

# A Mosquito *Culex cedecei* Stone and Hair (Insecta: Diptera: Culicidae)<sup>1</sup>

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*The Featured Creatures collection provides in-depth profiles of insects, nematodes, arachnids and other organisms relevant to Florida. These profiles are intended for the use of interested laypersons with some knowledge of biology as well as academic audiences.*

## Introduction

*Culex cedecei* is a mosquito endemic to Florida, and a member of the Spissipes section of the subgenus *Melanoconion* of *Culex*. Several members of the Spissipes section are important vectors of enzootic subtypes of Venezuelan equine encephalitis virus (VEEV). Everglades virus (EVEV) is subtype II of VEEV in Florida, for which *Culex cedecei* is the primary enzootic vector. *Culex cedecei* is typically found in forested wetlands of southern Florida, ranging from mangrove swamps to hardwood hammocks and lowland pine ecosystems (Hoyer et al., 2019). Larvae of *Culex cedecei* develop in limestone solution holes, and abandoned crab burrows in a variety of habitats. Although *Culex cedecei* is not generally considered a pest of humans, it feeds primarily on muroid rodents (rats and mice), which are important hosts of EVEV in Florida. *Culex cedecei* is therefore considered a vector of a zoonotic pathogen that can affect human health.

## Synonymy

*Culex opisthopus* Komp, 1926

*Culex taeniopus* Dyar and Knab, 1907

*Culex annulipes* Belkin, 1969

## Taxonomy

The taxonomic history of *Culex cedecei* is complicated, and at various times, *Culex cedecei* has been considered a synonym of *Culex annulipes* (Pratt et al. 1945), *Culex opisthopus* (Pratt et al. 1945), and *Culex taeniopus* (Sirivanakarn and Belkin 1980). *Culex cedecei*, *Culex taeniopus*, *Culex akritos*, and *Culex ikelos* are members of the *Taeniopus* group in the Spissipes section of the subgenus *Melanoconion* (Sallum and Forattini, 1996). Stone and Hair (1968) originally proposed the name *Culex cedecei* for all Florida populations of *Culex opisthopus*, citing a lack of pale bands on the tarsi in Florida populations. However, Sirivanakarn and Belkin synonymized *Culex opisthopus* with *Culex taeniopus* in 1980, shortly before Dziem and Cupp (1983) restored the name *Culex cedecei* to Florida populations. This decision was based upon cross-mating studies which revealed difficulty in mating between Florida populations and Guatemalan *Culex taeniopus* populations, indicating that the different populations were different species.

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## Distribution

*Culex cedecei* is only known to occur in Florida, particularly the southern half of the Florida peninsula. It is reported from fifteen counties in Florida, including Orange, Polk, Brevard, Indian River, St. Lucie, Martin, Palm Beach, Broward, Miami-Dade, Monroe, Collier, Lee, Charlotte, Sarasota, and Manatee Counties (Figure 1) (West et al., 2020; Darsie and Morris, 2005).

## Habitat

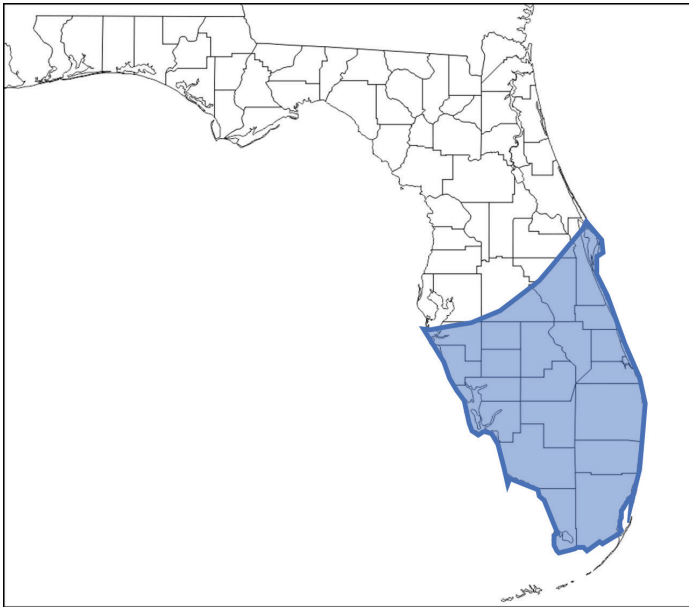


Figure 1. Map of Florida, USA, indicating the approximate distribution of *Culex cedecei*, according to Darsie and Ward (2005).

