Final Project Report to the NYS IPM Program, Agricultural IPM 2002-2003

Title: Statewide Survey of Mosquito Breeding (Species Identification and Prevalence) on NY Dairy Farms

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Project type: Monitoring, forecasting, and economic thresholds

Project locations: Our results are applicable throughout the Northeast

Abstract

Mosquitoes breeding on dairy farms may present a health risk to the citizens of New York State. Our study had four critical results. We determined that bunker tires on dairy farms are important mosquito production sites. We identified the mosquito species breeding in bunker tires and the adult species host seeking on dairies in select regions around New York State. We identified the current range of the invasive species *Oc. j. japonicus* breeding on New York dairies and we have established "negative presence" baseline data for *Ae. albopictus* on dairies in these 5 regions..

Background and Justification:

With the 1999 detection of West Nile virus (WNV) in the New York City area, the implications of this new pathogen and its public health impact have been a high profile issue. Since 1999, WNV has spread across the United States. As of October 2002, WNV has been recorded from 44 of the 48 continental states as well as 5 Canadian provinces (CDC data presented at http://www.cfe.cornell.edu/erap/WNV). As of Nov 29, 2002, CDC reported 3,737 laboratory confirmed human cases of West Nile fever (201 fatalities) from 39 states and Washington DC. Illinois (776), Michigan (523), and Ohio (419) had the highest caseloads in 2002. The number of WNV-infected horses exceeded 14,000 in 2002 with Texas, Illinois and Nebraska each exceeding 1,000 positive-infected animals. Of concern to vector ecologists studying the ecology of WNV is the potential importance of two invasive species new to the Northeast, *Ochlerotatus j. japonicus* (formerly *Aedes japonicus*) and *Aedes albopictus*, the Asian tiger mosquito.

Oc. j. japonicus was first discovered in New York and New Jersey in 1998 (Peyton et al. 1999). Since its initial recovery, *Oc. j. japonicus* has been detected from areas as far north as Maine, as far south as Virginia and west into Southeastern Ohio. The PI's in this project collected *Oc. j. japonicus* from several central NY dairy farms in 2001 (Kaufman unpubl. data). *Oc. j. japonicus* is reported to feed on birds and mammals, including humans (Tanaka et al. 1979). This mosquito has been shown to be a competent vector of Eastern Equine Encephalitis (Sardelis et al. 2002b), La Crosse virus

(Sardelis et al. 2002a) and 2-4 times more competent at transmission of WNV than the bird-to-bird vector *Culex p. pipiens* (Turell et al. 2001, Sardelis & Turell 2001). It is quite likely that this invasive species, as a potential bridge vector, will play an active role in future disease transmission

The Asian tiger mosquito, *Aedes albopictus*, was first detected in Texas in 1985 and has since expanded its range (Sprenger and Wuithiranyagool 1986). *Ae. albopictus* has spread east and north and was reported from collections in New Jersey in 2001 (Moore 1999). This species is of considerable public health importance because it is an efficient vector of numerous human pathogens including dengue, Yellow fever, and Eastern equine encephalitis, as well as dog heartworm (Moore and Mitchell, 1997).

Oc. j. japonicus and *Ae. albopictus* are efficient vectors of WNV in the laboratory (Mithchell 1991, Sardelis et al. 2002b) and have been found naturally infected with WNV in the field (CDC 2000, Sardelis et al. 2002b). Larvae of both species have been collected from tires. These species were most likely introduced in tires from Asia (Hawley et al. 1987,Peyton et al. 1999). The propensity of these invasive species for tires make mosquito breeding in bunker tires on dairy farms a primary concern.

Reducing risk of WNV infection should focus in part on larval source reduction, which is consistent with IPM principles. However, one area that has been overlooked in NY is mosquito breeding on dairy farms, particularly bunker silage tire piles (Fig. 1A). Producers utilize discarded tires to hold tarps on bunker silage pits in order to create airtight covers that allow anaerobic fermentation and ultimately preservation of dairy forage. Often these discarded tires are not "cut", because the steel belts would tear the plastic cover, spoiling the silage. When not in use on silage pits, tires are often piled behind the pit and forming massive mounds with random tire arrangements (Fig. 1B). Because many of the tires in these piles are positioned vertically, rainwater accumulates in them providing readily accessible mosquito breeding sites.

