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A Key to Container-Breeding Mosquitoes of Michigan (Diptera: Clllcidae), With Notes on Their Biology

Thomas R. Wilmot
Midland County Mosquito Control

Deborah S. Zeller
Eastern Michigan University

Richard W. Merritt
Michigan State University

A KEY TO CONTAINER-BREEDING MOSQUITOES OF MICHIGAN (DIPTERA:CULICIDAE), WITH NOTES ON THEIR BIOLOGY

Thomas R. Wilmot[1], Deborah S. Zeller[2] and Richard W. Merritt[3]

ABSTRACT

An illustrated key to larvae and notes on the biology of container-breeding mosquitoes of Michigan are presented. Two species included in the key, *Aedes aegypti* and *Aedes albopictus*, are not endemic in Michigan, but occasional introductions could occur with commercial shipments of scrap tires or other containers.

Many container-breeding mosquito species are potential vectors of human disease agents in Michigan. *Aedes triseriatus* (Say), the most important vector of La Crosse Encephalitis virus, and *Culex pipiens* L. and *Culex restuans* Theobald, potential vectors of St. Louis Encephalitis virus, develop in natural and artificial containers.

Discarded tires may produce large populations of mosquitoes and are particularly important as a risk factor for mosquito-borne disease. Accumulations of tires have been directly and specifically associated with human cases of La Crosse Encephalitis in Wisconsin (Parry 1983), Minnesota (Hedberg et al. 1985) and other states. Reiter and Sprenger (1987) demonstrated that the used tire trade has been a major factor in the establishment and disperal in the United States of *Aedes albopictus* (Skuse), a potential vector of several disease agents.

Public health and mosquito control personnel in Michigan are developing expanded programs of surveillance of tires for mosquito larvae. Identification keys for mosquito larvae are available (Darsie and Ward 1981), however, these include species not commonly found in Michigan containers and do not include *A. albopictus*. This report presents an illustrated key to larvae of mosquitoes known to inhabit artificial containers in Michigan plus two exotic species of potential concern, *Aedes aegypti* (L.) and *A. albopictus*. *Wyeomyia smithii* (Coquillett), which is found only in leaves of pitcher plants, and *Toxorhynchites rutilus septentrionalis* (Dyar and Knab), which occurs through the southeastern United States to as far north as Indiana and Ohio, are not included in the key. The key is designed specifically for Michigan, but could be used throughout much of the north central U.S.

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[1]Midland County Mosquito Control, 2180 N. Meridian, Sanford, MI 48657.
[2]Department of Art, Eastern Michigan University, Ypsilanti, MI 48197.
[3]Department of Entomology, Michigan State University, East Lansing, MI 48824.

MORPHOLOGY

The terminology used here follows that of Harbach and Knight (1980). The body of a mosquito larva is divided into three distinct regions: head, thorax and abdomen (Figure 1). The thorax is composed of fused pro-, meso- and metathorax which are distinquished by series of bilaterally paired setae. The abdomen is composed ot ten segments, of which nine are apparent. The first seven abdominal segments are similar and unmodified. The posterior segments are functionally specialized and provide many useful taxonomic characters (Figure 1). The eighth segment of most mosquito larvae bears a series of projections known as the **comb scales** laterally and an elongate **siphon** dorsally. At the base of the siphon is a small lateral sclerite, the **siphon acus**. In most species the siphon bears a comb-like row of spines, the **pecten**. The final segment, referred to as the tenth abdominal segment or the anal segment, possesses a sclerotized **saddle** dorsally. The **anal papillae** are soft elongate structures surrounding the anus. Setae of mosquito larvae are numbered sequentially for each body region. For example, seta number 5 on the head capsule (cranium) is designated 5-C and seta number 1 on the tenth abdominal segment is designated 1-X. The abbreviations used in setal designation are as follows:

Cranium	C
Prothorax	P
Mesothorax	M
Metathorax	T
Siphon	S
Abdominal Segments	I, II, . . . X