*Culex cedecei* can be found in a variety of habitats in South Florida but is most commonly found in various forested wetland habitats, including hardwood hammock, mangrove swamp and pine lowlands (Hoyer et al., 2019). Larvae are aquatic and have been described from limestone solution holes, abandoned crab burrows, and hollowed out tree-stumps (Pratt et al., 1945).

## Description

### Eggs

Eggs of *Culex cedecei* are laid together in rafts either on the surface of water or on the sides of containers (Blosser and Burkett-Cadena, 2017) and have been observed containing from 22-147 eggs per raft in laboratory colonies (Dziem and Cupp, 1983). Shape of the rafts vary but have most commonly been described as hexagonal or oval in shape (Figure 3). Eggs of *Culex cedecei*, and other mosquitoes, are white when newly laid and turn black once sclerotized

(Figure 3), typically 1-2 hours after being laid. Eggs of *Culex cedecei* hatch 1-2 days after being laid.

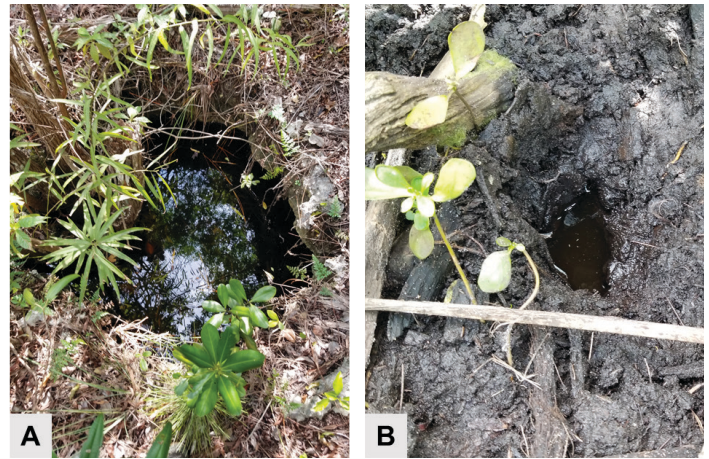


Figure 2. Limestone solution holes (A) and abandoned land crab burrows (B) are reported habitats of the larvae of *Culex cedecei*. Credits: Kristin Sloyer, UF/IFAS

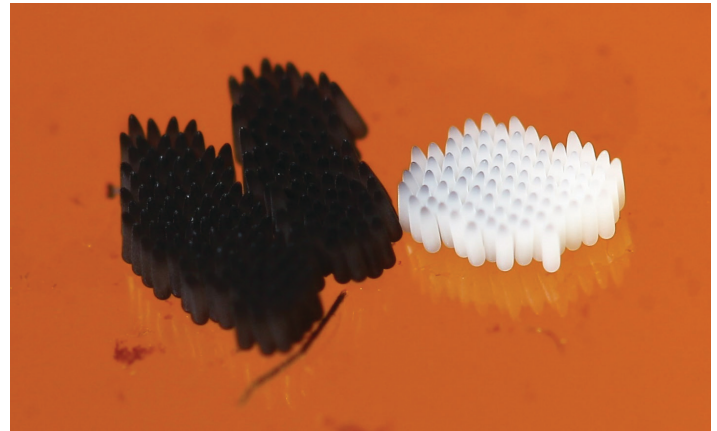


Figure 3. Three egg rafts of *Culex cedecei* Stone and Hair. The two black rafts have sclerotized whereas the white raft was laid more recently and is not yet sclerotized. Credits: Kristin Sloyer, UF/IFAS

