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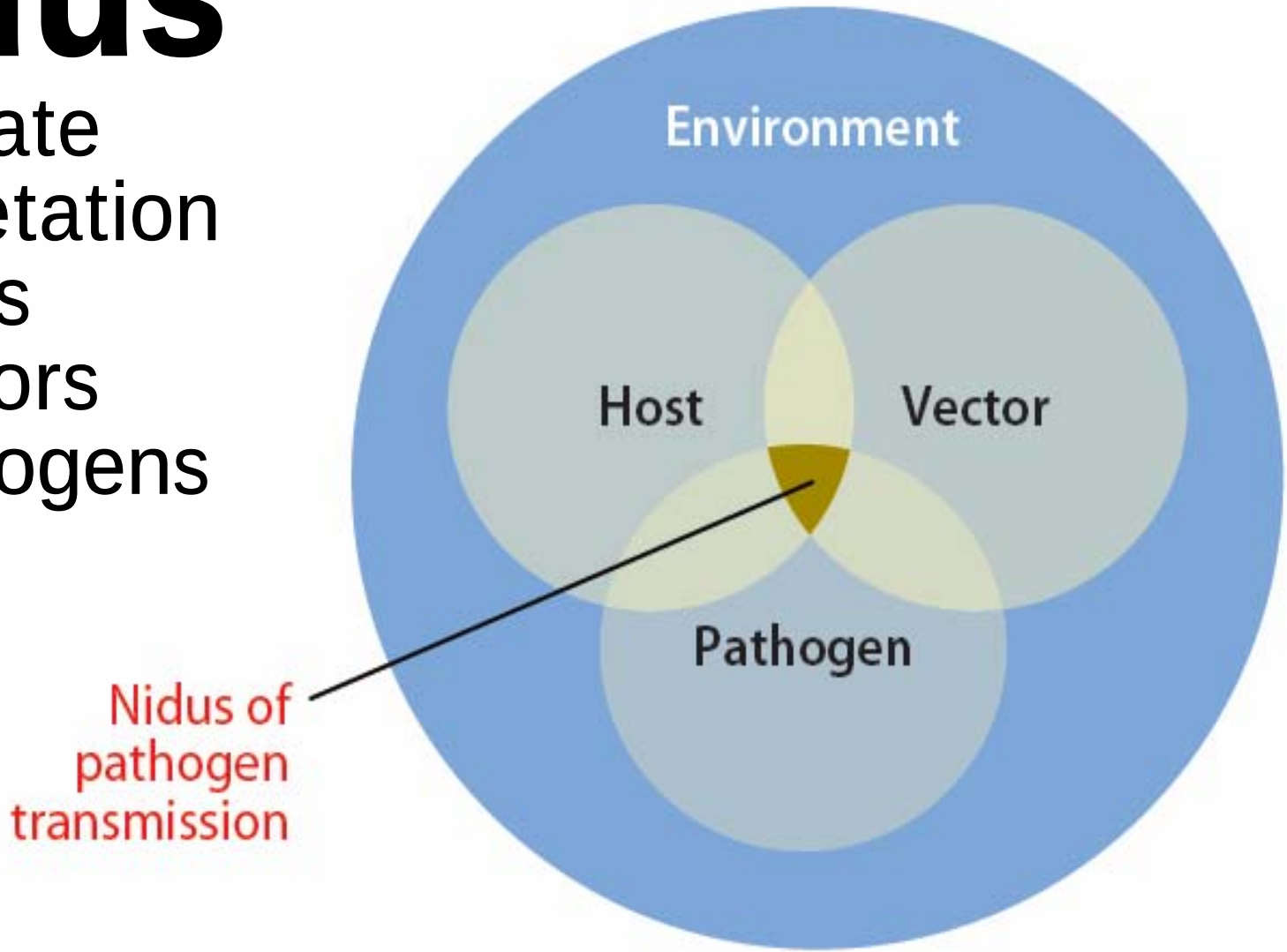
KHTC

Nidus

- Climate
- Vegetation
- Hosts
- Vectors
- Pathogens



Conceptual nidus showing how vector, host, and pathogen populations intersect within a permissive environment to enable pathogen transmission.

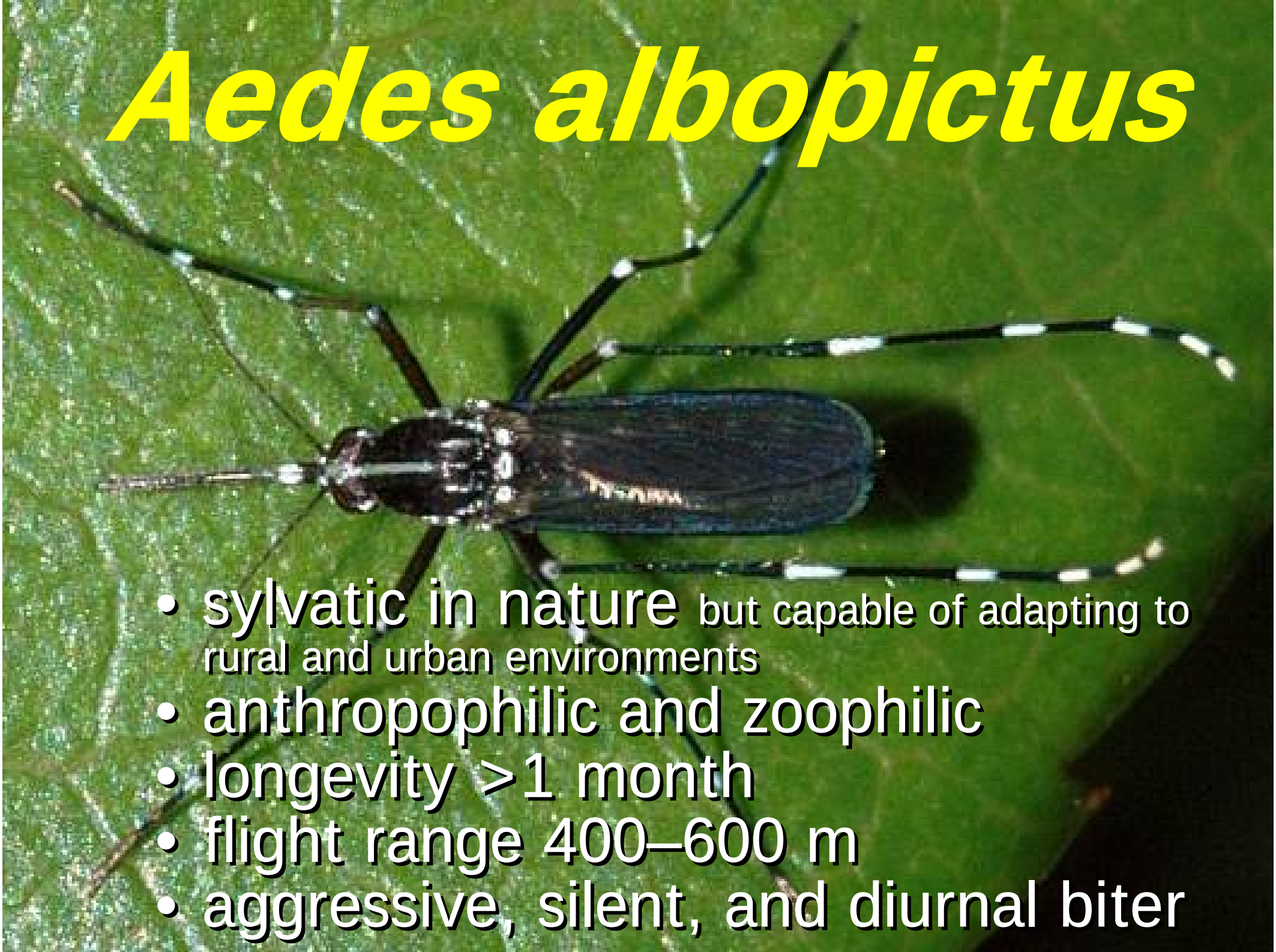
During unfavorable weather periods, nidus often contract to spatially delimited refugia that enable host and/or vector and pathogen persistence. Under permissive temperatures, moisture related focus contraction actually may enhance host-vector contact and therefore transmission.