KEY TO THE MOSQUITO LARVAE (FOURTH INSTAR) OF MICHIGAN CONTAINERS

1	Siphon absent (Fig. 2) (Genus *Anopheles*)	2
1'	Siphon present (Fig.1)	3
2(1)	Setae 5-C, 6-C and 7-C short, simple (Fig. 3)	*Anopheles barberi*
2'	Setae 5-C, 6-C and 7-C long, multibranded (Fig. 4)	*Anopheles punctipennis/A. quadrimaculatus*
3(1')	Siphon without pecten spines (Figs. 5, 6) (Genus *Orthopodomyia*)	4
3'	Siphon with pecten spines (Figs. 7, 8b)	5
4(3)	Seta 1-S usually with 6 or more branches, much longer than basal width of siphon; with large tergal plate on abdominal segment VIII (Fig. 5)	*Orthopodomyia signifera*
4'	Seta 1-S usually with 3 or 4 branches, subequal to basal width of siphon; without tergal plate on abdominal segment VIII (Fig. 6)	*Orthopodomyia alba*
5(3')	Siphon with pair of setae arising near base (with or without setae beyond base) (Fig. 7) (Genus *Culiseta*)	*Culiseta inornata*
5'	Siphon with one or more pair of setae but never arising near base (Figs. 8b, 11)	6
6(5')	Siphon with several pairs of setae (Figs. 8b, 9b, 10) (Genus *Culex*)	7
6'	Siphon with a single pair of setae, setae arising near midsiphon (Figs. 11–15) (Genus *Aedes*)	9
7(6)	Setae 5-C and 6-C single or double (Fig. 8a); Siphon long and slender (Fig. 8b)	*Culex territans*
7'	Setae 5-C and 6-C with three or more branches (Fig. 9a)	8

8(7') Siphon usually with 4 pair of setal tufts, tufts generally in a line but with apical or subapical pair out of line; Seta 2-X usually with two or three branches (Fig. 9b) ..... *Culex pipiens*

8' Siphon with several irregularly-placed single hairs, perhaps one or two pair of setae tufted; Seta 2-X usually single (Fig. 10) ..... *Culex restuans*

9(6') Seta 1-S inserted within pecten; Comb scales 24 to 90 (usually more than 34) in a patch, individual comb scale short with subequal spinules; siphon short and blunt (Fig. 11) .... *Aedes atropalpus*

9' Seta 1-S beyond pecten; Comb scales 6–15 in a single or irregular double row; Individual comb scales variable (Figs. 12–15) ... 10

10(9') Comb scale blunt apically, evenly fringed with short spinules; siphon acus present (Figs. 12, 13) 11

10' Comb scale thorn-like, with pointed median spine; siphon without acus (Figs. 14, 15) 12

11(10) Siphon acus attached or near to main sclerite; anal papillae relatively short and tapered, ventral pair shorter than dorsal; Seta 1-X usually with four or more branches (Fig. 12) ..... *Aedes triseriatus*

11' Siphon acus detached from main sclerite; Anal papillae bulbous, subequal in size; Seta 1-X usually with one to three branches (Fig. 13) ..... *Aedes hendersoni*

12(10') Comb scale with strong subapical spinules (Fig. 14) ..... *Aedes aegypti*

12' Comb scale with fringe of fine spinules basally (Fig. 15) ..... *Aedes albopictus*

BIOLOGICAL NOTES

***Aedes (Ochlerotatus) atropalpus* (Coquillett)**

Aedes atropalpus occurs from southern Canada through the eastern United States. In Michigan, it is most commonly taken along the upper peninsula shores of Lakes Superior and Michigan. Eggs may be deposited on the sides of cavities or singly on the surface of the water, thus this species is able to survive winter and periods of drought in the egg stage and to quickly colonize new habitats (Berry and Craig 1984). Larvae are usually found in rock crevices and rock-filled pools but may inhabit tires and other artificial containers. Adults are autogenous and have been maintained in culture for several generations without a blood meal. This species is seldom abundant but may be of concern locally. *Aedes atropalpus* is a potential vector of La Crosse virus (Craig 1983) and it is capable of transmitting Eastern Equine Encephalomyelitis and Western Equine Encephalomyelitis viruses (Zavortink 1972).

***Aedes (Protomacleaya) hendersoni* Cockerell**

Aedes hendersoni is the most widespread treehole-breeding mosquito in North America (Zavortink 1972), however, it is much less common in tires than is *Aedes triseriatus*. Adults of these sibling species are difficult to separate morphologically, but larvae are distinctive. Live *A. hendersoni* larvae are easily distinquished from those of *A. triseriatus* by their lighter color. Eggs are the overwintering stage and are deposited on the sides of containers just above the water line. *Aedes hendersoni* is biologically capable of transmitting the nematode *Dirofilaria immitis* (Rogers and Newson 1979), but its definitive role in the transmission of dog heartworm in Michigan is unknown. It is probably not an effective vector of La Crosse Encephalitis virus (DeFoliart et al. 1986).

