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Aedes aegypti vector competence studies: a review

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Abstract

Aedes aegypti is the primary transmitter of the four viruses that have had the greatest impact on human health, the viruses causing yellow fever (YFV), dengue fever (DENV), chikungunya (CHIKV), and Zika fever (ZIKV). Because this mosquito is easy to rear in the laboratory and these viruses grow in laboratory tissue culture cells, many studies have been performed testing the relative competence of different populations of the mosquito to transmit many different strains of viruses. We review here this large literature including studies on the effect of the mosquito microbiota on competence. Because of the heterogeneity of both mosquito populations and virus strains used, as well as methods measuring potential to transmit, it very difficult to perform detailed meta-analysis of the studies. However, a few conclusions can be drawn: (1) Almost no population of Ae. aegypti is 100% naturally refractory to virus infection. Complete susceptibility to infection has been observed for Zika, Dengue and Chikungunya, but not Yellow Fever virus (2) The dose of virus used is directly correlated to the rate of infection. (3) Brazil populations of mosquito are particularly susceptible to DENV-2 infections. (4) The Asian lineage of ZIKV is less infective to Ae. aegypti populations from the American continent than is the African ZIKV lineage. (5) Virus adaptation to different species of mosquitoes has been demonstrated with CHIKV. (6) Co-infection with more than one virus sometimes causes displacement while in other cases has little effect. (7) The microbiota in the mosquito also has important effects on level of susceptibility to infection with these four viruses. (8) Resistance to virus infection due to the microbiota may be direct (e.g., bacteria producing antiviral proteins) or indirect in activating the mosquito host innate immune system. (9) Non-pathogenic insect specific virus (ISV) are also common in mosquitoes including genome insertions. These too have been shown to have an impact on the susceptibility of mosquitoes to pathogenic viruses.
One clear conclusion is that it would be a great advance in this type of research to implement standardized procedures in order to obtain comparable and reproducible results.

**Background**

There are hundreds of known arthropod-borne-viruses (arboviruses) of which about 30 are known to cause disease in humans (Cleton et al., 2012). Despite this diversity, only four arboviruses have caused by far the most human suffering, the viruses causing yellow fever, dengue, chikungunya and Zika. Not coincidentally, one mosquito, *Aedes aegypti*, has historically been the primary vector in almost all major human epidemics of these four viruses. “Not coincidently” because these viruses are native to Africa, humans are a native African primate, and *Ae. aegypti* is a native African mosquito. It has been suggested that this long history together has allowed the viruses, mosquito, and primate host to coevolve in their native Africa before spreading around the world (Powell 2018).

These four viruses are all single-stranded RNA viruses, known to have high mutation rates, which has likely aided their rapid evolution and adaptation to replicate in different hosts (Weaver 2006; Ruckert and Ebel, 2018). Three are flaviviruses, yellow fever virus (YFV), dengue viruses (DENVs), and Zika virus (ZIKV) and one an alphavirus, chikungunya virus (CHIKV). All cause similar symptoms in humans, high fever lasting 4-14 days and joint pain. Yet each has its unique pathology with high rates of mortality for YFV and sometimes DENVs, but rarely for CHIKV or ZIKV.

Fortuitously, *Ae. aegypti* is the easiest mosquito to rear and manipulate in the laboratory. The viruses can be grown in mosquito cell tissue cultures and either injected or added to blood used to feed females. This has led to a large number of laboratory studies of the relative competence (see definition below for vector competence) of mosquitoes from diverse geographic populations to transmit these viruses. The prevalence of diseases caused by these viruses is geographically heterogeneous likely, at least partly, due to variation in competence among local populations of *Ae. aegypti*.