In Asia and the Indian Ocean region the main chikungunya virus vectors are ***Ae. aegypti*** and ***Ae. albopictus***.

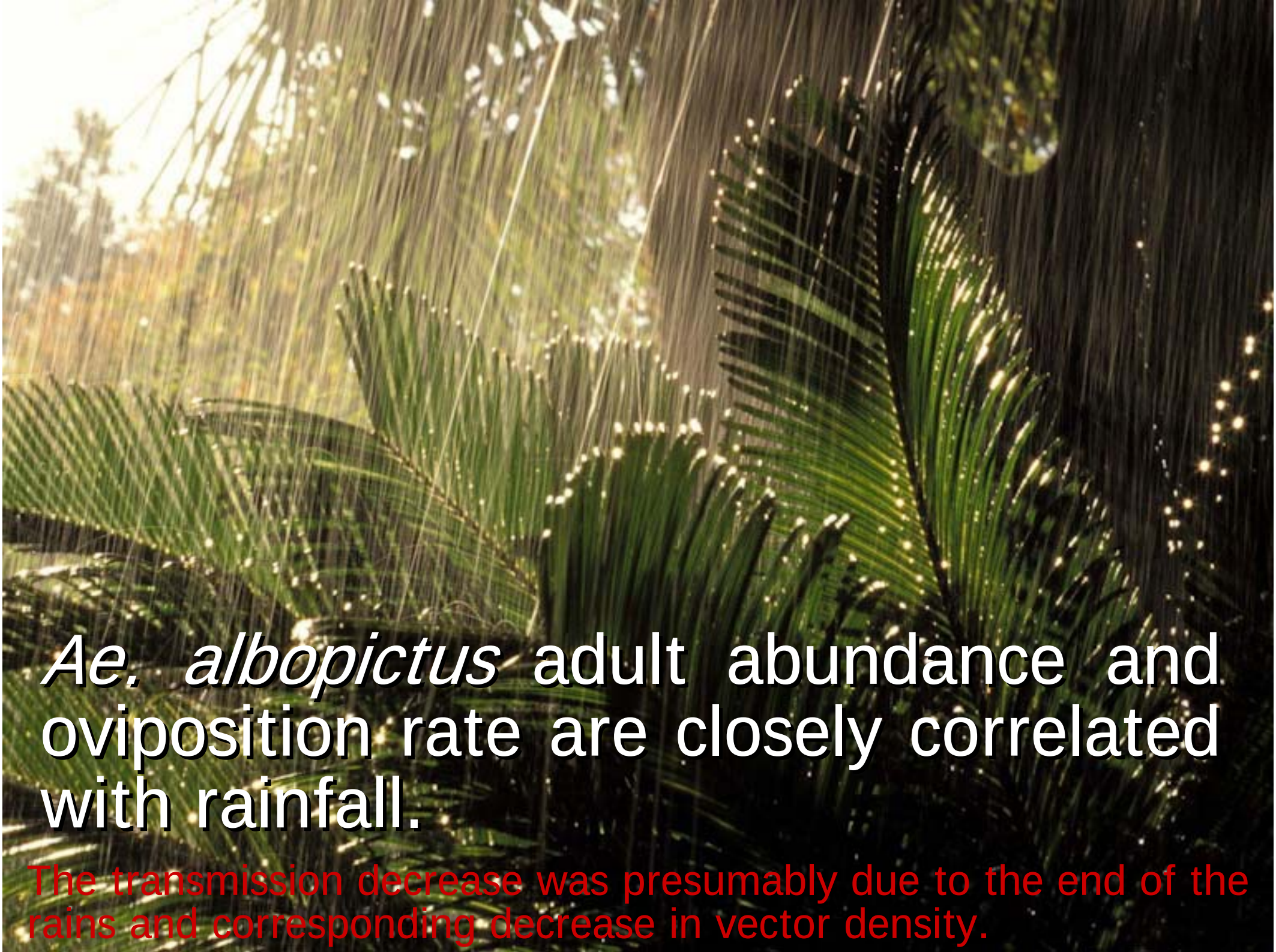
A larger range of *Aedes* species *(Ae. furcifer, Ae. vittatus, Ae. fulgens, Ae. luteocephalus, Ae. dalzieli, Ae. vigilax, Ae. campto-rhynchites)* transmit the virus in Africa, and *Culex annulirostris, Mansonia uniformis*, and *Anopheles* mosquitoes have also occasionally been incriminated.

Recent invasion by *Ae. albopictus* of the United States has been accompanied by a parallel decrease *of Ae. aegypti* in the Southeast.

