A LARVAL SURVEY OF THE MOSQUITOES OF DELAWARE COUNTY, INDIANA

R. M. KRUGER[1] AND R. R. PINGER[2]

ABSTRACT. During 1978 and 1979, mosquito larvae were collected in Delaware County, Indiana in an effort to detect any changes in the mosquito fauna since an earlier study by Siverly (1966). The total number of species identified in the current study is 24. Four new county records, *Aedes hendersoni*, *Culex tarsalis*, *Orthopodomyia alba*, and *Psorophora howardii* are reported. By comparing qualitative productivity of selected mosquito habitats it does not appear that the mosquito fauna of Delaware County has changed significantly in the interim since Siverly's study.

INTRODUCTION

The most recent intensive study of the mosquitoes of Delaware County, Indiana was made by Siverly (1966), who published an account of 27 species collected in 1964. In his 1972 publication, *Mosquitoes of Indiana*, Siverly added 5 new county records bringing the total to 32 species. The study reported here was initiated in 1978 to update Siverly's work and to serve as a foundation for the study of mosquito-borne disease problems of concern to Hoosiers, including St. Louis encephalitis (SLE), California encephalitis (CE) and heartworm disease of dogs.

In 1975, when SLE was epidemic throughout much of the United States, Indiana ranked second nationally in the number of cases confirmed with 323 cases and second in cases per capita with 6 cases per 100,000 population.[3] Encephalitis due to La Crosse virus (CE group) has also been confirmed periodically in Indiana, and this disease may be more prevalent than SLE in Delaware County. In a recent survey of 217 Delaware County residents 2.3% had antibodies to SLE virus while 2.8% had antibodies to LAC virus (P.R. Grimstad, personal communication).

Another prevalent mosquito-borne disease in Indiana is dog heartworm disease. Studies conducted at Purdue University between 1976–1979 indicated an infection rate of 6.5% in Indiana dogs (Walter Weirick, D.V.M., personal communication). Veterinary hospital records in Muncie for 1977–79 indicated that 142/5560 (2.6%) dogs tested for heartworm disease were positive (unpublished data).

The objectives of our study were: (1) determine the species of mosquitoes which occur in Delaware County, (2) detect any changes in the mosquito fauna which have occurred since earlier studies, and (3) compare the qualitative productivity of selected mosquito habitats in Delaware County, Indiana.

[1] Department of Entomology, North Dakota State University, Fargo, North Dakota.

[2] Associate Professor, Department of Physiology and Health Science, Ball State University, Muncie, Indiana.

[3] R. D. Telle, M.D. 1976. St Louis Encephalitis, Indiana-1975. Unpublished Report. Indiana State Board of Health, Indianapolis, Indiana.

METHODS

Delaware County, located in east central Indiana occupies 398 square miles of gently rolling to nearly level terrain. Elevation varies from about 800 to 1,100 ft. above sea level. Delaware County is a glaciated area with the northeastern portion of the county draining northward into the Mississinewa River and the remainder of the county draining southward into the White River. The northern part of the county contains several peat bogs and numerous depressions which may hold water for long periods of time. The major permanent body of water is 1,252 acre Prairie Creek Reservoir, located in the south-eastern portion of the county.

Larval samples were taken with a standard 460 ml white enameled dipper and a larval concentrating device. A suction meat baster was used for sampling tree holes. Larvae were transported to the Public Health Entomology Laboratory at Ball State University for species determination and in some instances, for rearing to the adult stage. Larvae were collected from April 9 to September 24, 1978 and from March 13 to August 12, 1979.

Habitats were classified as specifically as possible in order to indicate the diversity of habitats sampled. Considerable effort was made to sample sites reported in previous studies by Siverly and every effort was made to identify and frequently monitor significant production sites. It was not the intent in this study to attempt to make quantitative comparisons with Siverly's 1964 study since his data were not quantified.

RESULTS

A total of 182 samples was taken, 114 during 1978 and 68 during 1979. From these samples, 5,277 individual larvae were identified, 3,109 during 1978 and 2,168 during 1979. In addition, 3,122 identifications were made of adults reared from immature stages.

A listing of the mosquitoes found in Delaware County, by species, is given in Table 1. During the present study, 24 species were identified including *Aedes hendersoni* Cockerell, *Culex tarsalis* (Coquillett), *Orthopodomyia alba* Baker, and *Psorophora howardii* Coquillett which represent new Delaware County records. No new state records were found.