Here we review studies of the ability of these four viruses to be transmitted by geographically diverse populations of *Ae. aegypti*. We struggle with the issue of heterogeneity in laboratory procedures and virus strains used in an attempt to detect underlying patterns. How genetic diversity that affects phenotypes, such as vector competence, varies among populations remains an open question. However, the fact that populations of *Ae. aegypti* are genetically distinct (e.g., Gloria-Soria et al. 2016) makes it more likely that they vary in vector competence compared to genetically uniform species. We also consider the contribution of
microbiota in vector competence. Microbiota is a normal part of the physiology of vectors and it is clear that these microbes can affect how mosquitoes react to infection with viruses. However, details of the interactions and how these interactions vary among genetically heterogeneous mosquito populations remain to be elucidated

Quantifying the epidemiological impact of *Ae. aegypti*

*Aedes aegypti* was first identified as vector for arbovirus in 1900 in Cuba by Walter Reed, Carlos Finlay and James Carroll (Reed and Carroll 1901). A few years later (1906), Thomas Bancroft demonstrated that *Ae. aegypti* is able to also transmit DENVs and linked frequency of transmission to the diurnal biting habits of *Ae. aegypti* (Bancroft, 1906). The identification of the role of mosquitoes in the transmission cycle of human pathogens led scientists to the concept of vector control, that is, the control of pathogen transmission through the control of vectors. To formulate epidemiological predictions and assess the impact of vector control strategies, objective parameters have been proposed since the early 1900s that would mathematically link mosquito behaviors and their biological properties to pathogen transmission (Smith et al., 2012). The basic elements of the mathematical model of mosquito-borne disease were first conceptualized in the Ross-MacDonald "vectorial capacity" equation (Smith et al., 2012). Vectorial capacity defines the transmission potentials of a mosquito population and equals to $VC=[ma^2bp^n]/ln(p)$ where “m” is the density of vectors in relation to the host; “a” is the daily probability that the vector feeds on a host, this variable is raised to the second power because a mosquito needs to bite twice to perpetuate pathogen transmission; “b” is the intensity of transmission in relation to the initial infection rate, also called vector competence; “p” is the daily survival rate of a vector; “n” is the days it takes for a pathogen to move from the point of entry in the mosquito body (i.e. the mosquito midgut) to the point of exit (i.e. saliva), a parameter called “extrinsic incubation period” (EIP); and “1/ln(p)” is the probability of vector’s surviving the EIP (Kauffman and Kramer, 2017; Rückert and Ebel, 2018).

Environmental and genetic factors of both the vector and the pathogen interact to influence the parameters of the VC equation. For instance, temperature influences EIP, the probability of mosquito survival, and may also indirectly affect adult density by impacting larval developmental time as amply discussed and reviewed elsewhere (Le Flohic et al., 2013; Gould and Higgs, 2009; Fish, 2008; Tabachnick, 2016; Kauffman and Kramer, 2017). Temperature also influences *Ae. aegypti* vector competence to DENVs (Carrington et al., 2013; Chepkorir et al., 2014; Gloria-Soria et al., 2017). *Vector competence* is defined as the capacity of a mosquito to acquire the pathogen and support its transmission; it is one of the most difficult parameters to
compare among studies because no standardized procedures have been proposed and agreed upon by workers in the field to define viral transmission. An attempt to reduce the variability in vector competence estimates based on the genetic variability of the mosquito populations under test is to measure the heritability of viral titers in half-sibling experiments (i.e. Garcia-Luna et al., 2018; Vezzeille et al., 2016).

It has been challenging to identify a proxy for transmission given the difficulties in developing animal models for arboviral diseases that mimic pathogenesis and immunity in humans (Zompi and Harris, 2012). For instance, for DENVs, ZIKV and CHIKV various mouse models have been developed by genetically suppressing the mouse immune systems to allow viral replication and manifestation of disease symptoms (Na et al., 2017; Morrison and Diamond, 2017). However, these models are not applicable to all DENV serotypes (Na et al., 2017). YFV infects Indian crown and rhesus macaques and were used to develop early YFV vaccines (Beck and Barrett, 2015). In older literature, vector competence is often expressed in terms of infection and/or dissemination rate, that is the percentage of engorged females with virus detected in the head (as a proxy for the salivary glands, which are located at the base of the mosquito head) and/or in the whole body or legs. In more recent literature, the percentage of engorged females with viral particles in the saliva following the EIP (i.e. transmission rate) is often reported (Supplementary Table 1). Viruses can be detected with various methods, primarily with RT-PCR using virus-specific primers and indirect immunofluorescent assays on head squashes. A few studies have tested transmission by inoculating tissue cultures (Aedes albopictus C6/36 and Ae. aegypti Aeg2 are the most used) with mosquito body extracts or saliva and doing plaque assays or testing for viral particles after an incubation period (Calvez et al., 2017; Agha et al., 2017); this confirms live virus particles are present in saliva, rather than simply viral RNA as detected by RT-PCR. Viral detection to test for transmission is mostly pursued between 7-14 days after viral infection (Supplementary Table 1). Shorter incubation periods are used for CHIKV as this virus has a faster dissemination rate than DENVs (Dubrulle et al., 2009; Rückert and Ebel, 2018).