Aedes albopictus

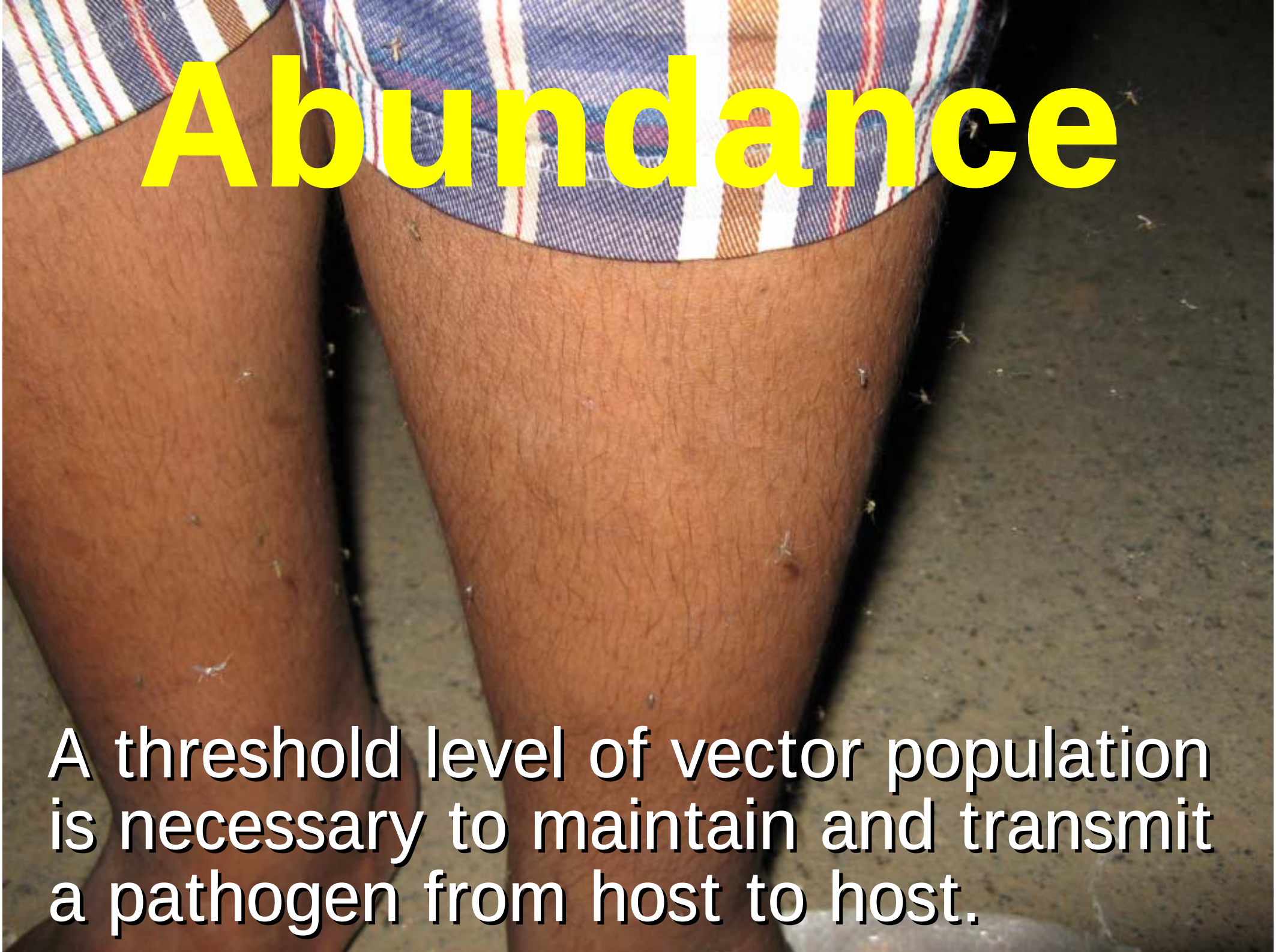


- sylvatic in nature but capable of adapting to rural and urban environments
- anthropophilic and zoophilic
- longevity >1 month
- flight range 400–600 m
- aggressive, silent, and diurnal biter



Ae. albopictus adult abundance and oviposition rate are closely correlated with rainfall.

The transmission decrease was presumably due to the end of the rains and corresponding decrease in vector density.


Abundance
A threshold level of vector population is necessary to maintain and transmit a pathogen from host to host.

Breeding habitats

Ae. aegypti: animal detritus

Ae. albopictus: plant detritus

Daugherty et al. (2000) showed that animal detritus additions could increase the likelihood of coexistence between competing container mosquitoes *Ae. aegypti* and *Ae. albopictus*, whereas leaf-only treatments led to the competitive exclusion of *Ae. aegypti* by *Ae. albopictus*.

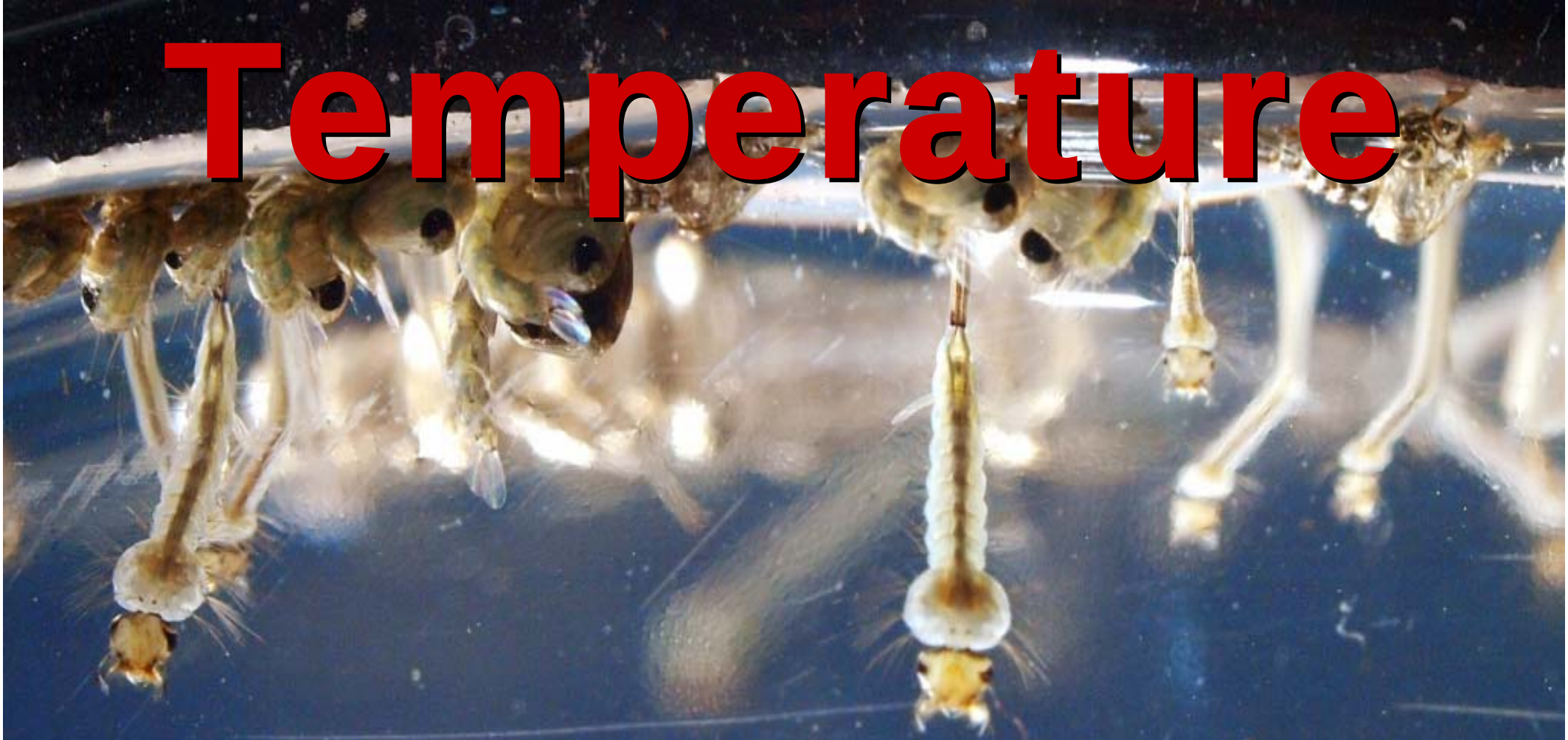

Larval competition, common in natural mosquito populations, has important indirect effects on adults by altering mosquito–virus interactions.

Interspecific competition *Ae. aegypti* and *albopictus*

In *Ae. Albopictus*, competition resulted in greater infection, body titer, and dissemination rates compared to low-competition conditions.

Alto et al. Larval competition differentially affects arbovirus infection in *Aedes* mosquitoes Ecology 2005; 86(12): 3279-88

Temperature



Adult females with the largest body size were produced from the temperature 18°C took the longest to mature, and six times more likely to be infected with CHIKV than females reared at 32°C.