Table 2 lists the habitats of the mosquito species collected during the present study. *Cx. pipiens* Linnaeus, *Cx. restuans* Theobald, *Cx. territans* Walker, and *Anopheles punctipennis* (Say) had the

Table 1. Species of mosquitoes collected in Delaware County during 1964, 1978, and 1979 larval surveys.

Years			
1964	1978	1979	Species
*		*	*Ae. aurifer*
*	*	*	*Ae. canadensis*
	*[1]	*	*Ae. dorsalis*
*			*Ae. excrucians*
*			*Ae. fitchii*
*			*Ae. flavescens*
*			*Ae. grossbecki*
	*[2]	*	*Ae. hendersoni*
*			*Ae. sticticus*
*		*	*Ae. stimulans*
*			*Ae. thibaulti*
*	*	*	*Ae. triseriatus*
*	*	*	*Ae. trivittatus*
*	*	*	*Ae. vexans*
*	*	*	*An. barberi*
*			*An. crucians*
*	*	*	*An. punctipennis*
*	*	*	*An. quadrimaculatus*
*	*		*Cx. erraticus*
*	*	*	*Cx. pipiens*
*	*	*	*Cx. restuans*
		*[1]	*Cx. salinarius*
	*[2]		*Cx. tarsalis*
*	*	*	*Cx. territans*
*	*	*	*Cs. inornata*
*			*Cs. melanura*
	*[2]	*	*Or. alba*
*	*	*	*Ps. ciliata*
*	*		*Ps. columbiae*
*			*Ps. discolor*
		*[1]	*Ps. horrida*
	*[2]		*Ps. howardii*
*	*		*Ur. sapphirina*

[1] Reported by Siverly 1972.
[2] New county records.

Table 2. Habitats of the mosquito species collected in Delaware County, Indiana in 1978 and 1979.

Mosquito species	Habitats
Ae. aurifer	Bog
Ae. canadensis	Temporary pool (fresh)
Ae. dorsalis	Temporary pool (fresh/polluted)
	Settling pond (polluted)
	Roadside ditch (brackish)
Ae. hendersoni	Tree hole
	Tire (one individual)
Ae. stimulans	Temporary pool (fresh)
	Bog
Ae. triseriatus	Tree hole
	Tire
	Paint can
	Plastic milk jug
	Car wheel
Ae. trivittatus	Temporary pool (fresh)
	Swamp (wooded)
Ae. vexans	Temporary pool (fresh/polluted)
	Roadside ditch (fresh/polluted)
	Swamp (wooded)
	Wheel tracks
	Cattail marsh (eutrophied)
An. barberi	Tree hole
	Tire
An. punctipennis	Temporary pool (fresh)
	Roadside ditch (fresh/polluted)
	Stream (fresh/polluted)
	Cattail marsh (fresh)
	Oxbow pond (eutrophied)
	Fountain
	Beer can
	Wheel tracks
An. quadrimaculatus	Lake cove (polluted)
	Roadside ditch (fresh)
	Wheel tracks
Cx. erraticus	Lake
Cx. pipiens	Temporary pool (fresh/polluted)
	Lake cove (polluted)
	Roadside ditch (fresh/polluted)
	Stream (fresh/polluted)
	Cattail marsh (fresh/eutrophied)
	Basement of house
	Permanent pool (polluted)
	Settling pond (polluted)
	Animal burrow
	Lake
	Tire
	Coffee can
	Fountain
	Metal trash barrel
	Cardboard barrel
	Wheel tracks
Cx. restuans	Temporary pool (fresh/polluted)
	Lake cove (polluted)

Table 2. *(Continued).*

Mosquito species	Habitats
Cx. restuans	Roadside ditch (fresh/polluted)
	Stream (polluted)
	Cattail marsh (fresh/polluted)
	Oxbow pond (polluted)
	Base of house
	Tire
	Metal trash barrel
	Plastic milk jug
	Metal tub
	Cardboard barrel
	Pipe
	Wheel tracks
Cx. salinarius	Roadside ditch (polluted)
	Wheel tracks
Cx. tarsalis	Roadside ditch (fresh)
Or. abla	Tree hole
Ps. ciliata	Temporary pool (fresh)
	Wheel tracks
Ps. columbiae	Wheel tracks
Ps. horrida	Temporary pool (fresh)
Ps. howardii	Temporary pool (polluted)
Ur. sapphirina	Lake (margin)

broadest habitat range, while 15 species were found in only one or 2 types of habitats.