**Vector competence of Ae. aegypti populations for arboviruses**

Despite the lack of uniformity in the procedures to test for vector competence and a focus on sampling mosquitoes in geographic areas with endemic arboviral infections or with significant epidemics (i.e. Thailand, Vietnam, New Caledonia, Mexico, Brazil, Florida, La Reunion island and Senegal), review of literature on infection, dissemination and transmission rates of arboviruses by *Ae. aegypti* mosquitoes support some general conclusions, data in
Table 1. (1) Cases of complete refractoriness to arboviral infection are rare (Kay et al., 1979; Rosen et al., 1985; Diallo et al., 2008; Dickson et al., 2014; Agha et al., 2017). (2) Complete susceptibility to infection has been detected for Ae. aegypti populations from New Caledonia, Thailand, Australia, South Africa for DENVs; for ZIKV Dominican Republic, Brazil, China and Singapore; for CHIV Mexico and Guadaloupe for CHIKV (Girod et al., 2011; Vega-Ruiz et al., 2014), but no completely susceptible for any population tested for YFV (Table 1); (3) Initial infection dose of virus positively correlates with infection rate. (4) Brazilian populations of Ae. aegypti are particularly susceptible DENV-2 (Goncalves et al., 2014; Carvalho-Leandro et al., 2012; Lourenco-de-Oliveira et al., 2004). (5) The African lineage of ZIKV was shown to be more infective to Ae. aegypti mosquitoes from the American continent than the ZIKV Asian lineage (Weger-Lucarelli et al., 2016; Roundy et al., 2017). (5) Virus adaptation different mosquito species appears an important evolutionary force for CHIKV, but its role in DENVs evolution is still controversial (Lambrechts et al., 2009; Tsetsarkin et al., 2011; Fansiri et al., 2016). The best-known example of vector-driven adaptation in an arbovirus is the emergence on La Reunion in 2005 of the A226V amino acid substitution in the E1 envelope glycoprotein of CHIKV that favors CHIKV replication in Aedes albopictus mosquitoes (Tsetsarkin et al., 2007). (6) Limited data are available on co-infections with different viruses or serotypes/genotypes of one viral species. Some co-infection experiments suggest competitive displacement of DENV-4 over DENV-1 (Vazeille et al., 2016) or superinfection interference (Muturi et al., 2017). Other studies indicate that Ae. aegypti infection with one arbovirus (i.e. CHIKV, DENV2 or ZIKV) only mildly affects infection with a subsequent infection with another (Rückert et al., 2017).

The most obvious and well accepted observation from reviewing literature on vector competence in Ae. aegypti is that there is great variability in susceptibility to arboviral infections across geographic populations and even for the same population with different viral species and strains; this variability includes comparisons between the domestic Ae. aegypti aegypti and the sylvatic Ae. aegypti formosus with respect to DENVs infections (Bosio et al., 1999; Gaye et al., 2014; Dickson et al., 2014). The great variation among geographic populations of mosquito is likely due to the fact that vector competence is a complex and evolving phenotype dependent on the tri-partite interaction among the host (i.e. mosquito), the pathogen, and other host symbionts (Vasilakis and Tesh, 2015; Hedge et al., 2015). The high genetic structure among Ae. aegypti populations is also a likely contributing factor. This variation across populations suggests that the co-evolution between Ae. aegypti and arboviruses did not favor a single pathway/factor in the mosquito, likely because exposure to arboviral infection is the accidental consequence of hematophagy the primary purpose of which is to support to egg development.
Furthermore, it is unclear how great, or even if there is, any fitness cost to mosquitoes to transmit these viruses (see e.g., Padilha et al. 2018). Selection-driven variation is more likely to be on the virus.