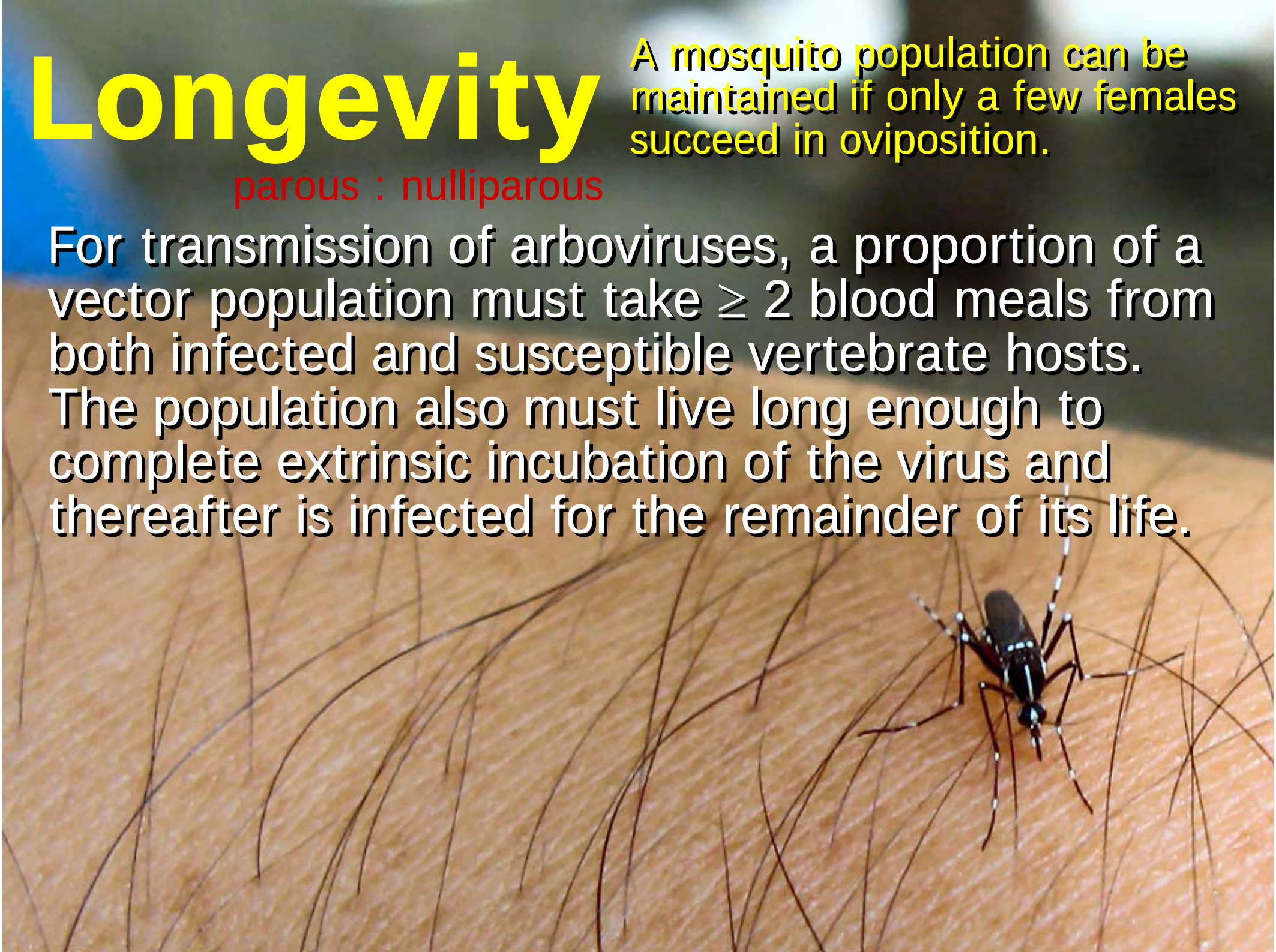
Catherine et al. Larval environmental temperature and the susceptibility of *Aedes albopictus* Skuse (Diptera:Culicidae) to Chikungunya virus. Vector-Borne and Zoonotic Diseases. doi:10.1089/vbz.2009.0035.

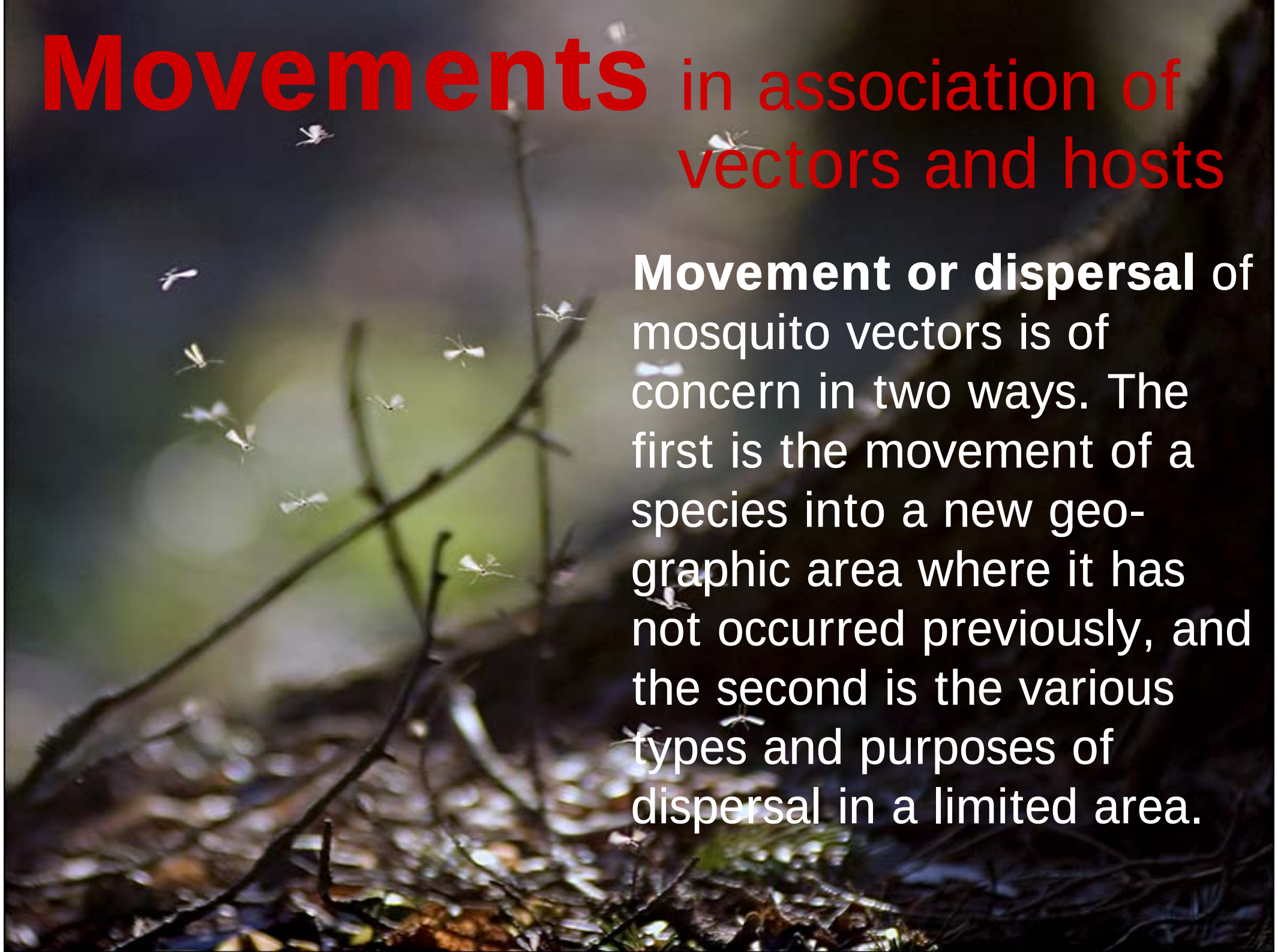
Longevity

parous : nulliparous

A mosquito population can be maintained if only a few females succeed in oviposition.