Various man-made containers including automobile tires appeared favorable for production of *Ae. triseriatus* (Say), *Cx. pipiens* and *Cx. restuans*. A discarded motorcycle helmet containing 1,450 ml water was found to contain about 600 larvae of *Cx. territans*. Artifacts such as wheel tracks were productive for *An. punctipennis, Ae. vexans* (Meigen), *Cx. territans, An. quadrimaculatus* Say, *Cx. pipiens, Cx. restuans, Cx. salinarius, Ps. ciliata* (Fabricius), and *Ps. columbiae* Dyar and Knab.

Table 3 presents larval associations of the species collected during the present study. *Aedes vexans, An. punctipennis, Cx. pipiens, Cx. restuans,* and *Cx. territans* were found in association with 12 or more other species. *Ae. aurifer* (Coquillett) was collected with only one other species, *Ae. stimulans* (Walker).

DISCUSSION

Some remarks relative to the weather in Delaware County seem valuable before commenting on the 1978 and 1979 surveys. The winter of 1977–78 was a very severe one with abundant snowfall and below average temperatures. Total snowfall was 46.80 inches. A late spring was noted and when the weather moderated in late March, water from snowmelt and spring rains readily filled ditches and depressions. The winter of 1978–79 was less severe with snowfall totaling 24.50 inches. Temperatures were moderate and while snowmelt and spring rains created suitable habitats it was noted that water disappeared from ditches and depressions more rapidly than the previous year.

The larvae of early spring *Aedes* species such as *Ae. stimulans*, appeared in March while the larvae of *Cx. pipiens, Cx. restuans* and *An. punctipennis* persisted into late September. Larval sampling was delayed until early April in 1978 but commenced as soon as ice broke in March of 1979. This partially explains the absence of *Ae. stimulans* in the 1978 survey. Exhaustive searching for the larvae of *Ae. sticticus* (Meigen) was futile, yet the investigators frequently collected biting adults of this species well into the summer.

Table 3. Larval mosquito associations found in 1978 and 1979 surveys.

Associated species	No. of associations	Mosquito species																						
		Ae. aurifer	*Ae. canadensis*	*Ae. dorsalis*	*Ae. hendersoni*	*Ae. stimulans*	*Ae. triseriatus*	*Ae. trivittatus*	*Ae. vexans*	*An. barberi*	*An. punctipennis*	*An. quadrimaculatus*	*Cx. erraticus*	*Cx. pipiens*	*Cx. restuans*	*Cx. salinarius*	*Cx. tarsalis*	*Cx. territans*	*Cs. inornata*	*Or. alba*	*Ps. ciliata*	*Ps. columbiae*	*Ps. horrida*	*Ps. howardii*	*Ur. sapphirina*
Ae. aurifer	1					X																		
Ae. canadensis	6					X			X		X				X			X	X					
Ae. dorsalis	3								X					X	X									
Ae. hendersoni	4						X			X					X					X				
Ae. stimulans	3	X	X						X															
Ae. triseriatus	5				X					X				X	X					X				
Ae. trivittatus	7								X					X	X			X	X		X		X	
Ae. vexans	15		X	X		X		X			X	X		X	X	X		X	X	X	X	X	X	X
An. barberi	5				X		X							X	X					X				
An. punctipennis	13		X						X			X		X	X	X	X	X	X		X	X	X	X
An. quadrimaculatus	6								X		X			X	X		X					X		
Cx. erraticus	2													X				X						X
Cx. pipiens	17			X			X	X	X	X	X	X	X		X	X	X	X	X		X		X	X	X
Cx. restuans	14		X	X	X		X	X	X	X	X	X		X		X		X	X		X				
Cx. salinarius	5								X		X			X	X			X						
Cx. tarsalis	4										X	X		X				X						
Cx. territans	12							X	X		X		X	X	X	X	X				X	X		X
Cs. inornata	7		X					X	X		X			X	X						X			
Or. alba	3				X		X			X														
Ps. ciliata	8							X	X		X			X	X			X	X				X	
Ps. columbiae	4								X		X	X						X						
Ps. horrida	5							X	X		X			X							X			
Ps. howardii	3								X		X			X										
Ur. sapphirina	3												X	X				X						

Four new county records were established during the present study. *Orthopodomyia alba* was collected from a tree hole on the campus of Ball State University. Water in this tree hole contained large amounts of decaying organic debris and was the color of dark tea. *Or. alba* was found in association with *Ae. triseriatus, Ae. hendersoni*, and *An. barberi* Coquillett. *Ae. hendersoni* was initially collected from the same tree hole mentioned above. This species was subsequently taken at several other sites in Delaware County. All individuals were collected from three holes except for a single individual recovered from a tire. One individual of *Ps. howardii* Coquillett was collected from a small highly polluted seepage pool at a food processing plant. This individual was taken in association with numerous other species in the same pool. One *Cx. tarsalis* (Coquillett) larva was collected in an exposed grassy roadside ditch. Adults were taken in light traps in the same area by another investigator.