### Larvae

Larvae of *Culex cedecei* are small and typically dark brown in color (Figure 4). The head is wider than it is long and seta 6-C is unbranched or with two branches (Figure 5). The antennae of *Culex cedecei* larvae are entirely dark in color, a feature that is unique among members of the subgenus *Melanoconion* in Florida (Figure 4, 5). Seta 7-I is double, which is a useful distinguishing feature of this species. On abdominal segment VIII, all comb scales are more or less evenly fringed with subequal spinules (Darsie and Ward, 2005). The respiratory siphon of *Culex cedecei* is long and thin, more than seven times longer than it is wide and contains five tufts of short setae (Darsie and Ward, 2005). Finally, on segment X, the saddle is not aciculate (having irregular streaks and scratches) (Darsie and Ward, 2005).



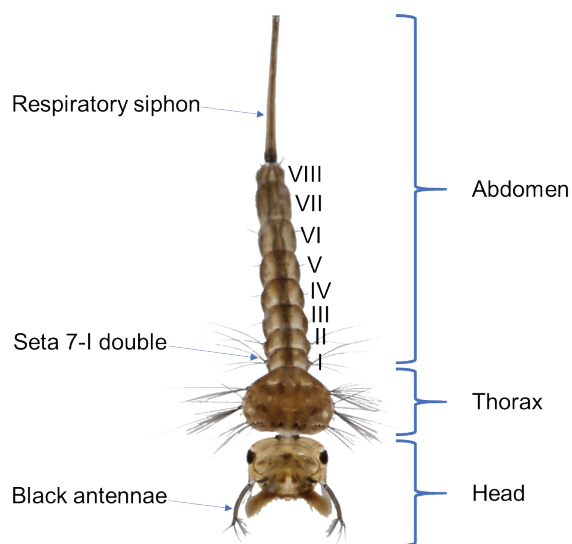


Figure 4. Fourth instar larva of *Culex cedecei*.  
Credits: Kristin Sloyer, UF/IFAS

## Pupae

As with other mosquitoes, *Culex cedecei* pupae are shaped like a comma (Figure 6), are commonly referred to as ‘tumblers’, and are a non-feeding life stage. The pupae have primarily been described as *Culex opisthopus* (now *Culex taeniopus*) from the Caribbean, but both species are similar, and characters have been compared to a Florida laboratory colony. Mosquito pupae breathe through paired appendages on the cephalothorax called ‘respiratory trumpets’ (Figure 6). In *Culex cedecei* the respiratory trumpets are long and slender, about 9-10 times as long as wide, but not more than 12 times the length of greatest width. Setae 1, 2, and 3 of the cephalothorax (fused head and thorax) are triple, with seta 1 being the longest of the three. On the metanotum (dorsal, sclerotized integument of the 3<sup>rd</sup> thoracic segment), seta 10 is double. Seta 8 is located in the posterior and lateral corner of segment VIII (Darsie, 2005). Paddle seta 8 is much shorter than one-third the length of the paddle. The posterior and lateral corners of segment VIII are gently rounded. The distal border of the pinna (the part of the trumpet from the apex to the longitudinal axis at the proximal margin of the spiracular opening) is truncate or slightly evaginated, never with a notch (Foote, 1954).

## Adult Females

The adult female of *Culex cedecei* is a small to medium-sized mosquito with a dark integument (Figure 7). As with other members of the subgenus *Melanoconion* of *Culex*, it does not have middorsal acrostichal (bristles on the mesothorax) setae on the scutum. Unlike most other *Melanoconion* species in Florida, *Culex cedecei* lacks broad, appressed scales on the vertex and along the ocular line of the head, and instead has numerous narrow appressed

scales medially. On the pleuron of the thorax, patches of pale scales occur on the upper mesokatepisternum (the largest, rectangular-shaped sclerite located on the lateral section of the thorax – see Figure 7 for exact location) (seven or more scales) and near the border of the mesepimeron (sclerite located in the anterior part of the thorax – see Figure 7 for location) and mid-coxa. The mesepimeron is scaleless but has a distinct semi-circular area of pale integument beginning at the mesokatepisternum and not usually extending across the entire sclerite (Figure 7). The legs of *Culex cedecei* are dark scaled, however the hind tarsi possess very narrow indistinct bands of pale scales (Figure 7). These pale bands are typically difficult to observe in lateral view but are visible when the tarsi are viewed from the dorsal perspective.

