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# DISCARDED CIGARETTE BUTTS ATTRACT FEMALES AND KILL THE PROGENY OF *AEDES ALBOPICTUS*

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ABSTRACT. Discarded cigarette butts (DCB) waste occurs worldwide, pollutes landscapes, is unsightly, and results in added debris removal costs. There is, therefore, a great deal of current interest in making use of DCBs in beneficial ways. Despite evidence that DCBs are harmful to water fleas (*Daphnia magna*), which breed in aquatic environments as do mosquito larvae, their impact on dengue vectors is unknown. We examined whether *Aedes albopictus* alters its ovipositional responses, larval eclosion, and development in response to presence of DCBs in its habitats. We found oviposition activity in DCB-treated water similar to that of control water and that ovipositional activity in DCB solutions steadily increased over time as those solutions aged to 10 days. Larval eclosion was initially suppressed on day 1 in DCB solution, but increased thereafter to levels similar to control larval eclosion rates. The DCB–water solutions produced significantly higher mortality in both 1st and 2nd instars over control larvae for several days after initial exposure. Mortality rates decreased sharply 3 to 5 days postexposure as DCBs continued to decompose. We found increased survival rates during late development, but daily input of fresh DCBs prevented most young larvae from completing development. Taken together, these observations suggest that decomposing did not deter gravid *Ae. albopictus* females from ovipositing in treated containers and that DCB solutions had larvicidal effects on early instars. Our results are discussed in the context of DCB use to control container-breeding *Ae. albopictus*, a competent dengue vector in Asia and other parts of the world.

**KEY WORDS** Cigarette butt, *Aedes albopictus*, dengue, mosquito control, larvicide

## INTRODUCTION

Dengue fever and dengue hemorrhagic fever are acute febrile diseases transmitted by *Aedes* mosquitoes, e.g., *Ae. albopictus* (Skuse) (Hawley 1988), which occur in tropical and temperate zones worldwide. Dengue fever is the fastest spreading mosquito-borne viral disease and is believed to be the next emerging global public health threat (Bast 2010). Attempts have been made to control this disease through insecticide spraying of adults and larval habitats and through public health sanitation programs with limited success. Prophylactic drugs and vaccines to prevent infection currently do not exist (WHO 1999, Chaturvedi et al. 2005). Other reasons for failure include the emergence of insecticide resistance and the increasingly restricted use of mosquito control insecticide applications and materials driven by environmental protection agencies around the world (Gubler 2004). The demand for more environmentally friendly methods has led to the search for new strategies to reduce the amounts of insecticides released into the environment. Attempts to control dengue vectors are currently focused on lethal ovitrap development and improvement of adult and larval surveillance devices (Fay and Eliason 1966, Ritchie et al. 2003). Although mosquito surveillance with ovitraps has sometimes been successful, surveillance programs based solely on this strategy have been widely determined to be inappropriate for dengue vectors (Reiter 1986, Savage et al. 2008). Over the past decade, there has been increased interest in the use of lethal ovitraps consisting of water-filled black plastic cups containing an insecticide-treated oviposition substrate or ovistrip (Perich et al. 2003). Their effectiveness has sometimes been demonstrated against gravid *Ae. aegypti* (L.) in both laboratory (Zeichner and Perich 1999) and wild populations (Perich et al. 2003). Despite their sustained impact on dengue vector population densities under some conditions (Perich et al. 2003), previous evidence exists that their incorporated cups do not become productive breeding sites for *Ae. aegypti* (Zeichner and Perich 1999).

The larvae of container-breeding mosquitoes, including dengue vectors, use leaf detritus by browsing microorganisms contained in the biofilm on the leaf surface (Fish and Carpenter 1982) or by directly ingesting particulate matter (Kaufman et al. 1999). After falling into a natural or artificial container, leaf substrate undergoes decomposition, which releases a number of compounds (Dieng et al. 2002b) that are crucial to larval development (Walker et al. 1997). Leaf litter that decays rapidly has been favorable for mosquito growth, resulting in quicker development and higher population sizes (Dieng et al. 2002b). However, detrimental effects of some plant materials have also been reported in

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