+L = CDC trap + CO2+Light

T+C = CDC trap + CO2 (no light)

BPA = Back Pack Aspirator

LMA = Landing – Mouth Aspiration

Productivity of Aspiration Collections Based on Time of Day



PER HOUR SPECIMEN PRODUCTIVITY FOR TARGET SPECIES* BY CASE SITE AND TECHNIQUE

Technique	site 1	site 2	site 3	site 4	site 5	site 6	site 7
Trap unit-hrs	40	69	62	72	54	37	18
Specimens Per trap-hr	0.15	0.10	0.13	0.31	0.04	0.22	2.61
LMA**-hrs	2.5	1.15	6.5	13.0	5.0	2.0	4.2
Specimens Per man-hr	3.20	1.70	8.00	9.70	4.30	11.50	5.95

*Target species = *Ae. albopictus, Oc. japonicus, Oc. triseriatus*

**LMA = Landing-Mouth Aspiration

MOSQUITO COLLECTION* AND VIRUS (LAC) TESTING RESULTS

Mosquito Species	Vector Status	Number of Specimens	Number of Pools Tested	Test (TaqMan) Results
Ae. albopictus	+++	207	61	NEG.
Oc. japonicus	+(?)	139	37	NEG.
Oc. triseriatus	++++	25	17	NEG.
An. punctipennis	No	10	7	NEG.
Ae. vexans	No	5	5	NEG.
Cx. pipiens comp.	No	1	1	NEG.
Totals		387	128	NEG.

*96 % of collected specimens were the target species that may transmit La Crosse encephalitis

POOLING DATA FOR TARGET SPECIES COLLECTED IN TRANSYLVANIA CO., 2005

mosquito species	# of specimens	# of pools	range in pool size	ave. # per pool
Ae. albopictus	207	61	1-17	3.4
Oc. japonicus	139	37	1-20	3.8
Oc. triseriatus	25	17	1-5	1.5
Totals	371	115	-	-

Small Mammal Trapping

15 Squirrels
7 Chipmunks
3 Shrews

1790 Daylight Trap-Hours
Sciurid Trap-Hour Success: 1.2%
Neutralizing antibodies found at two residences.

EXCEPTIONAL CIRCUMSTANCES OCCURRING IN BREVARD IN 2005

- **Exceptional rainfall during late June to early August**
- **Hot dry weather from mid-August into early October, which overlapped the known annual peak of La Crosse virus transmission each year**
- **Exceptional abundance of gray squirrels and chipmunks due to a city-wide ordinance in Brevard protecting a white squirrel variety of the gray squirrel**

WHITE SQUIRRELS OF BREVARD

PUBLISHED RISK FACTORS FOR LA CROSSE ENCEPHALITIS IN THE SOUTHERN APPALACHIAN REGION

- Living in areas where the virus cycle occurs
- Children up to 16 years old (adults infrequently)
- Living close to forest and tree holes
- Number of hours per day spent outdoors
- High level of exposure to the tree hole mosquito, *Ochlerotatus triseriatus*
- High level of exposure to Asian tiger mosquito, *Aedes albopictus*
- Abundance of discarded tires and other artificial containers near residences

WHAT MAKES TRANSYLVANIA COUNTY AN IDEAL PLACE FOR LA CROSSE ENCEPHALITIS?

- Close proximity of homes to forest, and/or many large trees and dense shrubbery in yards
- Many tree holes
- Many artificial containers with water
- No solid waste ordinance that focuses on artificial containers
- Large populations of the mosquito vectors
- Many squirrels and chipmunks
- Many unscreened porches and decks
- Large population growth = higher human – mosquito contact at or near the home
- Highest annual rainfall per year in NC, with high humidity in dense forests and shrubbery near homes during the summer months
- Low use of repellents and protective clothing

CONCLUSIONS FROM THE 2005 STUDY

- **All of the case residences were high risk LAC sites.**
- **Although known and suspected vectors were abundant and collected at the case residences, pools of these species tested by the TaqMan PCR were negative for LAC virus**
- **Two of three (67%) case residences sampled had virus amplifying hosts that were positive for neutralizing antibodies to LAC**
- **Enzootic LAC virus transmission occurred at LAC encephalitis case residences in Brevard and Transylvania County, NC, in 2005**