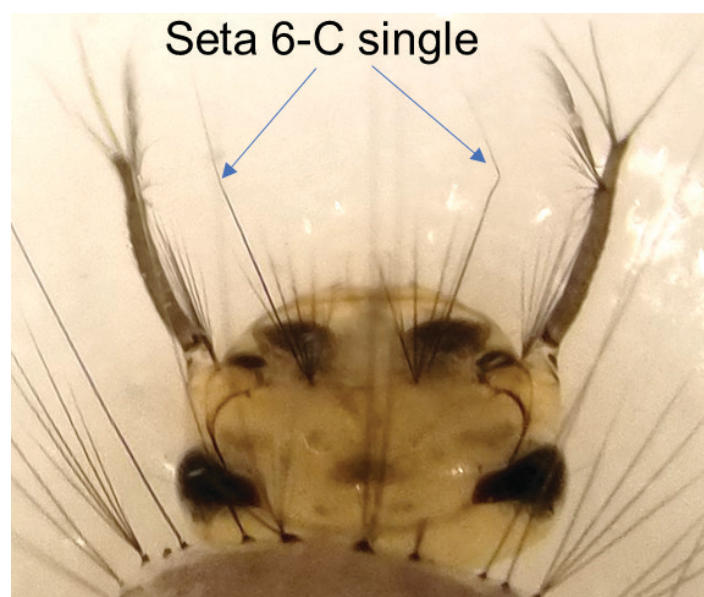


Figure 5. Head of *Culex cedecei* larva showing black antennae and setae 6-C single (not branched).  
Credits: Kristin Sloyer, UF/IFAS

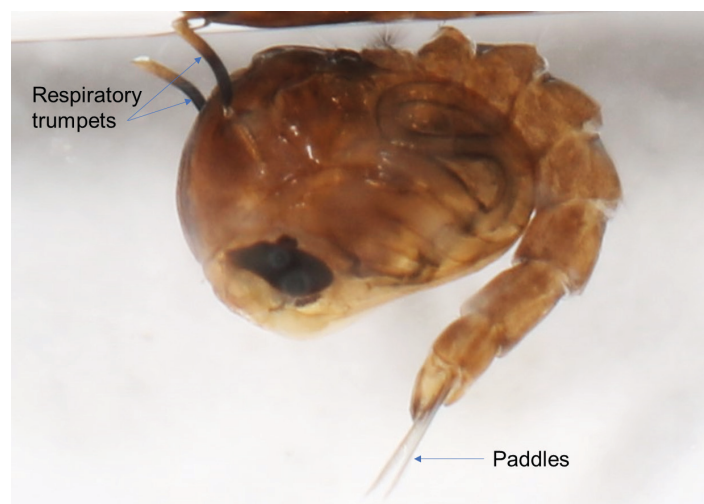


Figure 6. Pupa of *Culex cedecei* indicating locations of paddles and respiratory trumpets.  
Credits: Kristin Sloyer, UF/IFAS

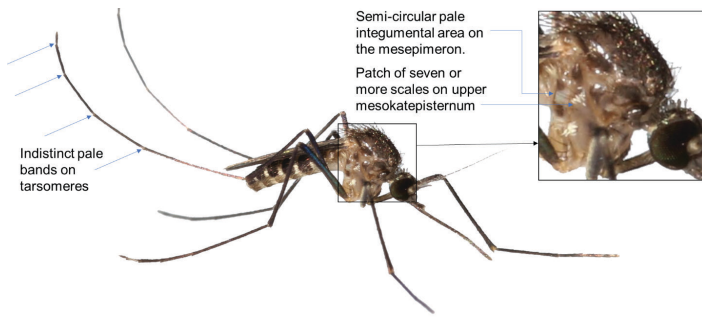


Figure 7. Adult female of *Culex cedecei*. Inset shows characteristic patches of pale scales and pigmentation on thoracic pleuron.  
Credits: Kristin Sloyer, UF/IFAS

## Adult Males

The adult males of *Culex cedecei* share many characters with the female, including the pale integumental area on the mesepimeron, and patch of six or more broad pale scales on the upper mesokatepisternum. As with many male mosquitoes, the palps are longer than the proboscis. Unique among the *Melanoconion* in Florida, *Culex cedecei* males have pale-scaled bands at the junctures of palpal segments (Figure 8).