The data suggest that *An. punctipennis, Cx. pipiens, Cx. restuans,* and *Cx. territans* tolerate a wide range in habitats. Tree hole species, *Psorophora* species, *Ae. aurifer, Ae. canadensis* (Theobald), *Ae. stimulans, Ae. trivittatus* (Coquillett), *Cx. erraticus* (Dyar and Knab), *Cx. tarsalis*, and *Uranotaenia sapphirina* (Osten-Sacken) were collected in very restricted habitats.

The effects of human activities on both the occurrence and abundance of larvae

were evident at a food processing plant where settling ponds and seepage pools supported massive production of *Cx. pipiens, Ae. vexans,* and *Ae. dorsalis* (Meigen). The recently constructed Prairie Creek Reservoir provides a high production potential because of numerous coves, cattail marshes, and temporary pools around the edges of the lake. Species collected in 20% or more of the survey samples included *Ae. vexans, An. punctipennis, Cx. pipiens, Cx. restuans,* and *Cx. territans.*

It does not appear that the mosquito fauna of Delaware County has changed significantly in the 14-year interim since Siverly's study. In some respects it is difficult to make comparisons since Siverly's larval sampling was concentrated in April and May of a single year while the present study covered a period of 12 months over a 2 year span. Also, Siverly's study involved a total of 51 larval surveys whereas the present study resulted in 182 samples.

Siverly's study reported a total of 26 species of mosquitoes collected in the immature stages. The present study yielded 24 species. Species collected by Siverly but not collected during the present study included *Ae. excrucians* (Walker), *Ae. fitchii* (Felt and Young), *Ae. flavescens* (Muller), *Ae. grossbecki* Dyar and Knab, *An. crucians* Weidemann, *Cs. melanura* (Coquillett), *Ae. sticticus, Ae. thibaulti* Dyar and Knab, and *Ps. discolor* (Coquillett). Species collected during the present study but not by Siverly included *Ae. hendersoni, Cx. salinarius, Cx. tarsalis, Or. alba, Ps. horrida* (Dyar and Knab), and *Ps. howardii.*

Major production sites studied by Siverly were still present and productive during the present study. One new production site was noted during the current study, that being Prairie Creek Reservoir. Siverly indicated that the larvae of *Ae. triseriatus, An. punctipennis, Cx. restuans,* and *Ur. sapphirina* were "common." We collected the former three species in 18%, 20% and 29% of the samples respectively. However, *Ur. sapphirina* was collected only one time. Siverly described the larvae of *Cx. territans, Cx. pipiens, Ae. vexans,* and *Ae. stimulans* as "abundant." We collected these species in 25%, 32%, 20% and 12% of the samples respectively.

Orthopodomyia alba and *Ae. hendersoni* have probably been present for some time in Delaware County. Although this is the first published record of them, Siverly had found them before (Donald Shroyer, personal communication).

The significance of finding a single larva of *Cx. tarsalis* in 1978 is difficult to measure. A number of adults were collected in light traps in 1978, but none in 1979. It is interesting to read Siverly's 1972 distribution account in which he states that this species appeared more common in earlier years than in those immediately preceding the 1972 publication date. Apparently, *Cx. tarsalis* expands and contracts its range depending upon environmental factors. Although there is not evidence from our study to suggest that *Cx. tarsalis* is expanding its range permanently, future surveillance activities may yield such evidence.

The extensive and intensive mosquito production in Delaware County is an annoyance to local residents and has implications for their health and the health of their pets. Human and animal serological surveys have established the presence of recent infections with SLE virus, several members of the CE virus group and western equine encephalomyelitis virus in the county. Recently, citizens have become aware of the fact that dog heartworm is a problem in Delaware County. This larval survey will serve as a foundation for further investigation into vector biology associated with these health problems.

ACKNOWLEDGMENTS. We wish to thank Alice K. Thomas for aiding in the identification of adult specimens reared from immature stages and for field assistance in the collection of larvae.

References Cited

Siverly, R. E. 1966. Mosquitoes of Delaware County, Indiana. Mosq. News 29:221–229.

Siverly, R. E. 1972. Mosquitoes of Indiana, Indiana State Board of Health, Indianapolis, Indiana. 126 p.