Tire piles are known sources for mosquito breeding and their use has been abandoned in states such as Florida where mosquitoes are a year round threat. Preliminary data collected from dairy farm tire piles during 2001 by the PI's have identified several mosquito species of importance. The potential WNV-transmitting species recovered were *Culex p. pipiens*, *Culex restuans, Culex salinarius, Ochlerotatus triseriatus* and *Oc. j. japonicus*. Entomologists are still uncertain what species is primarily responsible for WNV transmission to humans, however, certain mosquitoes are strong candidates. It is thought that *Cx. p. pipiens* and *Cx. restuans* maintain the pathogen among birds while others such as *Oc. j. japonicus* and *Cx. salinarius* serve as bridge vectors, transmitting the disease to mammals. The 2001 preliminary survey was conducted in central NY (Tompkins, Cayuga, Cortland and Onondaga counties). To date, no one has examined the mosquito species that exist in bunker silage tire piles across the greatly varied geography and climactic conditions that exist in NY.

In addition to breeding sites, tires may serve as resting sites for many mosquito species. Adult mosquitoes seek daytime resting sites that offer protection and a dark humid habitat. It is critical to document the species that utilize these microhabitats as well as whether mosquito adults produced from tires remain in the area to seek hosts.

This information may be useful to dairy producers if they must respond to the public about the significant bunker tires for mosquito vector production. It is critical that we not only be prepared to answer these questions, but to have management options available. The results of this project will benefit not only the dairy farmers of New York, but also the entire citizens of the state.

Objective: Conduct a statewide survey for mosquito species breeding in bunker tires on dairy farms.

Procedure:

Larval sampling - Mosquitoes were sampled bi-weekly from three dairies at each of four non-Finger Lakes regions across NY state. Additionally, five dairies were sampled in the Finger Lakes region. Dairies in each region were a minimum of 10 miles apart and had discarded tire piles present as a result of silage management practices. Areas sampled included farms in Wyoming Co. (western NY), St. Lawrence Co. (northern NY), Montgomery Co. (East-central NY) and Dutchess Co. (lower Hudson River). Samples were taken by removing larvae from tires using a standard white ladle. Tires were sampled until 10 different tire collections per farm were obtained. Following each Wyoming county collection and September collections in Montgomery and St. Lawrence counties mosquito larvae and pupae were extracted and collected into alcohol. Specimens were returned to Dr. Rutz for identification. At all other sites and dates, larval mosquitoes were held for adult emergence in plastic cups (473 ml) that were fitted with emergence cones. Newly emerged adult mosquitoes were collected daily and transferred to labeled containers and frozen for future identification. Specimen identification was conducted under the supervision of Dr. Harrington.

Adult sampling – Adult mosquito CO2-baited CDC miniature light traps (with the light bulb removed to avoid collection of moths and other insects) were operated one night each week at the Finger Lakes sites near the tire pile and in the calf-greenhouse. These traps were utilized to identify the adult mosquito distribution on dairy farms and in particular those species that may be resting in tires and seeking blood meals in the area. CDC traps were positioned 1.5 m above the ground and baited with 0.5 kg dry ice held in a slow release cooler (dry ice emits CO2, which mimics that given off by a host animal). Traps were set out around 18:00 EST and retrieved no later than 10:00 EST the following day. Captured mosquitoes were returned to the laboratory, frozen and identified to species. A subsample of mosquitoes will be tested for WNV infection. Placement of CDC traps at sites other than the Finger Lakes region was done at the time of larval sampling. All Wyoming county and Montgomery and St. Lawrence county (September only) adult samples were frozen and returned to Cornell University for identification and enumeration.

Results and Discussion

The results of this project will directly impact not only all New York dairy farmers that utilize discarded tires on bunker silage, but due to the vector potential of these pests, the entire citizenry of the state. It is estimated that more than 75% of dairy farms utilize tires for silage bunker storage. Discarded tire piles range from a few hundred to several thousand tires. According to dairy producers, tires were obtained from local or on-farm sources. None of the producers asked had received out-of-state tires, which may have served as a mode of introduction of invasive species.

A description of farm locations, farming operations and an estimate of numbers of discarded tires on the farm is provided (Table 1). The numbers of tires piled behind/beside the silage bunker varied each week as silage was removed from the bunker (tires slowly added) and as crop-harvest commenced (large numbers removed). The sizes of the tires varied greatly as well, ranging from large rear wheel tractor tires to 13-inch car tires and smaller. Most tires were in the car-tire size range.