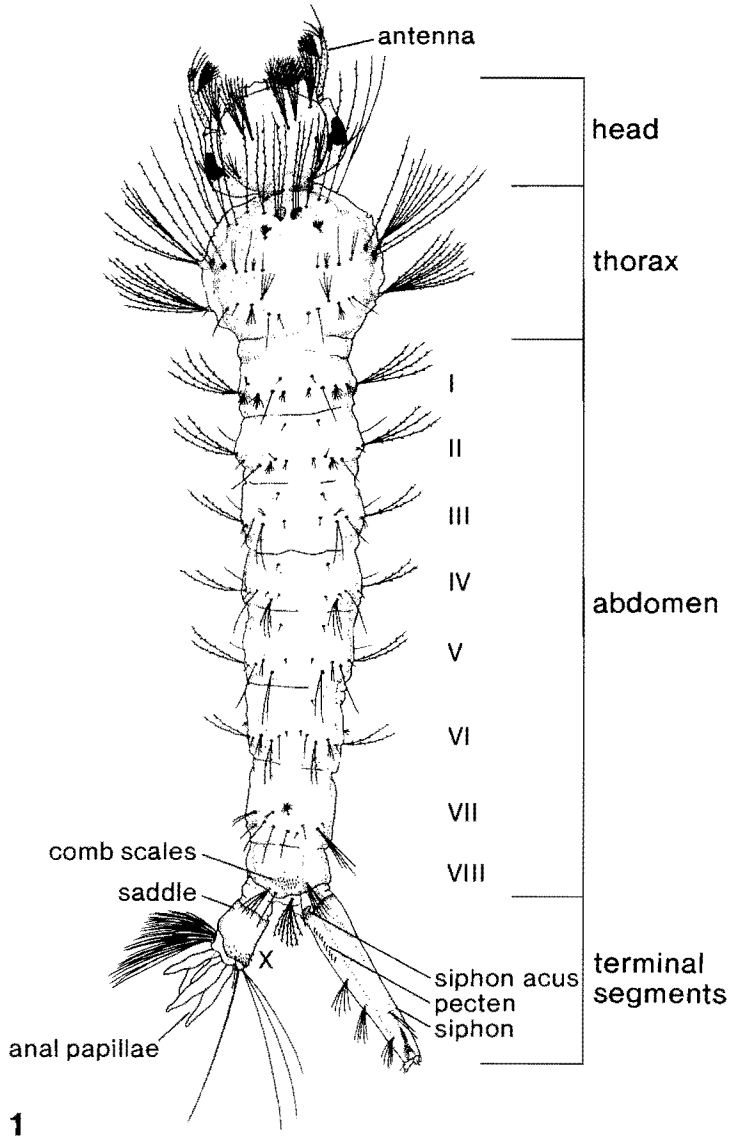
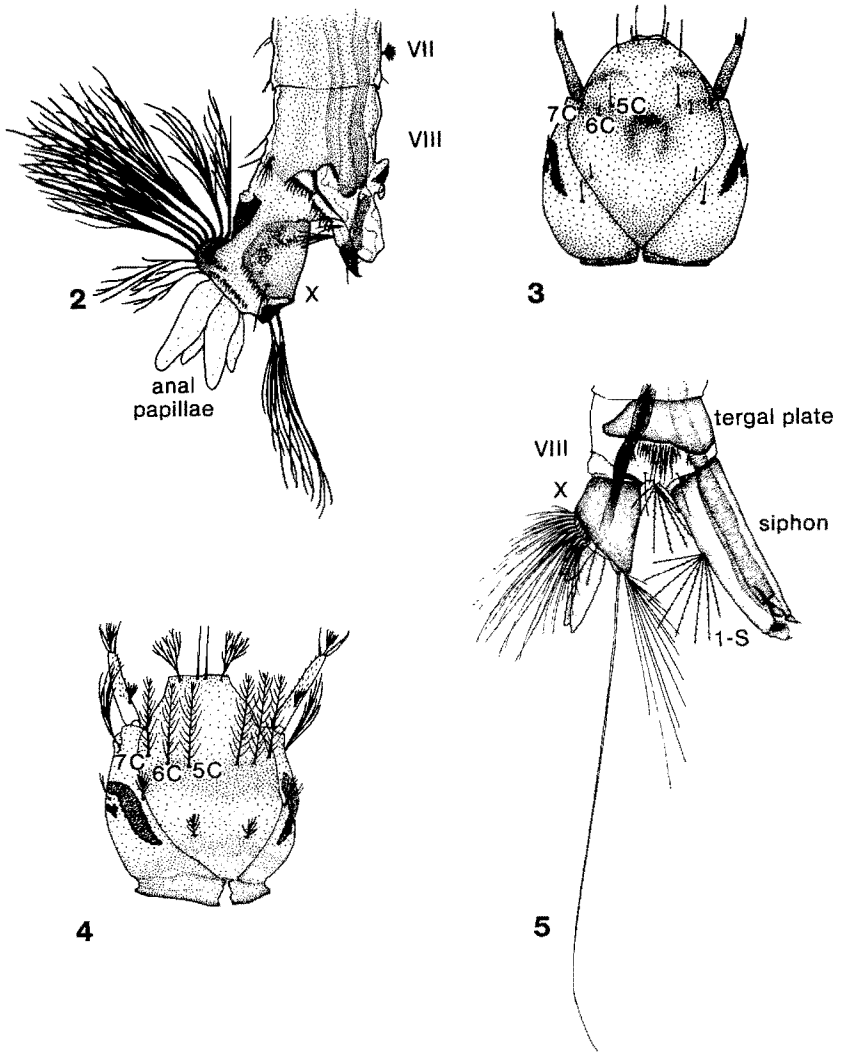
