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Mosquito-borne viruses circulating in Kinshasa, Democratic Republic of the Congo

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SUMMARY

Background: Diseases caused by mosquito-borne viruses are among the most important emerging diseases that threaten human and animal health, particularly in Africa. However, little attention has been paid to these diseases in the Democratic Republic of the Congo (DRC). The present cross-sectional study was undertaken between March and May 2014 to investigate the presence of mosquito-borne viruses in mosquitoes collected from five municipalities of Kinshasa, DRC.
Methods: Mosquitoes were collected using BG-Sentinel traps and battery-powered aspirators. Female mosquitoes were pooled according to their genera and sampling locations, preserved in RNAlater, and later screened for viruses using reverse transcription PCR (RT-PCR) assays.
Results: A total of 2922 mosquitoes were collected and 29 pools of female mosquitoes, containing approximately 30 mosquitoes each, were tested. Twelve of the 29 (41.4%) mosquito pools were found to be infected with at least one arbovirus, with eight (27.5%) pools positive for *Alphavirus*, nine (31%) for *Flavivirus*, and five (17.2%) for *Bunyaviridae*. Chikungunya, o'nyong'nyong, and Rift valley fever viruses were detected.
Conclusions: The present study shows that mosquitoes in Kinshasa carry mosquito-borne viruses that may have serious public health implications. Further investigations on the presence of mosquito-borne viruses in the human and livestock populations of Kinshasa and DRC are recommended.
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Introduction

Arboviral diseases are among the most important emerging infectious diseases threatening public health in many countries of the world.[1] The Democratic Republic of the Congo (DRC) is the second largest African country and shares a long boundary with nine countries, including Congo, Central African Republic (CAR), South Sudan, Uganda, Rwanda, Burundi, Tanzania, Zambia, and Angola. Over the past decade, significant population movements arising from conflicts may have contributed to the introduction of arboviral diseases into new areas. Indeed, 2.4 million people were displaced within DRC because of war and 46 300 refugees have come in from neighbouring and endemic countries.[2] Because of its large population of non-human primates and other animal reservoir hosts, DRC is believed to be the origin of several important emerging viruses of humans.[3] However, few studies have been conducted on arboviruses within the country, hampering a reliable estimation of the current status and burden of arboviruses in DRC.

A recent study in the Congo basin that assessed the role of wildlife species as reservoirs for arboviruses (flaviviruses and alphaviruses) by testing sera from various animals, such as buffaloes, elephants, duikers, mandrills, gorillas, monkeys, and chimpanzees, showed the presence of antibodies against chikungunya, o'nyong'nyong, West Nile, dengue, and yellow fever viruses.[4] In 1999 and 2000, two outbreaks of febrile illness were reported in humans following heavy rains in Matete and Kingabwa townships of the DRC capital city, Kinshasa. An estimated 50 000 humans cases were reported, and chikungunya virus was identified as the cause of these febrile illness outbreaks.[5] A high proportion of

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tested sera from these cases presenting with febrile illness were found to have immunoglobulin M (IgM) antibodies against chikungunya virus but not against dengue virus, West Nile virus, or bunyaviruses.[5] Later on, when the chikungunya viruses were isolated and their partial genomic sequences determined, the isolates from DRC were found to constitute a homogeneous group that was more closely related to CAR and Ugandan isolates than to Tanzanian and South African strains.[6] These data called for urgency in conducting and expanding disease surveillance in DRC for emerging viruses that may represent an imminent threat to the population of Africa. However, disease prevention efforts have mostly focused on malaria and little has been done to understand the burden of arboviral disease and to mitigate the risks of possible large-scale outbreaks occurring in DRC.

The present study was conducted to investigate the presence of arboviruses such as yellow fever virus, dengue virus, o'nyong'-nyong virus, Rift Valley fever virus, and chikungunya virus, in order to provide information that could serve as an early warning for possible outbreaks and to understand the exposure risk in certain selected areas of Kinshasa. The findings of this study may assist in the development and implementation of strategies for the control of arboviral diseases.

Methods

Study area

Mosquitoes were collected in selected areas within Kinshasa (Figure 1), the capital city of DRC, located at 4° 19′ 30″ S and 15° 19′ 20″ E. Kinshasa covers an area of 9965 km^2, of which 90% is rural. It borders Brazzaville across the wide Congo River and is surrounded by four provinces, including Kongo-Central in the south and Kwilu, Kwango, and Mai-Ndombe in the north and in the east. The climate of Kinshasa is characterized by two seasons: a dry season from the second half of May to September and a rainy season from October to the first half of May, with a short break in February. Kinshasa experiences an average of 1482 mm of rainfall per year and has an average annual temperature of 25.2 °C and average annual relative humidity of 80.3%. The landscape ranges from the larger plain to some hills on the periphery, and a considerable hydrographic network crosses Kinshasa. The soils are sandy, sandy-argillaceous to argillaceous, with vegetation including steppes, semi deciduous and riverine forest islands, and wooded and grassy savannah. Kinshasa is divided into 24 municipalities.