For transmission of arboviruses, a proportion of a vector population must take ≥ 2 blood meals from both infected and susceptible vertebrate hosts. The population also must live long enough to complete extrinsic incubation of the virus and thereafter is infected for the remainder of its life.

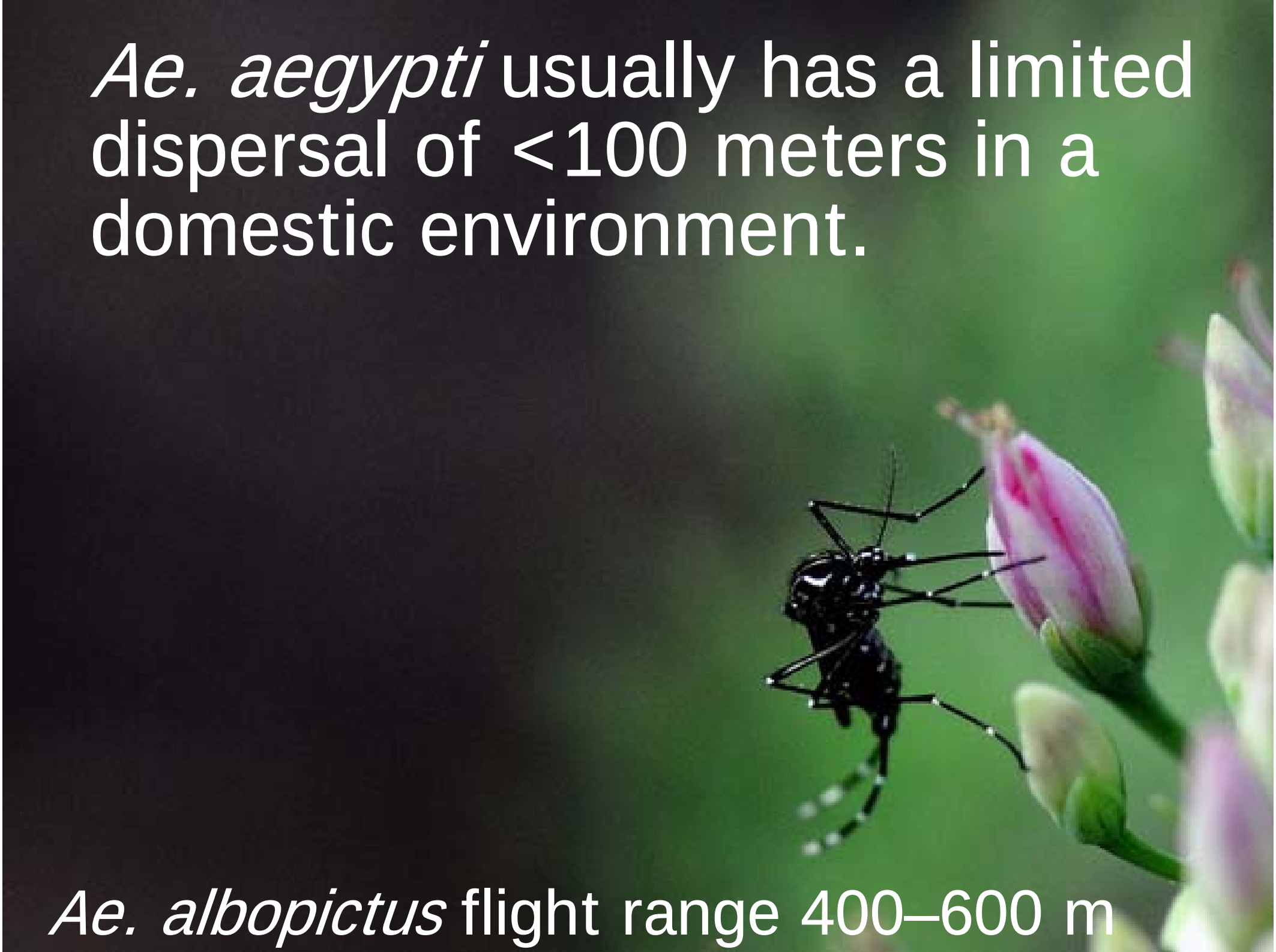




Movements in association of vectors and hosts

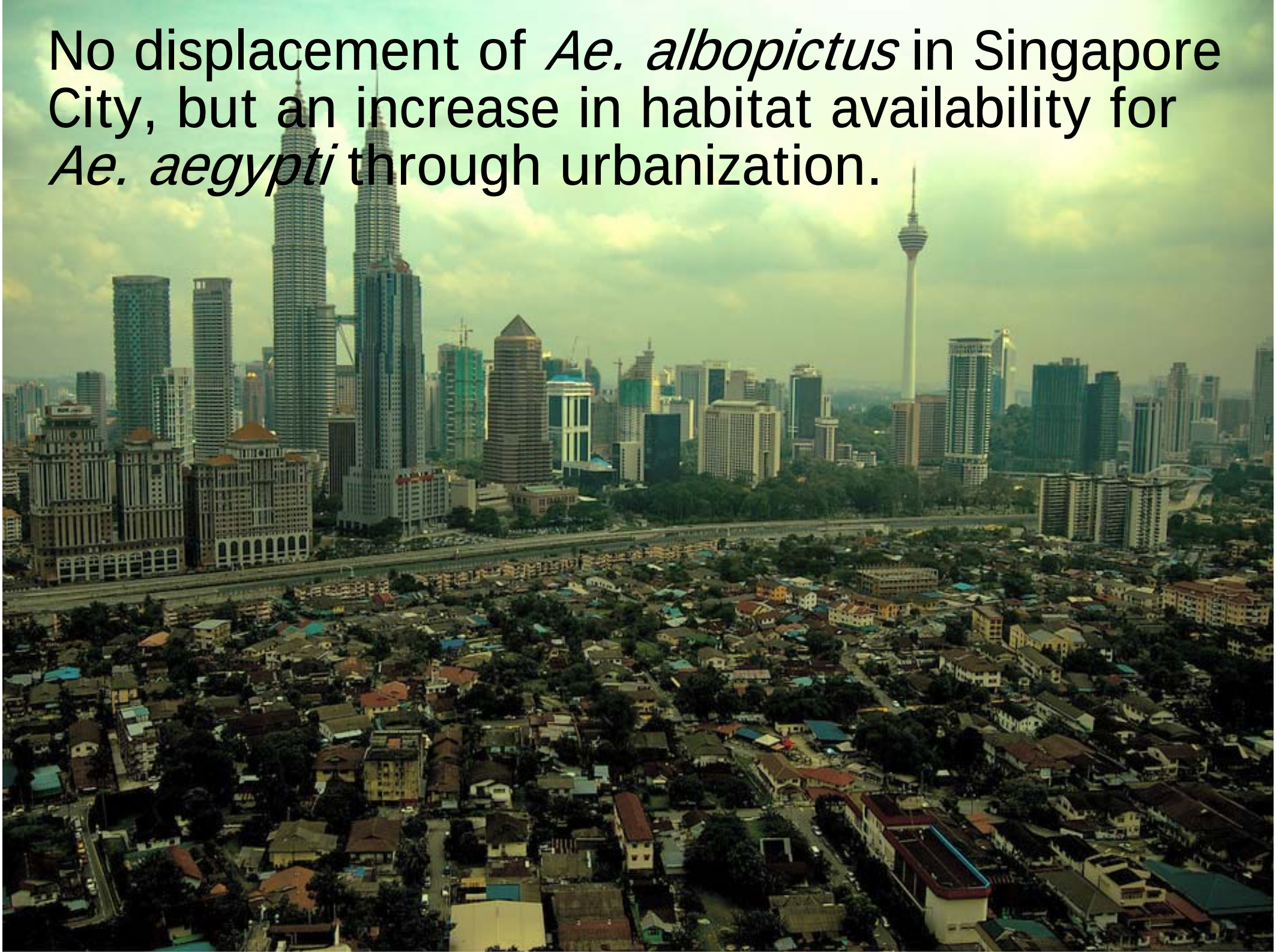
Movement or dispersal of mosquito vectors is of concern in two ways. The first is the movement of a species into a new geo-graphic area where it has not occurred previously, and the second is the various types and purposes of dispersal in a limited area.

