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Abundance and distribution of sylvatic dengue virus vectors in three different land cover types in Sarawak, Malaysian Borneo

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Abstract

Background: Mosquito-borne dengue virus (DENV) is maintained in a sylvatic, enzootic cycle of transmission between canopy-dwelling non-human primates and *Aedes* mosquitoes in Borneo. Sylvatic DENV can spill over into humans living in proximity to forest foci of transmission, in some cases resulting in severe dengue disease. The most likely vectors of such spillover (bridge vectors) in Borneo are *Ae. albopictus* and *Ae. niveus*. Borneo is currently experiencing extensive forest clearance. To gauge the effect of this change in forest cover on the likelihood of sylvatic DENV spillover, it is first necessary to characterize the distribution of bridge vectors in different land cover types. In the current study, we hypothesized that *Ae. niveus* and *Ae. albopictus* would show significantly different distributions in different land cover types; specifically, we predicted that *Ae. niveus* would be most abundant in forests whereas *Ae. albopictus* would have a more even distribution in the landscape.

Results: Mosquitoes were collected from a total of 15 sites using gravid traps and a backpack aspirator around Kampong Puruh Karu, Sarawak, Malaysian Borneo, where sylvatic DENV spillover has been documented. A total of 2447 mosquitoes comprising 10 genera and 4 species of *Aedes*, were collected over the three years, 2013, 2014 and 2016, in the three major land cover types in the area, homestead, agriculture and forest. Mosquitoes were identified morphologically, pooled by species and gender, homogenized, and subject to DNA barcoding of each *Aedes* species and to arbovirus screening. As predicted, *Ae. niveus* was found almost exclusively in forests whereas *Ae. albopictus* was collected in all land cover types. *Aedes albopictus* was significantly ($P = 0.04$) more abundant in agricultural fields than forests. Sylvatic DENV was not detected in any *Aedes* mosquito pools, however genomes of 14 viruses were detected using next generation sequencing.

Conclusions: Land cover type affects the abundance and distribution of the most likely bridge vectors of sylvatic DENV in Malaysia Borneo. Conversion of forests to agriculture will likely decrease the range and abundance of *Ae. niveus* but enhance the abundance of *Ae. albopictus*.

Keywords: *Aedes*, Mosquito, Spillover, Sylvatic, Dengue virus, Arbovirus, Land cover, Borneo

Background

The four serotypes of mosquito-borne dengue virus (DENV-1-4), the etiological agents of dengue fever and dengue hemorrhagic fever/shock syndrome, are transmitted among humans by *Aedes aegypti* across the tropical and subtropical regions of the world [1]. In the 1950's, Smith proposed the existence of a sylvatic, enzootic cycle

of DENV when he discovered high seroprevalence of anti-DENV antibodies in rural human populations in Malaysia in areas where *Ae. aegypti* were absent [2, 3]. *Aedes albopictus* were abundant in these areas, suggesting that this species might act as a bridge vector between an enzootic reservoir of DENV and humans [2, 3]. *Aedes albopictus* is a tree-hole breeding mosquito that adapts easily to a wide variety of environments including cities [4]. This species prefers to feed on humans but will feed opportunistically on a wide variety of non-human animals in proportion to

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