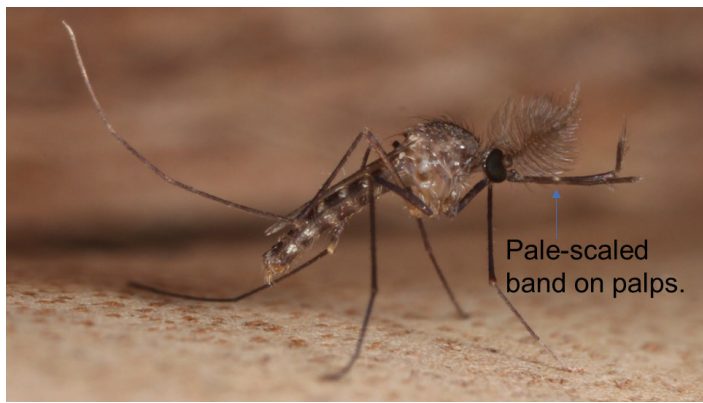


Figure 8. Adult male of *Culex cedecei* showing pale-scaled band on the palps.  
Credits: Nathan Burkett-Cadena, UF/IFAS

## Life Cycle

As with other mosquito species, *Culex cedecei* are holometabolous and pass through four complete life-stages which include egg, larva, pupa and adult (Figure 9). *Culex cedecei* egg rafts average 66 eggs per raft (Blosser and Burkett-Cadena 2017) and are laid either directly on the surface of the water or on solid substrate just above the water line (Blosser and Burkett-Cadena 2017) and hatch within two days. Larvae of *Culex cedecei* are filter-feeders and feed primarily on bacteria and decomposing organic matter. Larvae and pupae obtain atmospheric oxygen from the respiratory siphon and respiratory trumpets, respectively. The pupa is a non-feeding stage and moves vertically through the water using paddles in order to avoid predation. Adults emerge from the pupal stage after approximately three days and

sit on top of the water until their exoskeleton sclerotizes. While both adult males and females feed on plant sugars for nutrition, only the adult female takes a blood meal. *Culex cedecei* is a mammal biting mosquito that will feed upon a wide variety of available mammals, although rats and mice appear to be preferred hosts (Edman 1979, Hoyer et al. 2017). The blood meal is taken to provide protein for the development of eggs, with eggs being laid typically 7-10 days after a blood meal.

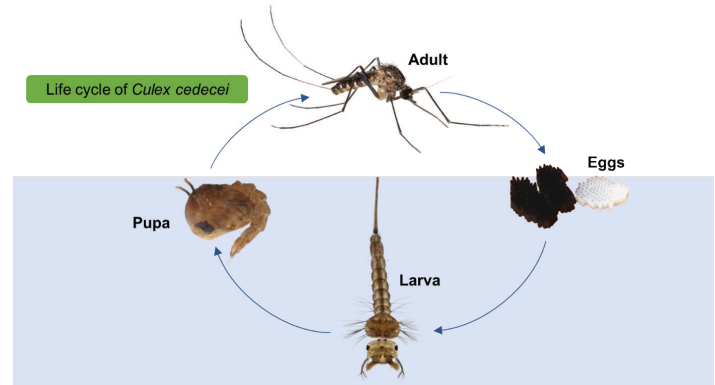


Figure 9. The life cycle of *Culex cedecei*.  
Credits: Kristin Sloyer and Nathan Burkett-Cadena, UF/IFAS