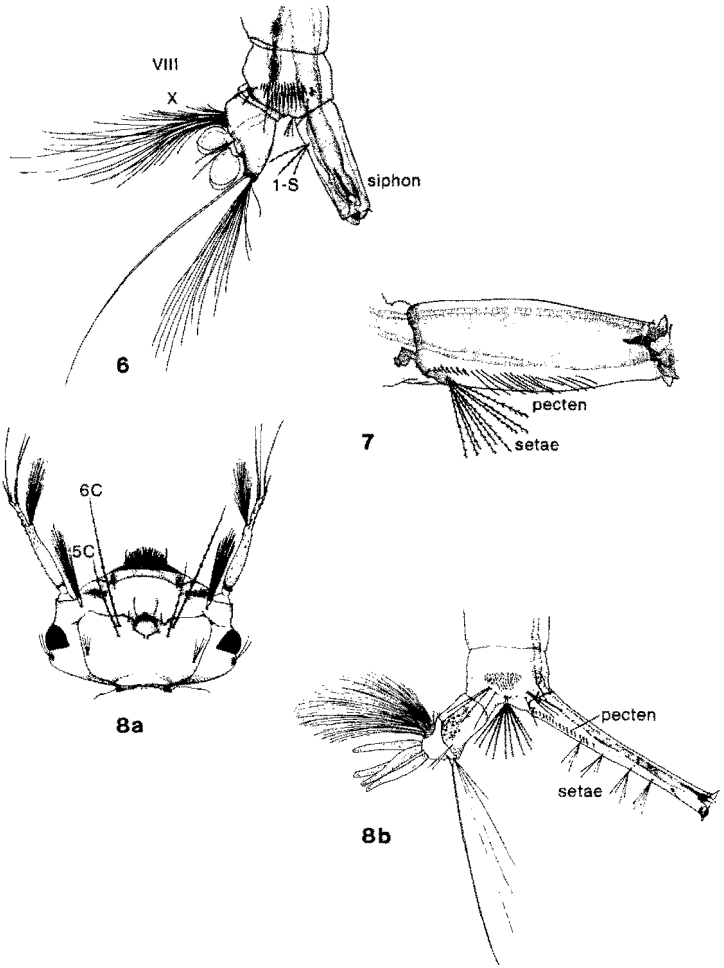