Weather patterns, particularly rainfall impacted mosquito prevalence in 2002. The recovery of mosquito larvae on May 28 in Wyoming county was most likely reduced by freezing temperatures just prior to sampling. At that time, late-instar mosquito larva cadavers were observed in many tires and the few live larval mosquitoes recovered were generally found only in larger tires. Dry, hot weather in late-June and through July resulted in tires with limited and in some cases no water, thereby disrupting mosquito development. Many of the *Aedes* and *Ochlerotatus* species readily survive drought conditions in the egg stage and as was expected, when summer rainfall events occurred, mosquito production resumed.

The diversity of mosquito species recovered from tires varied from region to region. Statewide, the larval survey recovered 6 genera and 14 species which included *Cx. p. pipiens, Cx. restuans, Cx. salinarius, Cx. territans, Aedes vexans, Oc. j. japonicus, Oc. triseriatus, Oc. atropalpus, Anopheles perplexeins, Anopheles punctipennis, Anopheles quadrimaculatus, Anopheles barberi, Coquillettidia perturbans, Toxorhynchites rutilus septentrionalis.*

In the northern region (St. Lawrence county), collections were conducted between May 30 and September 20 and with the exception of two *Oc. triseriatus* specimens collected on August 21, only *Culex* species were recovered (Fig. 2). No specimens of *Oc. j. japonicus* were recovered in the northern region during 2002. The most prevalent species recovered in the region were *Cx. restuans* (57%), followed by *Cx. p. pipiens* (22%). In total, 1,246 adult mosquitoes were reared from 7 collection dates and 744 larvae were collected at two sample dates.

In the capital region (Montgomery county), collections were conducted between May 31 and September 26. The most prevalent species recovered was *Cx. restuans* (51%) followed by *Cx. salinarius* (25%) (Fig. 3). The invasive species *Oc. j. japonicus* accounted for about 2% of mosquitoes collected. Interestingly, *Oc. atropalpus* were recovered in the capital region in larger numbers than in any other region and accounted for 2% of the recovered specimens. In total, 1,924 adult mosquitoes were reared from 6 collection dates and 1,071 larvae were collected at two sample dates. This may have been due to the proximity of collection sites to natural rock pools, the preferred habitat of *Oc. atropalpus*.

In the Southern Hudson region (Dutchess county) collections occurred between May 23 and October 15. The predominant mosquito reared from larval collections was *Oc. j. japonicus* (44%) followed by *Cx. restuans* (34%) (Fig. 4). Another *Ochlerotatus* species, *Oc. triseriatus* accounted for 3% of species recovered. This was the only region in the state where *Cx. restuans* was not the primary species recorded. Additionally, several specimens of *Tx. r. septentrionalis*, a non blood-feeding predaceous mosquito, were recovered from September 22 and October 15 collections at two of the three farms. As a larva, *Tx. r. septentrionalis* feeds heavily on other mosquito larvae. In total, 2,836 adult mosquitoes were reared from 11 collection dates in Dutchess county.

In the Finger Lakes region, (Tompkins, Cortland, Onondaga and Cayuga counties), *Cx. restuans* (52%) was the predominant species (Fig. 5). *Oc.* j. *japonicus*, which was also recovered in 2001 from these farms, accounted for 8% of the mosquitoes reared to the adult stage in 2002. In total, 6,492 adult mosquitoes were reared from 9 collection dates at 5 farms.

Initial Finger Lakes region larval collections contained moderate numbers of Anopheline species including, *An. perplexeins, An. punctipennis, An. quadrimaculatus, An. barberi*. Few of these species successfully emerged as adults. This genus may require different rearing conditions than were present in this study. Collectors sampling in the eastern regions reported few adult *Anopheles* specimens from reared-larval collections. It is unknown whether tires are dead-end development sites for Anopheline larvae.

Samples from the western region (Wyoming county) were collected between May 28 and October 02. Only a few of the samples have been identified and preliminary data are presented (Fig. 6). *Culex pipiens* and *Cx. restuans* were the most prevalent species recovered. Overall, these data will certainly provide different results because collections reflected species sampled in tires without the selection bias of lab rearing.