Ae. aegypti usually has a limited dispersal of <100 meters in a domestic environment.



Ae. albopictus flight range 400–600 m

The application of insecticides to domestic environments tended either to eliminate the domestic portion of a vector population or to drive the mosquitoes out-of-doors and this was reflected in a change in their feeding habits.


No displacement of *Ae. albopictus* in Singapore City, but an increase in habitat availability for *Ae. aegypti* through urbanization.

Dispersal and Distribution

Urban- Rural- Sylvatic Ecosystems

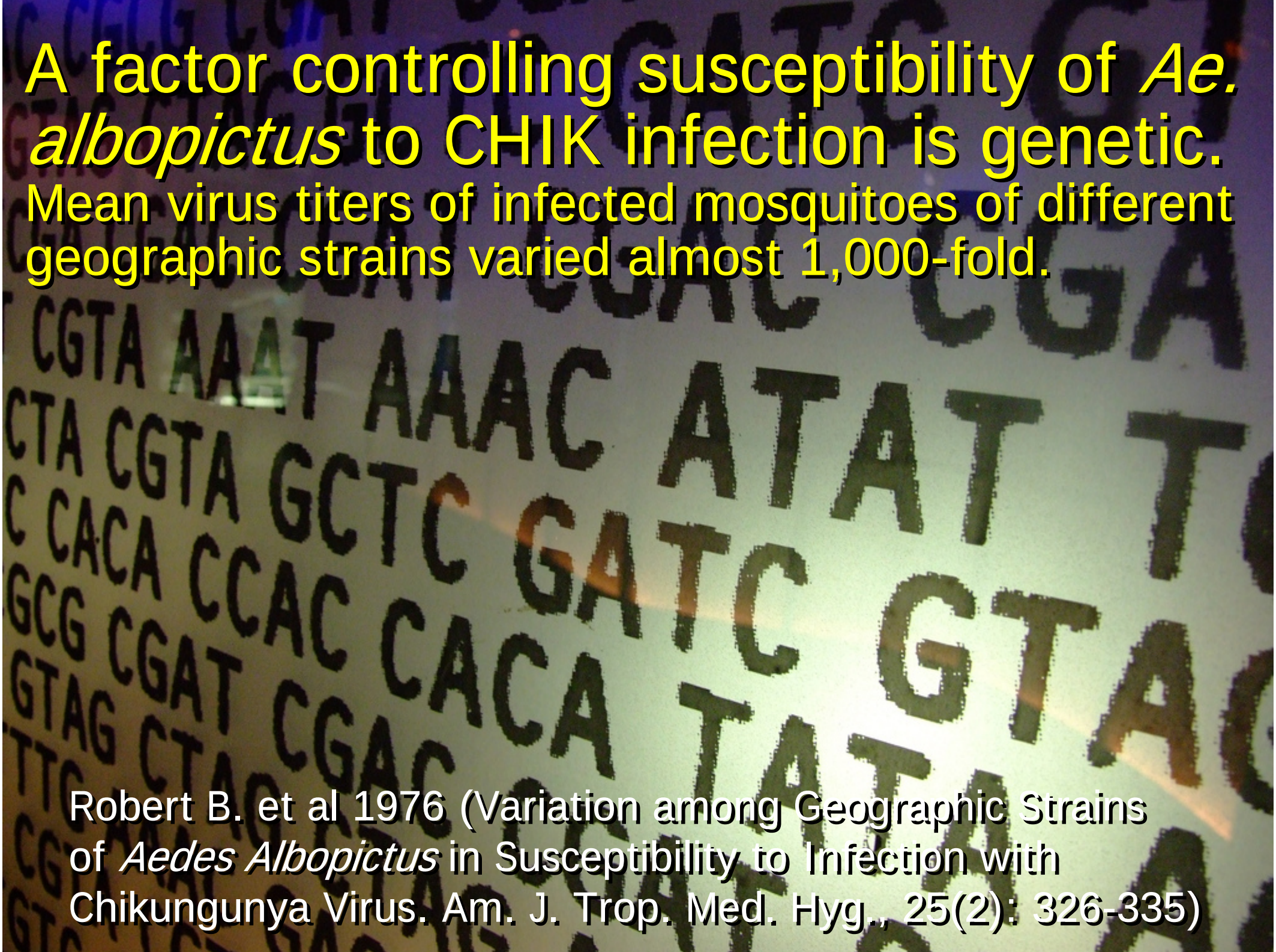
Biotic and abiotic factors

Coexistence of *Ae. aegypti* and *Ae. albopictus*

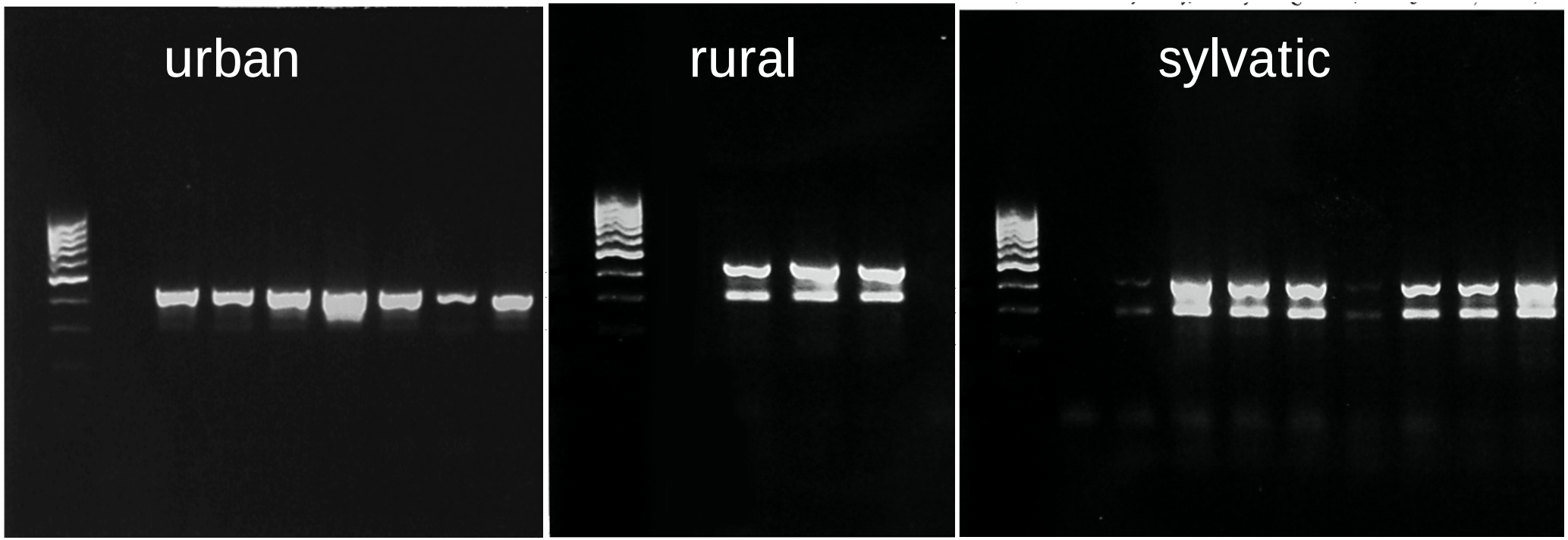
Bangkok: albopictus mosquitoes occurred both indoors and mostly outdoors in small proportion (7-10%)

Prachinburi: up to 100% indoors

Occurrence, distribution and prevalence of *Ae. albopictus* in Bangkok metropolitan
Samung et al. 2008. Komalamisra personal communication, 2009


A factor controlling susceptibility of *Ae. albopictus* to CHIK infection is genetic.
Mean virus titers of infected mosquitoes of different geographic strains varied almost 1,000-fold.
Robert B. et al 1976 (Variation among Geographic Strains of *Aedes Albopictus* in Susceptibility to Infection with Chikungunya Virus. Am. J. Trop. Med. Hyg., 25(2): 326-335)

Urban strain contained point mutation that was different from rural and sylvatic strain, indicating an absence of genetic exchange with rural and sylvatic strain.