Figure 1. *Culex pipiens* larva; dorsal view.



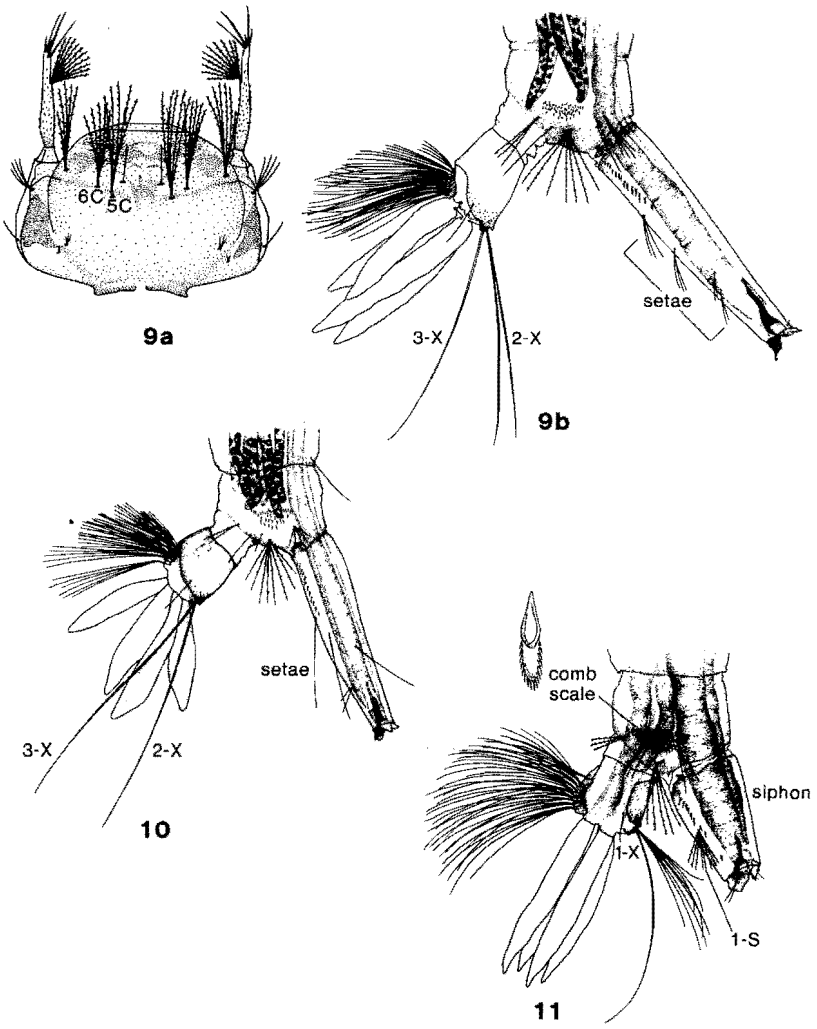
Figures 2–5: 2. Anopheline larva; lateral view of terminal abdominal segments. 3. *Anopheles barberi*; dorsal view of head. 4. *Anopheles punctipennis*; dorsal view of head. 5. *Orthopodomyia signifera*; lateral view of terminal abdominal segments.



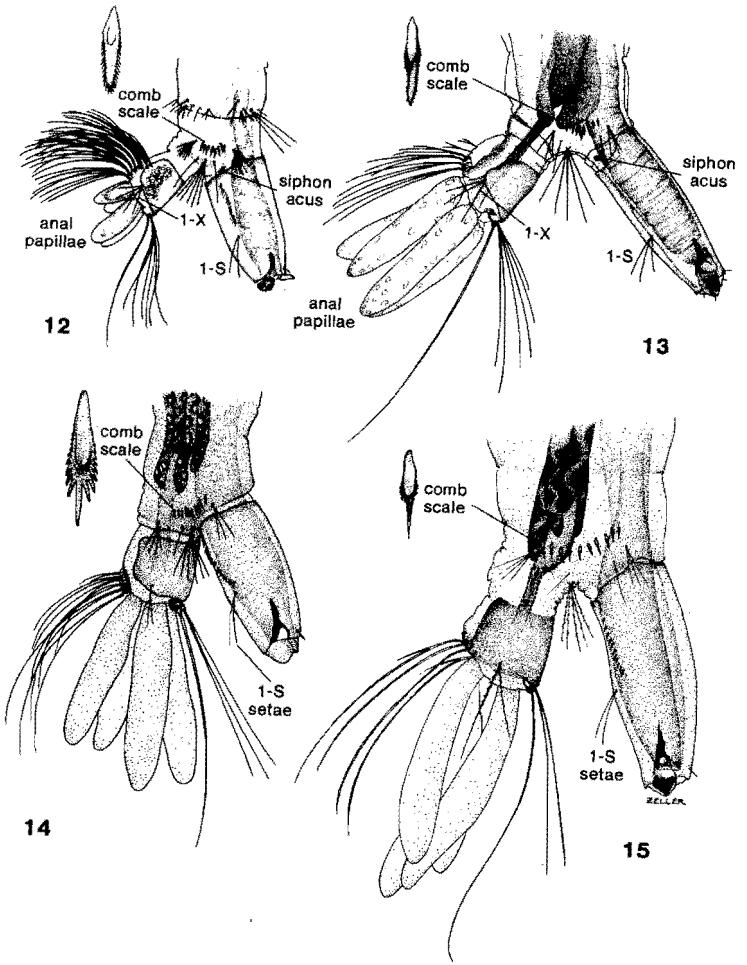
Figures 6–8: 6. *Orthopodomyia alba*; lateral view of terminal abdominal segments. 7. *Culiseta inornata*; lateral view of siphon. 8a. *Culex territans*; dorsal view of head; 8b. lateral view of terminal abdominal segments.