The sampling sites for the present study are known for being the most malaria-endemic areas. These study sites were chosen because they possess favourable mosquito breeding habitats and a history of occurrence of arboviral disease outbreaks. The five study sites selected included Kimwenza, Kingabwa, Ndjili, Kimbanseke, and Ngaba (Figure 1). Kimwenza is a semi-rural area of Mont-Ngafula municipality set on a plateau in western Kinshasa, where a bonobo sanctuary is located and where the last epidemic of chikungunya occurred. Kingabwa is a suburban area of Limete municipality in the north-eastern part of Kinshasa along the Congo River, where rice agriculture is practiced and previous urban chikungunya outbreaks have occurred. Ndjili municipality is located in south-eastern Kinshasa along the Ndjili River, where pig farming, agriculture, and automobile repairs are conducted. Kimbanseke municipality is the most populated suburban area located in the eastern part of Kinshasa and is where vegetable cultivation is practiced and the swampy areas of Mokali and Nsanga are located. Ngaba municipality is an area surrounding the main market in central Kinshasa, characterized by a polluted environment due to the lack of an appropriate drainage sewage system and waste collection.

Mosquito collection

The present cross-sectional study was conducted between March and May 2014 in order to detect the presence of mosquito-

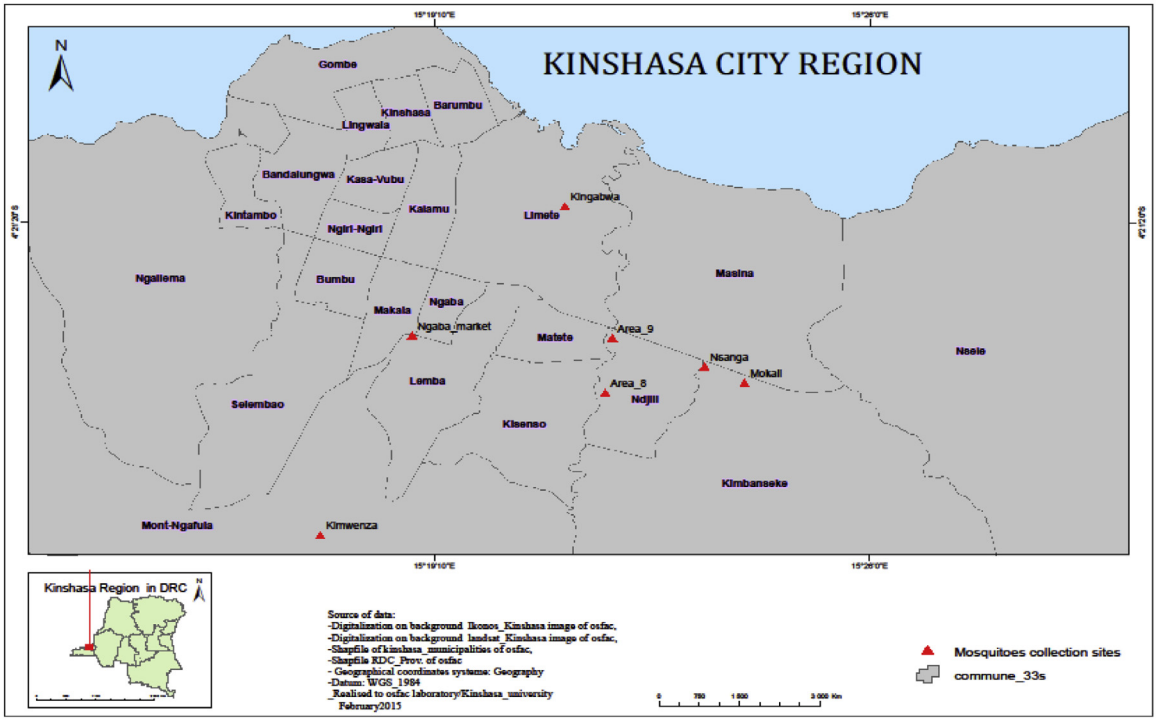

Figure 1. Map of Kinshasa showing the mosquito sampling locations. Adult mosquitoes were collected from Kimwenza (Mount Ngafula municipality), Kingabwa (Limete municipality), Area 8 and 9 (Ndjili municipality), Nsanga and Mokali (Kimbanseke municipality), and Ngaba market (Ngaba municipality). The insert shows the location of Kinshasa City in the Democratic Republic of the Congo.

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