The prevalence data for *Oc. j. japonicus* from the Southern Hudson and Finger Lakes regions indicate that this species was common throughout the season with a drop in the populations in early August most likely the result of drought (Fig. 7). Near the end of the summer nearly 80% of the specimens recovered from the Southern Hudson region were *Oc. j. japonicus*. This was the most common species collected over the season in the region (Fig. 4) and became more prevalent as the summer progressed. Our work indicates that in New York, *Cx. restuans* makes up a greater percentage of mosquitoes recovered from tires compared to *Cx. p. pipiens*. It is possible that *Oc. j. japonicus* may competitively replace *Cx. restuans* as the most common late-season, container-breeding species. Competitive displacement has been observed with another invasive species, *Aedes aegypti* in Florida. Replacement of mosquitoes in New York by competent human vectors of disease may have a dramatic impact on the epidemiology of several endemic diseases, including WNV and Eastern Equine encephalitis, therefore, this trend merits close monitoring.

Statewide, the adult survey with CDC traps recovered 5 genera and 11 species which included *Cx. p. pipiens, Cx. restuans, Cx. salinarius, Oc. j. japonicus, Oc. triseriatus, Ochlerotatus aurifer, Ochlerotatus fitchi, Aedes vexans, Anopheles punctipennis, Anopheles barberi, Coquillettidia perturbans.* Adult mosquito collections resulted in two species, *Oc. aurifer* and *Oc. fitchi*, that were not recovered in larval sampling probably due to the fact that these species developed at other sites and were host-seeking in the area. *Cq. perturbans* was recovered in adult traps from all areas, with the exception of the northern region. *Cq. perturbans* is one of the most important nuisance pest species in the northeast because it will attack humans readily. However, this mosquito breeds in swamps and pond margins and most likely flew into the area to seek a blood meal. Only two adults were recovered from collections at northern region dairies, one specimen each of *Cx. restuans* and *Oc. aurifer*.

Adult trap collections from the capital region yielded 125 adult specimens, including three specimens of *Ae. vexans* (Fig. 8). Southern Hudson region collections were dominated by *Cq. perturbans* (92% of 153 specimens), with a few specimens of *Cx. p. pipiens, An. barberi and Oc. triseriatus* recovered (Fig. 9). In the Finger Lakes region, 399 mosquito adults were collected from 5 dairies where two traps were placed per farm. The two species recovered in greatest abundance were *Cx. p. pipiens* and *Cx. restuans*, 53% and 24% respectively (Fig. 10). Adult collections from the western region were dominated by *Cx. restuans* (45%) and unidentifiable *Cx*. species (32%) (due to specimen damage from the CDC trap) with 156 specimens recovered (Fig. 11). In addition, three specimens of *An. punctipennis* and a single specimen each of *Oc. j. japonicus* and *Oc. fitchi* were collected. This documents the westernmost point in New

York where *Oc. j. japonicus* has been detected on dairy farms. We will more completely document the presence of *Oc. j. japonicus* in western NY when the larval samples are fully identified and enumerated. We did not recover *Ae. albopictus* at any of the 17 dairy farms in 5 regions of New York, therefore, we now have baseline data that can be used to track the spread if it is introduced.

Our important results are 1) tire bunkers are productive breeding sites for potential vector mosquitoes, 2) the species developing in bunker tires was identified by region throughout the state, 3) the current distribution of the invasive mosquito vector *Oc. j. japonicus* was determined, and 4) we have established "negative presence" baseline data for *Ae. albopictus* on dairies in these 5 regions.

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Table 1. Description of farm location, operation and estimate of discarded tire number.

Region	County	Farm ID	No. Cows	No. Silage Bunkers	Estimated No. Tires
S. Hudson	Dutchess	SHud1	120	1	1,000
		SHud2	305	6	300
		SHud3	60	2	4,000
Capital	Montgomery	Cap1	600	7	17,000
		Cap2	300	4	13,000
		Cap3	115	2	4,000
Northern	St. Lawrence	North1	300	3	7,000
		North2	100	1	100
		North3	385	1	300
Finger Lakes	Tompkins	Fing1	750	5	5,000
	Tompkins	Fing2	185	3	1,500
	Cortland	Fing3	650	4	4,000
	Onondaga	Fing4	350	3	800
	Cayuga	Fing5	350	3	3,000
Western	Wyoming	West1	300	1	350
		West2	200	1	250
		West3	600	2	600

Figures 1A and 1B. Tires on a bunker silo and pile of discarded tires at dairy farm.