***Aedes (Protomacleaya) triseriatus* (Say)**

Aedes triseriatus is distributed throughout the eastern United States. It is one of the most common species seen in tires and other artificial containers in Michigan. Eggs are deposited on the sides of containers, just above the water line, and the winter is passed in the egg stage. Larvae are most common in treeholes with decaying vegetation (i.e. leaf litter) (Walker et al. 1991) and in shaded areas. *Aedes triseriatus* is the most important vector of La Crosse Encephalitis virus in the midwest and may be an important vector of dog heartworm in Michigan (Rogers and Newson 1979). DeFoliart (1983) and Craig



Figures 9–11: 9a. *Culex pipiens*; dorsal view of head; 9b. lateral view of terminal abdominal segments. 10. *Culex restuans*; lateral view of terminal abdominal segments. 11. *Aedes atropalpus*; lateral view of terminal abdominal segments.



Figures 12–15: 12. *Aedes triseriatus*; lateral view of terminal abdominal segments. 13. *Aedes hendersoni*; lateral view of terminal abdominal segments. 14. *Aedes aegypti*; lateral view of terminal abdominal segments. 15. *Aedes albopictus*; lateral view of terminal abdominal segments.

(1983) have recently reviewed the biology of this species as it relates to disease transmission and control.

***Aedes (Stegomyia) aegypti* (Linnaeus)**

Aedes aegypti is a highly domestic mosquito found throughout the tropical regions of the world and extending into temperate areas seasonally. It is not endemic in Michigan, but it could be introduced and survive the summer months. Eggs are laid singly just above the water line and can withstand

desiccation for several months with little if any reduction in vigor. Larvae are commonly seen in fairly clean water. They are unable to survive prolonged exposure to temperatures above 40° or below 10° C. *Aedes aegypti* is the most important vector of dengue and urban yellow fever throughout much of the world. Christophers (1960) presented an extensive review of the biology of this species.

***Aedes (Stegomyia) albopictus* (Skuse)**

Aedes albopictus is found throughout the Oriental Region and in parts of the United States, Mexico and Brazil. It is not yet known from Michigan, but it has been found in Illinois, Indiana and Ohio. *Aedes albopictus* has been well studied in Asia and considerable variation in biology with different strains has been observed. Hawley et al. (1987) suggest that the strains which have been introduced into the U.S. are probably from Japan.

Aedes albopictus colonizes a wider range of containers than does *A. aegypti*, and is therefore less susceptible to source reduction programs. Eggs are deposited on the sides of containers just above the water line. This species is an important vector of dengue virus in Southeast Asia. It can transmit dog heartworm and could potentially become involved in the transmission of La Crosse Encephalitis virus in the United States. Hawley (1988) has recently reviewed the biology of this species.

***Anopheles (Anopheles) barberi* Coquillett**

Anopheles barberi is widespread throughout the eastern United States. In Michigan, it occurs at least as far north as the central lower peninsula (Wilmot et al. 1987). *Anopheles barberi* prefers large permanent treeholes, but it may be collected from tires. Eggs are laid singly on the surface of the water. Larvae are facultative predators and are seldom taken in large numbers. This species overwinters as larvae in Michigan (Allen and Wilmot 1988), and the first adults emerge during late May or early June. Adults will feed on humans, but populations are seldom large and this species is not an important disease vector.

