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REVIEW

Impact of climate change and other factors on emerging arbovirus diseases

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Summary While some sceptics remain unconvinced that global climate change is a reality, there is no doubt that during the past 50 years or so, patterns of emerging arbovirus diseases have changed significantly. Can this be attributed to climate change? Climate is a major factor in determining: (1) the geographic and temporal distribution of arthropods; (2) characteristics of arthropod life cycles; (3) dispersal patterns of associated arboviruses; (4) the evolution of arboviruses; and (5) the efficiency with which they are transmitted from arthropods to vertebrate hosts. Thus, under the influence of increasing temperatures and rainfall through warming of the oceans, and alteration of the natural cycles that stabilise climate, one is inevitably drawn to the conclusion that arboviruses will continue to emerge in new regions. For example, we cannot ignore the unexpected but successful establishment of chikungunya fever in northern Italy, the sudden appearance of West Nile virus in North America, the increasing frequency of Rift Valley fever epidemics in the Arabian Peninsula, and very recently, the emergence of Bluetongue virus in northern Europe. In this brief review we ask the question, are these diseases emerging because of climate change or do other factors play an equal or even more important role in their emergence?

1. Introduction

Undoubtedly, if the damage we have already done to the ozone layer and thus to our planet cannot be reversed, or at least if we cannot reduce harmful chemical emissions and prevent further damage, the emergence of either new or reemerging arthropod-borne virus (arbovirus) diseases in new areas of the world, such as southern and northern Europe, would be expected to continue to occur, perhaps with increasing frequency.

During the past decade, human and animal pathogenic arboviruses such as West Nile virus (WNV), Chikungunya virus (CHIKV), Rift Valley fever virus (RVFV) and Bluetongue virus (BTV) have emerged and caused epidemics in North America,

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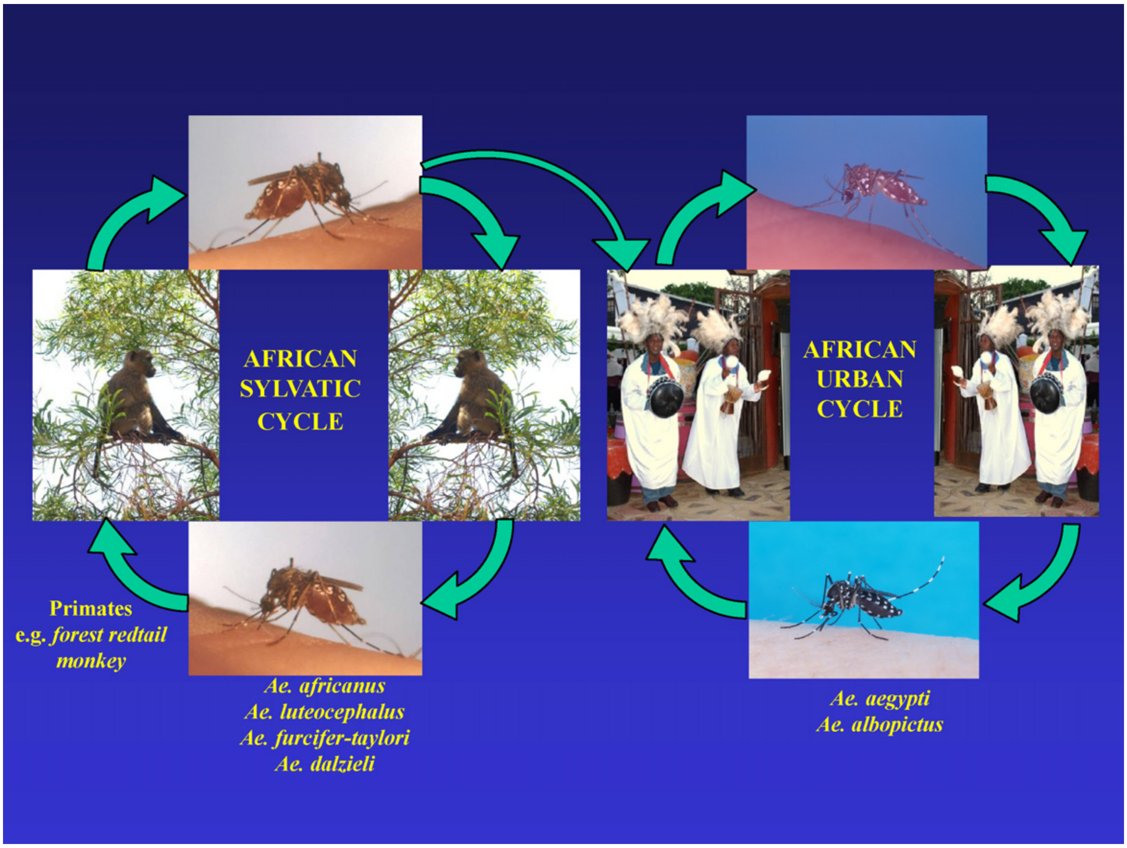

Figure 1 Representation of chikungunya virus life cycle in Africa.

Europe and the Arabian Peninsula. Their emergence may be attributable to the impact of climate change,[1,2] but a variety of other factors have in many cases been important contributory determinants of emerging epidemics.[3] These include: local levels of socio-economic development; increasing human travel; commercial transportation; urbanization; deforestation; land reclamation; irrigation projects; human, animal and arthropod population density increase; and political and military activities that lead to mass human evacuation. However, local climatic fluctuations may have exerted a transient impact on particular arbovirus epidemics. In the four specific examples of emerging arbovirus diseases provided below, we briefly examine the potential effects of climate change and other factors that have contributed to the most widely reported cases of recent arbovirus emergence.

2. Chikungunya virus

CHIKV, a member of the genus *Alphavirus* in the family *Togaviridae*, was isolated from the serum of a febrile female patient suffering with joint pains.[4] The virus is responsible for major outbreaks of febrile arthralgia in humans,[5] but until the recent outbreaks of chikungunya fever on the islands in the Indian Ocean was not associated with fatal disease. For many years chikungunya fever has occurred in or near many of the forested regions of Africa, among simians and humans. Arthropod vectors include sylvatic *Aedes* spp. mosquitoes (particularly *Aedes furcifer-taylori*, *Ae. luteocephalus* and *Ae. dalzieli*) that feed on simian species in the African jungles and the nearby savannah regions. Neither the simians nor the vectors display clinical evidence of infection by the virus. Nevertheless, mosquitoes infected after taking a bloodmeal from infected monkeys amplify the virus, which, it has been suggested, may be transferred to the eggs, which are then deposited in the forests. It is believed that, in common with certain other arboviruses, CHIKV may survive for long periods of time in these eggs. If this is the case, then during rainy periods, these transovarially infected eggs would hatch and subsequently produce adults able immediately to transmit virus to susceptible primates.

As there are no field or laboratory data that can confirm this mechanism of long-term CHIKV survival, alternative hypotheses have been proposed. One suggestion is that the virus may survive in wildlife species through constant transmission cycles moving in epizootic waves.[6] Outbreaks in rural regions tend to be on a small scale and dependent upon sylvatic mosquito densities, which increase following periods of heavy rainfall.[7] Humans entering areas in which infected mosquitoes circulate may serve as incidental hosts for the mosquitoes and thus become infected. These humans may then provide a source of virus to infect peridomestic mosquitoes, which then become involved in the transmission cycle of the virus. In the case of urban-dwelling anthropophilic *Ae. aegypti* and/or *Ae. albopictus*, if either of these species becomes involved in the transmission cycle, a human epidemic may ensue in the urban community (Figure 1).