Specific physiological and genetic factors in mosquitoes contributing to vector competence has been thoroughly reviewed elsewhere (Franz et al., 2015; Pando-Robles and Batista, 2017; Wang et al., 2017; Palmer et al., 2018).

**Microbiota and vector competence**

The gut of mosquitoes is colonized by a resident microbiota which influences key physiological processes related to pathogen transmission (Guégan et al., 2018; Pike et al., 2017). In *Ae. aegypti*, DENVs replication is significantly affected by gut bacterial flora (Xi et al., 2008; Ramirez et al., 2014), the depletion of which by antibiotics renders mosquitoes more susceptible (Xi et al., 2008). Oral reintroduction of specific bacterial species into the adult mosquito midgut results in decreased viral load in the vector (Ramirez et al., 2012; 2014). Mosquito gut bacteria are presumed to exert antiviral activity through either direct or indirect mechanisms (Dennison et al., 2014; Saraiva et al., 2016; Guégan et al., 2018). While these mechanisms are not completely understood, recent studies have demonstrated that indirect mechanisms rely mainly on the basal level activation of innate antiviral responses and antimicrobial peptides (AMPs) by the gut microbiota (Xi et al., 2008; Ramirez et al., 2012). On the other hand, antiviral activity may be directly mediated by bacterial antiviral compounds (Ramirez et al., 2014). Indeed, a *Chromobacterium sp.* isolated from the *Ae. aegypti* midgut in Panama (*Csp_P*) produces an aminopeptidase that can bind to envelope protein of DENVs and prevent viral attachment and further invasion/replication within the host cell (Saraiva et al., 2018). Interestingly, the same bacterium has been shown to be pathogenic to both *Ae. aegypti* and *An. gambiae* (Ramirez et al., 2014) via the production of hydrogen cyanide (Short et al., 2018). Besides, it is important to consider the massive increase of bacteria in the midgut of mosquito vectors after a blood meal, and the interference with physiological processes related to the control of midgut homeostasis, such as the production of Reactive Oxygen Species (ROS) and the peritrophic matrix (Kumar et al., 2010; Oliveira et al., 2011; Rodgers et al., 2017). These processes may potentially affect mosquito vector competence and should be further investigated.

The environment, especially the larval breeding water, is pivotal in determining the mosquito gut microbiota composition (Coon et al., 2014; Duguma et al., 2015; Gimonneau et al., 2014), which varies considerably among local habitats of geographically distinct populations.
Most of the diversity found in the *Ae. aegypti* larvae gut is also present in the water where mosquitoes developed, with about half of it being transtadially transferred from larvae to adults (Coon et al., 2014). In addition to the environment, the mosquito genetic background also likely influences gut microbial diversity. While the mechanisms surrounding this interplay are largely unknown, concomitant decreases in both mosquito and bacterial genetic diversity have been observed in *Ae. albopictus* populations recently introduced in France (Minard et al., 2015).

It remains an open question of whether (and how) the gut microbial diversity influences mosquito competence to transmit human pathogenic arboviruses. Is the difference in vector competence among distinct mosquito populations due to their intrinsic microbiomes or genetic differences in the mosquitoes or, most likely, a combination/interaction of both factors? In this context, assessment of the gut bacteria repertoire of the genetically-selected DENV-resistant (MOYO-R) and -susceptible (MOYO-R) *Ae. aegypti* strains, identified some bacterial genera exclusively in either the resistant or in the susceptible strain (Charan et al., 2013). More recently, bacteria from the families *Rhodobacteriaceae* and *Desulfuromonadaceae* have been described as potential biomarkers of ZIKV infection in *Ae. aegypti* (Villegas et al., 2018).