***Anopheles (Anopheles) punctipennis* Say**

Anopheles punctipennis is the most widely distributed anopheline in the U.S. and is found throughout Michigan. Hibernation is by adult females and oviposition begins in early spring. Eggs are laid singly on the surface of the water. *Anopheles punctipennis* larvae are found in a variety of habitats including streams, ponds and marshes. They prefer cool, unpolluted water and are less commonly taken from tires than are those of *A. quadrimaculatus*. *Anopheles punctipennis* is capable of transmitting dog heartworm and malaria, but is seldom seen in large enough numbers to be of serious concern. In Michigan, this species may be an important vector of Jamestown Canyon virus (DeFoliart et al. 1986).

***Anopheles(Anopheles) quadrimaculatus* Say**

Anopheles quadrimaculatus is widespread throughout the eastern U.S. and is the most common anopheline in Michigan containers. However, it is uncommon in tires. Hibernation is by adult females, and eggs are laid singly on the water surface. Larvae are found primarily in impounded water habitats with floating debris and vegetation. *Anopheles quadrimaculatus* was the primary vector of human malaria when that disease was endemic in the eastern U.S. This species also may be involved in the tranmission of Jamestown Canyon virus in Michigan (DeFoliart et al. 1986). Larvae of *A. quadrimaculatus* and *A. punctipennis* are difficult to dinstinquish morphologically.

***Culex (Culex) pipiens* Linnaeus**

Culex pipiens is the most widely distributed of all mosquitoes and it is one of the most common species in Michigan tires. Hibernation is as adult females, and eggs are laid together as rafts on the water surface. Larvae thrive in water of high organic content. Significant variation has been observed in adult feeding preference with different strains and subspecies and it is unknown if this species will feed on humans in Michigan. Autogeny has been reported from many temperate areas and avian hosts are usually preferred by those females seeking a blood meal. In areas where it will feed on humans, this species is a potential vector of St. Louis Encephalitis virus, Western Equine Encephalomyelitis virus and dog heartworm.

***Culex (Culex) restuans* Theobald**

Culex restuans is widely distributed in North America and very common in Michigan tires. Hibernation is as adult females. Eggs are laid together as rafts on the surface of the water. Larvae are found in a wide variety of habitats including ditches, flooded fields, ponds and containers. There is some question concerning adult feeding preferences and vector capacity of this species which may be due, in part, to the difficulty in separation of field collected adults of the subgenus *Culex*. However, this species should be considered a potential vector of St. Louis Encephalitis virus, Western Equine Encephalomyelitis virus and dog heartworm.

***Culex (Neoculex) territans* Walker**

Culex territans is widely distributed across Canada, the United States and Mexico. This species can be found throughout Michigan, but it is not commonly seen in tires. Larvae prefer cool clear water and are found predominantly in streams, swamps and marshes. Eggs are laid in rafts along the edge or on the surface of the water. Adults are very resistant to cold and winter is passed in this stage. Adults feed primarily on cold-blooded animals and are not important vectors of human disease.

***Culiseta (Culiseta) inornata* (Williston)**

Culiseta inornata is found in much of the Nearctic Region from Canada to northern Mexico. This is the most abundant species of the genus *Culiseta* in Michigan, but it is rarely seen in tires. Larvae prefer cold water and are more commonly found in swamps, marshes and flooded fields. Eggs are laid in rafts on the water surface. Adults feed primarily on large animals. *Culiseta inornata* has been found infected with Western Equine Encephalomyelitis virus, Eastern Equine Encephalomyelitis virus and Jamestown Canyon virus, but it seldom occurs in sufficient numbers to be considered an important disease vector.

***Orthopodomyia alba* Baker and *Orthopodomyia signifera* (Coquilett)**

Orthopodomyia alba and *O. signifera* are found throughout the eastern Unites States. Scattered populations of *O. signifera* occur in southwestern states. *Orthopodomyia alba* was the predominant mosquito species in a survey of treeholes in northern Indiana (Copeland 1984), but larvae primarily inhabit treeholes and wooden containers and neither species is common in Michigan tires. Live *O. alba* larvae are easily distinquished from those of *O. signifera* by their lighter color. Eggs are laid singly on the edge of containers or onto the water surface. Larvae are extremely tolerant of cold (Copeland and Craig 1990), and hibernation is in the larval stage. Adults prefer to feed on birds and are not known to attack man. *Orthopodomyia signifera* may play some role in enzootic maintenance of Eastern Equine Encephalomyelitis virus.

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