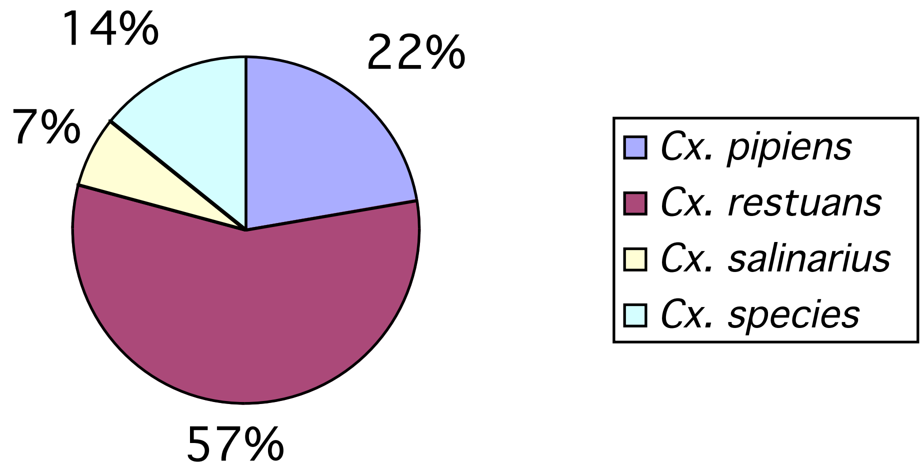

Figure 2. Mosquito species recovered from tires at 3 St. Lawrence county, NY dairies expressed as percent of species recovered – 8-week total.

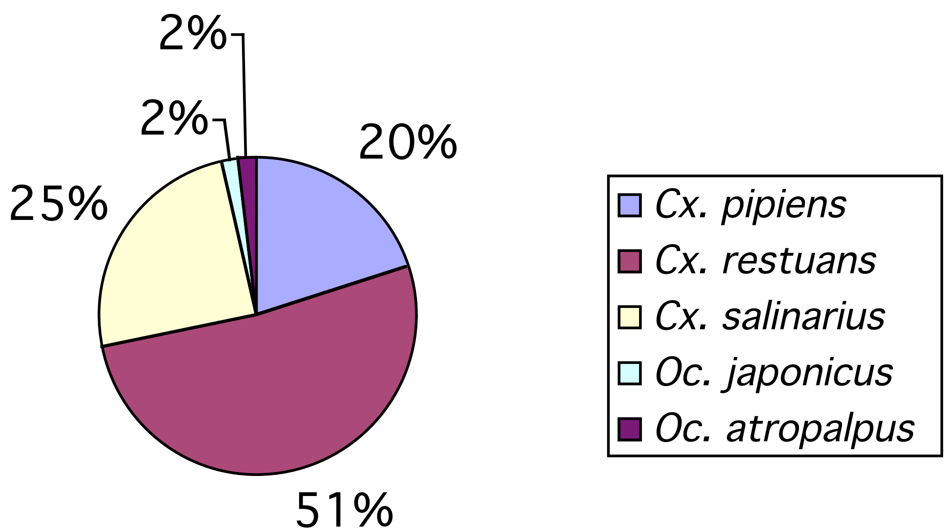

Figure 3. Mosquito species recovered from tires at 3 Montgomery county, NY dairies expressed as percent of species recovered – 8-week total.

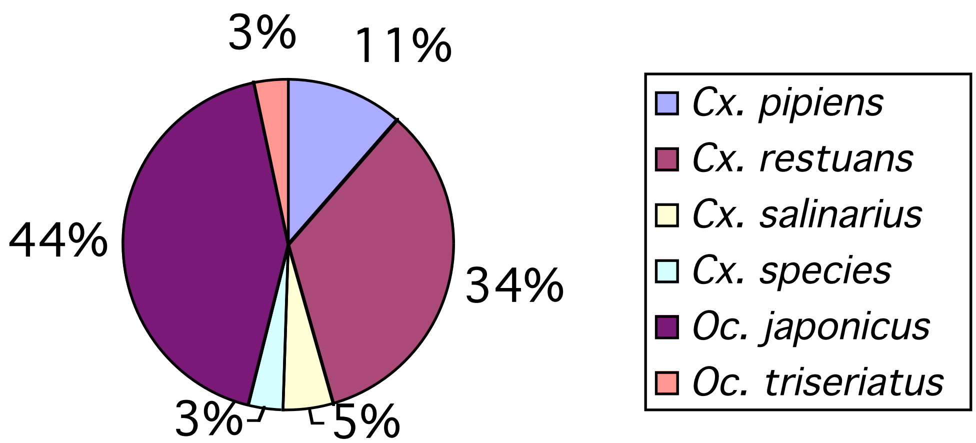

Figure 4. Mosquito species recovered from tires at 3 Dutchess county, NY dairies expressed as percent of species recovered – 11-week total.