Potiwat *et al*. 2009. Genetic structure of natural population of *Aedes albopictus*; urban, rural and sylvatic strain.

Ae. albopictus from different ecology vary in their vector competence for CHIK virus.

Ae. albopictus strains originating from different geographic localities vary not only in their oral susceptibility to infection with CHIK virus but also in their ability to replicate the virus once infected.

Tesh *et al*. 1976. Variation among geographic strains of Aedes albopictus in susceptibility to infection with chikungunya virus. Am J Trop Med Hyg. 25(2): 326-335.

Reservoirs

Human beings are reservoir during epidemic periods. Outside these periods the main reservoirs are monkeys, rodents, birds, and other unidentified vertebrates.

In some parts of Africa, CHIKV was isolated from zoophilic mosquitoes. It suggests that the virus circulates in rodents and cattle in the region. Virus was also obtained from a squirrel, chiroptera, and ticks (*Alectorobius sonrai*), as well as the presence of antibodies specific for CHIKV in rodents and birds, support the assumption that secondary wild cycles exist in animals.

rodent tick

chiroptera


Efficient transmission requires intimate and frequent association of an effective host and vector in the same environment.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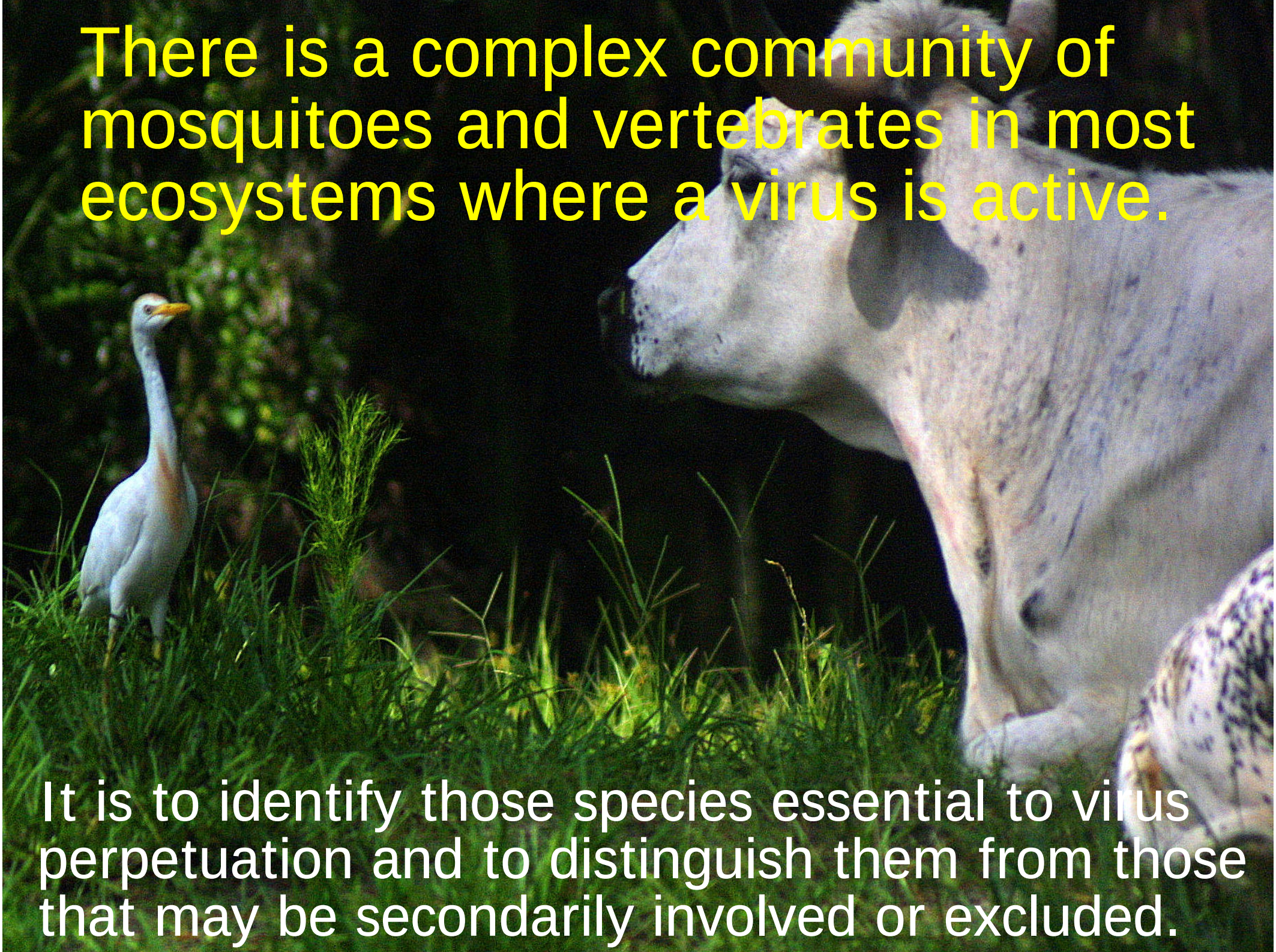
The inoculation rate was ~ one infective bite per mosquito per week, 21 bites of infected mosquitoes (not necessarily infective) per monkey for the transmission season.