## Medical Importance

*Culex cedecei* is the primary vector of EVEV due to high infection rates in nature, proclivity for feeding on EVEV vertebrate hosts hispid cotton rat, *Sigmodon hispidus*, and cotton mouse, *Peromyscus gossypinus*, and efficient vector competence. *Culex cedecei* was first implicated as a vector of EVEV when it was found to constitute a large proportion of EVEV-positive mosquito pools from early studies of the virus in the Florida Everglades (Chamberlain et al., 1969). A decade later, Edman (1979) demonstrated that *Culex cedecei* feeds heavily upon the hispid cotton rat and other rodents, which have been shown to have high EVEV infection rates in nature (Edman, 1974; Edman, 1979; Bigler et al., 1971; Bigler, 1969). Laboratory vector competence studies by Weaver et al. (1986) exposed *Culex cedecei* to three strains of sympatric subtype II EVEV (Fe4-32bm, Fe5-47et, and Fe3-7c) and found that 80% of females became infected with EVEV and all mosquitoes which became infected with the virus were able to transmit the virus to uninfected hamsters following a 19- to 22-day incubation period (Weaver et al., 1986). Presently, *Culex cedecei* is the only confirmed natural vector of EVEV, satisfying all four WHO criteria for vector incrimination.

EVEV is maintained in mesic forest environments in south Florida among the cotton rat (*S. hispidus*), cotton mouse (*P. gossypinus*), and the primary enzootic vector *Culex cedecei* (Figure 10). Like other enzootic VEE subtypes, there is no current evidence that humans or equines are hosts in

the natural transmission cycle of EVEV. Humans, who are thought to rarely develop symptoms from EVEV infection, may become incidental hosts when they enter mesic forest environments in southern Florida and are bitten by *Culex cedecei* (Aguilar et al., 2011; Ehrenkranz et al., 1970 and 1974; Ventura et al., 1974). Other mammals and birds may be capable of infection with EVEV, although it is not known whether they are competent hosts of the virus.

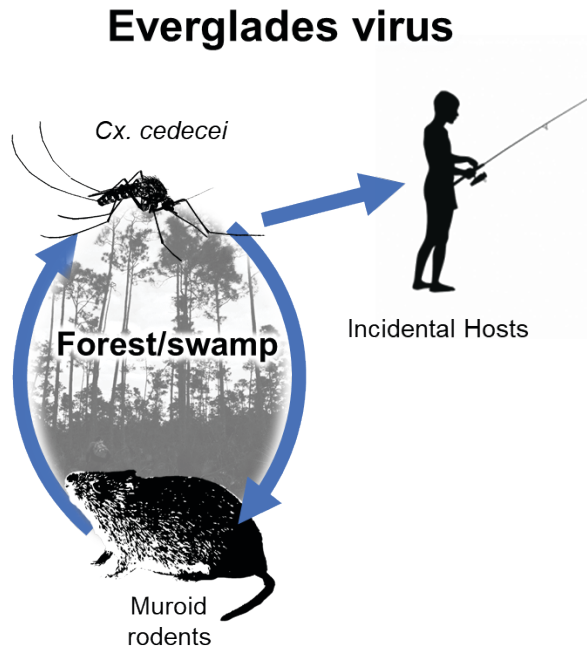


Figure 10. Diagram illustrating enzootic transmission cycle of EVEV and spillover into incidental hosts (humans).

Credits: Kristin Sloyer and Nathan Burkett-Cadena, UF/IFAS

## Management

*Culex cedecei* is not considered a biting nuisance of humans, because it is uncommon in developed areas and is not considered an aggressive biter, so it is not regularly targeted by mosquito control programs. However, since *Culex cedecei* transmits EVEV it therefore is a concern for zoonotic disease spillover into human populations. *Culex cedecei* has been known to infrequently bite humans that venture into its environment (Hoyer et al., 2019), and is likely responsible for transmission of EVEV to humans. It is therefore advisable for people who are visiting sylvatic areas with potentially large *Culex cedecei* populations (the Florida Everglades ecosystem) to wear protective clothing which covers skin and apply DEET-based or other EPA-registered mosquito repellants, to reduce risk of mosquito bites and transmission of EVEV. For more information on the general control and management of mosquitoes please visit <https://edis.ifas.ufl.edu/in1045>.

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