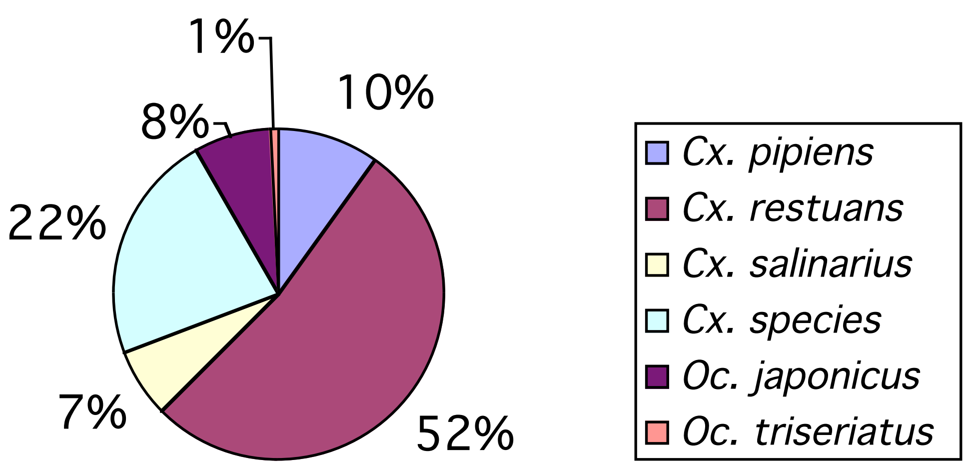

Figure 5. Mosquito species recovered from tires at dairies in the Finger Lakes region of New York expressed as percent of species recovered – 9-week total.

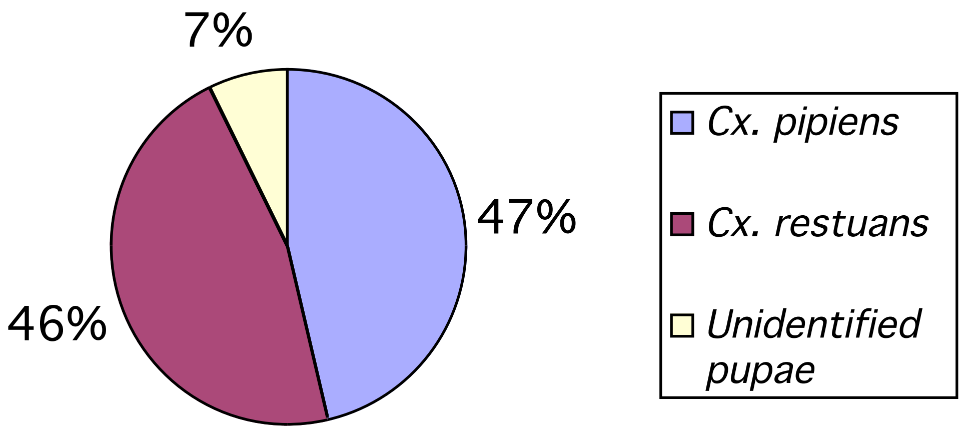

Figure 6. Mosquito species recovered from tires at 3 Wyoming county, NY dairies expressed as percent of species recovered – 9-week total.