Different mosquito species vary widely in their host preferences and may be most selective of their blood sources.


It is essential to search for a long-term reservoir host for chikungunya virus.


There is a complex community of mosquitoes and vertebrates in most ecosystems where a virus is active.
It is to identify those species essential to virus perpetuation and to distinguish them from those that may be secondarily involved or excluded.

Evidence of Transovarian transmission

The infection rate in *Ae. albopictus* was higher than in *Ae. aegypti*, with relative infection rate in male of both species being higher than in female.
(Thavara et al. 2009)

Evidence of sylvatic cycle in Malaysia

The first isolation of chikungunya virus from non-human primates in Malaysia

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Abstract

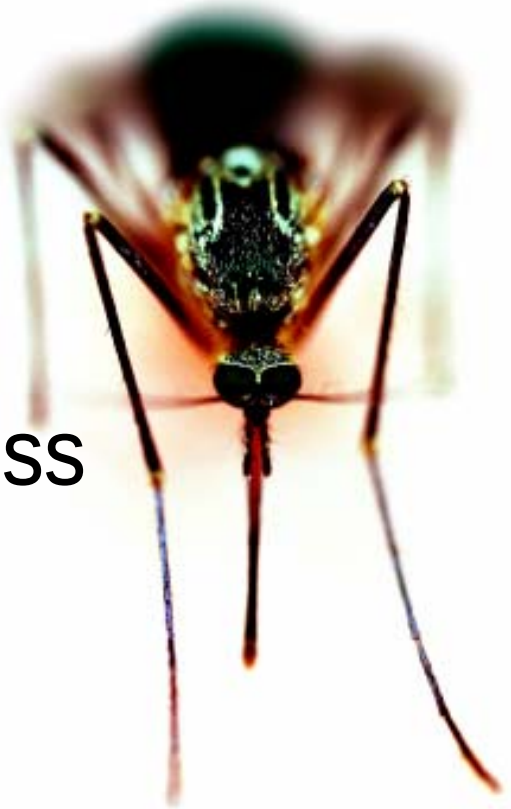
Chikungunya is a mosquito borne disease caused by chikungunya virus (CHIKV). The virus is transmitted to human by Aedes genus mosquitoes. Transmission cycles of CHIKV can be man - mosquito - man (urban cycle) or animal - mosquito - man (sylvatic cycle). Sylvatic transmission cycle of CHIKV has been described in Africa and may play a role in re-emergence of CHIKV infection. In Malaysia, CHIKV-neutralizing antibodies have been detected among wild monkeys in mid 1960s but so far CHIKV has never been isolated in monkeys.

Key words: Chikungunya virus, sylvatic cycle, non human primates, CHIKV genotypes.

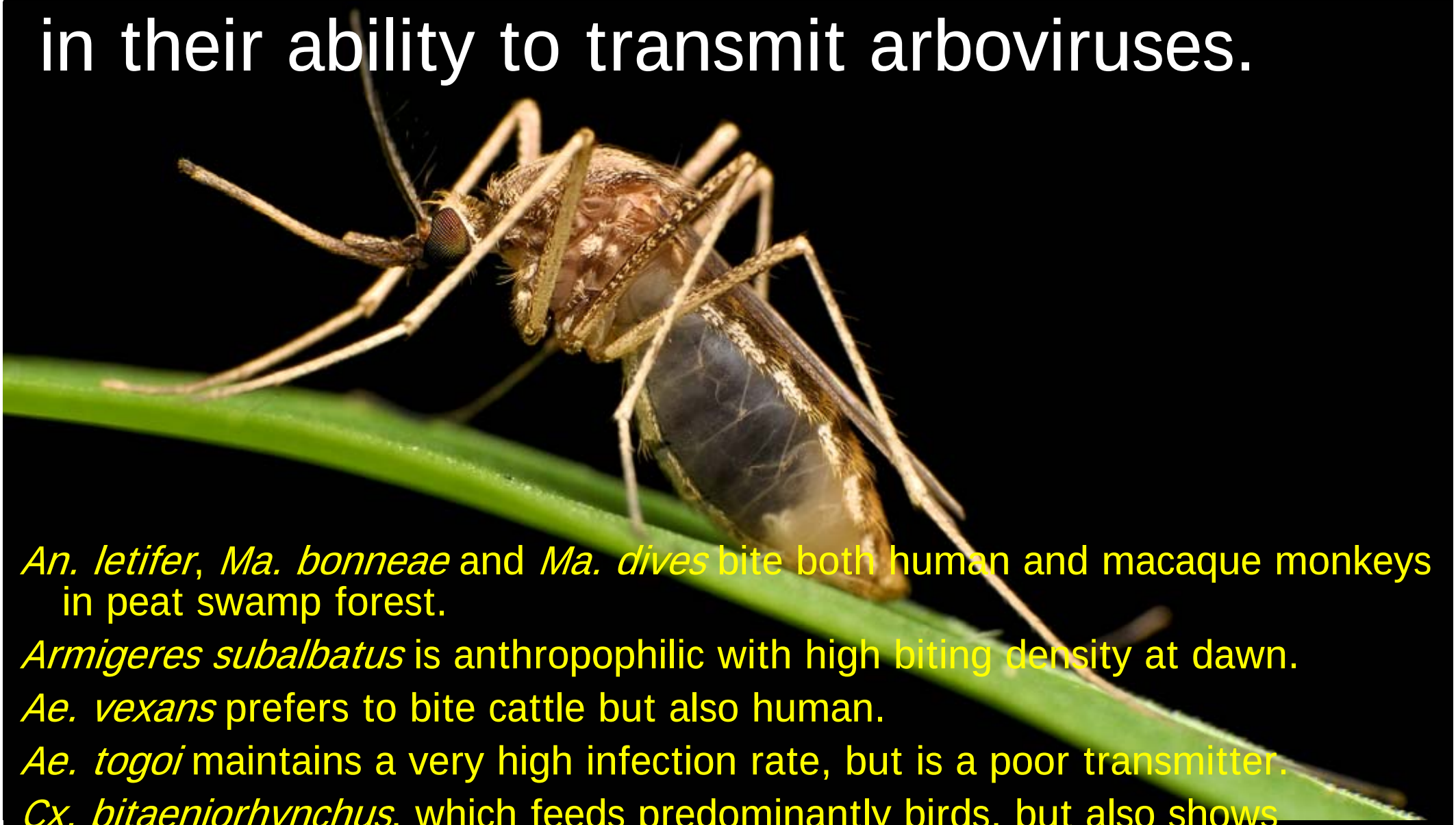
Biological transmission of arboviruses includes acquisition of the virus by the vector from an infectious blood meal,

- replication,
- dissemination of virus to the salivary glands, and
- transmission to a host by bite.

Successful completion of this process requires that infection and dissemination barriers within the mosquito be overcome.



Different mosquito species vary in their susceptibility to experimental infection and in their ability to transmit arboviruses.



An. letifer, *Ma. bonneae* and *Ma. dives* bite both human and macaque monkeys in peat swamp forest.

Armigeres subalbatus is anthropophilic with high biting density at dawn.

Ae. vexans prefers to bite cattle but also human.

Ae. togoi maintains a very high infection rate, but is a poor transmitter.

Cx. bitaeniorhynchus, which feeds predominantly birds, but also shows relatively high proportion of cattle and human feeds.


Thank you