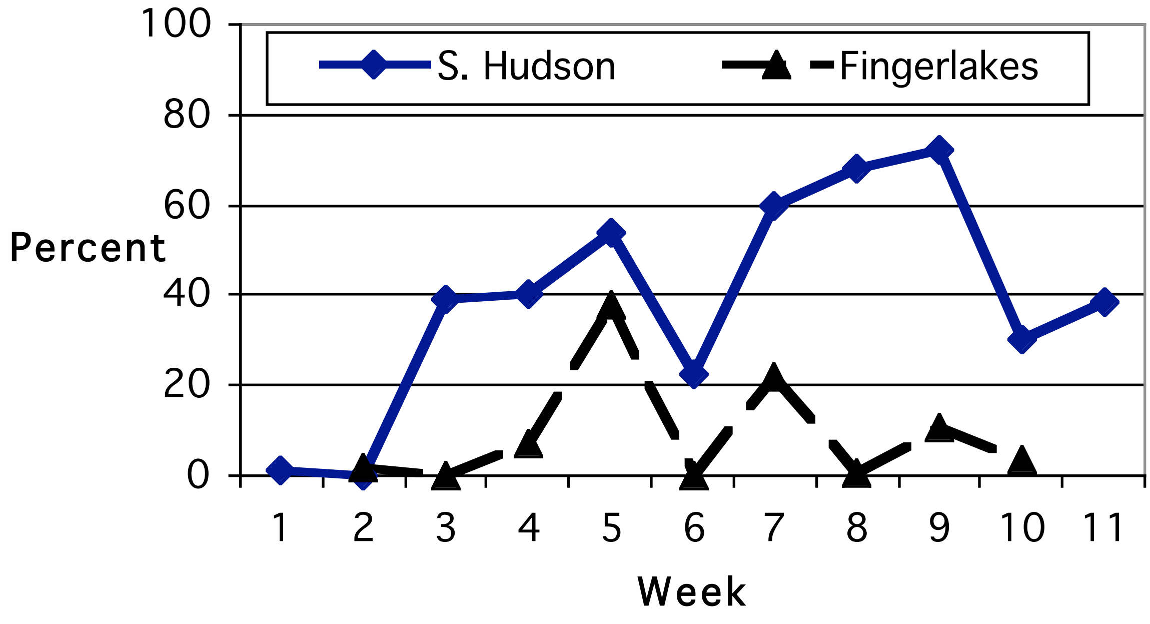

Figure 7. Seasonal prevalence of *Oc. j. japonicus* in two regions of NY as expressed as percent of the population (Week 1 = May 22, 2002).

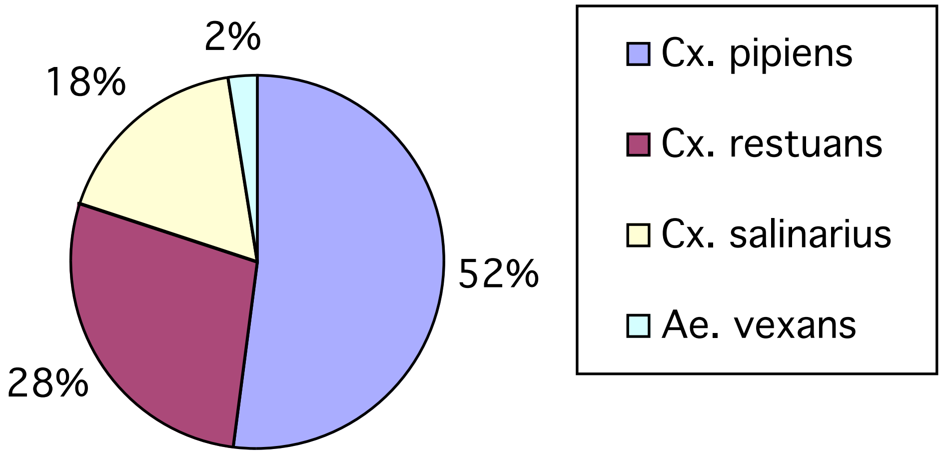

Figure 8. Adult mosquito species recovered from CO2-baited CDC traps placed near discarded tire piles at three dairies in Montgomery county, NY. Data expressed as percent of species recovered over 9-week total.

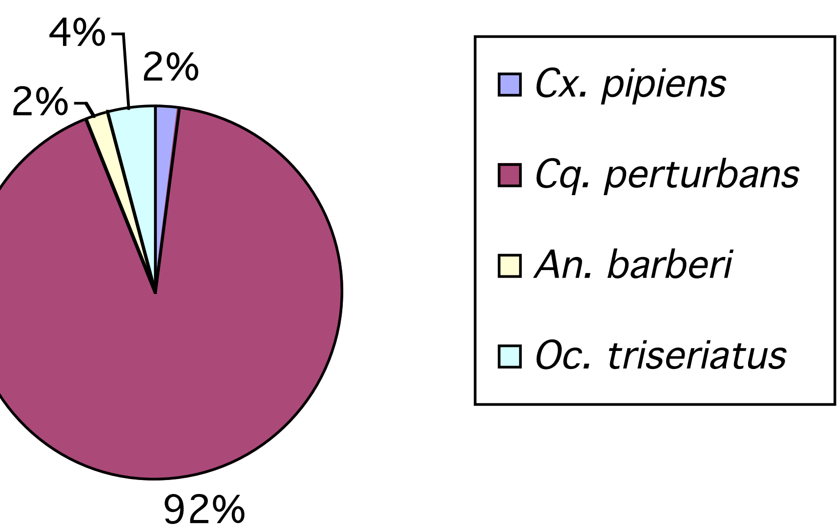

Figure 9. Adult mosquito species recovered from CO2-baited CDC traps placed near discarded tire piles at three dairies in Dutchess county, NY. Data expressed as percent of species recovered over 11-week total.

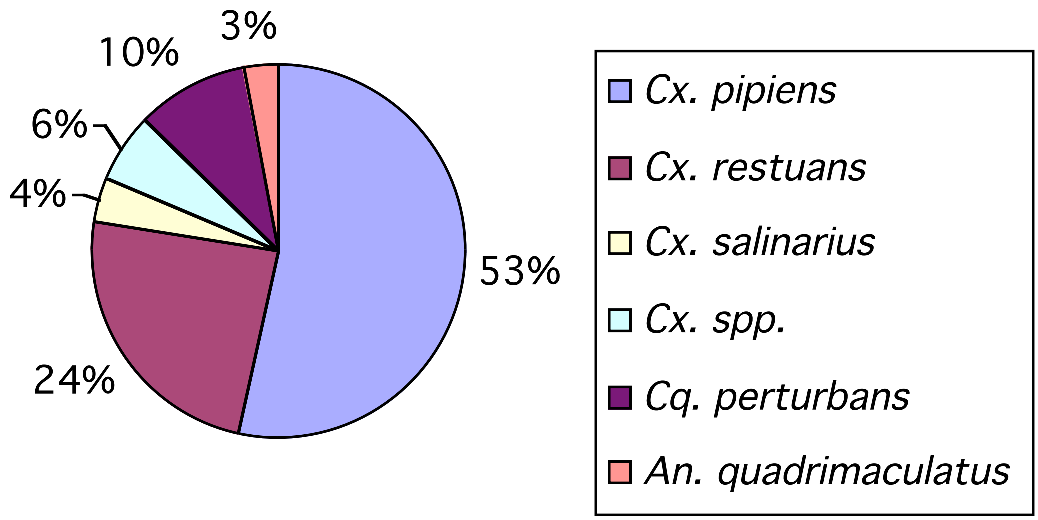

Figure 10. Adult mosquito species recovered from CO2-baited CDC traps placed near discarded tire piles at three dairies in Finger Lakes region (Tompkins, Cortland, Onondaga, Cauyga counties) of NY. Data expressed as percent of species recovered over 10-week total.

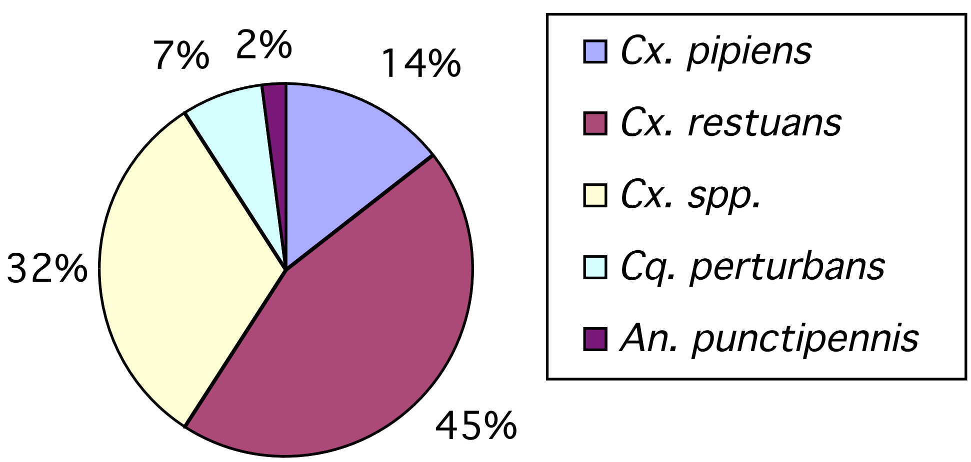

Figure 11. Adult mosquito species recovered from CO2-baited CDC traps placed near discarded tire piles at three dairies in Wyoming county, NY. Data expressed as percent of species recovered over 11-week total.