Exposure of germ-free *Ae. aegypti* larvae to different microbiota-derived bacterial species has been shown to result in variation in several mosquito life-history traits, including the load of DENVs disseminated to the insect head (Dickson et al., 2017). While these studies provide important insights on the interplay between mosquito microbiomes and vector competence, the relative contribution of mosquito genetics and its microbiome in the control of vector competence remains to be elucidated, but it will almost certainly be key for understanding fundamental aspects of the variation in arbovirus transmission by different populations of *Ae. aegypti*.

**Viriome and vector competence**

The recent explosion of metagenomics studies led to the discovery of novel viral species, which are insect-specific and not able to replicate in vertebrate cells despite being phylogenetically-related to arboviruses (Vasilakis and Tesh, 2015; Bolling et al., 2015; Roundy et al., 2017). Insect-Specific Viruses (ISVs) identified so far in *Ae. aegypti* mosquitoes belong primarily to the *Flaviviridae* family, followed by the *Negoviridae* and *Bunyaviridae* families (Vasilakis and Tesh, 2015; Bolling et al., 2015, Hall et al., 2017). While the landscape of ISVs and their prevalence in natural mosquito populations vary greatly, the cell fusing agent virus (CFAV) appears to be the most common ISV in field-collected *Ae. aegypti* (Cook et al., 2006;
Interestingly, CFAV transmits vertically and is absent in saliva and salivary glands of *Ae. aegypti* (Guegan et al., 2018). The impact of CFAV on *Ae. aegypti* vector competence has not been investigated yet, but heterologous interference was seen between Eilat virus and CHIKV in *Ae. aegypti* (Nasar et al., 2015). Eilat virus is an ISV of the *Alphavirus* genus, which was first isolated in *Anopheles constani* mosquitoes from Israel (Nasar et al., 2012). It readily infects *Ae. aegypti* (Nasar et al., 2014) and when used to infect mosquitoes prior to CHIKV infection, it delays CHIKV dissemination by 3 days (Nasar et al., 2015). Furthermore, it is possible that ISVs influence, to some extent, the mosquito’s innate immune response, which could directly impact viral replication and the gut microbial diversity. These studies underscore the importance of expanding our knowledge of the viriome (the set of viruses in an organism) and highlight its possible application for the control of arboviral infections within mosquitoes (Hall et al., 2017).

Interaction between viruses and mosquitoes may include horizontal transfer of genetic material. The genome of *Ae. aegypti* is rich in sequences with similarities to ISVs of the *Flavivirus* and *Rhabdovirus* genera and Chuviruses (Chen et al., 2015; Palatini et al., 2017; Whitfield et al., 2017). Sequences of viral origin are statistically enriched in piRNA clusters and encode for piRNAs, suggesting that they may function analogously to transposable element fragments within the piRNA pathway (Palatini et al., 2017, Whitfield et al., 2017). In light of this, it has been proposed that viral integrations constitute a heritable immune signal and thus could be an additional factor shaping mosquito vector competence (Olson and Bonizzoni, 2017; Palatini et al., 2017, Whitfield et al., 2017).

**Conclusions and perspective**

The recent emergence and spread of Zika, the current re-emergence of YFV in Brazil and Africa, the emergence of dengue in Europe, and the expansion of chikungunya to the New World brought vector-borne diseases to public attentions and fostered research. Despite great progress in the understanding of the interplay between arboviruses and vectors, the genetic and environmental elements that control vector competence in *Ae. aegypti* populations have yet to be fully understood. Here we reviewed historical and modern data on factors influencing vector competence in *Ae. aegypti* populations to four of the most prevalent arboviruses (i.e. DENVs, YFV, ZIKV and CHIKV). We identified no clear-cut distinctive natural factors associated with variation in vector competence among mosquito populations and/or viral species due primarily to the heterogeneity of materials (strains of mosquito and virus) and methods used in different studies. This highlights the need to standardize surveillance and laboratory procedures for
assessing vector competence and to expand the range of mosquito populations and viral strains (and serotypes) tested (Fig. 1). While workers target populations and virus strains of interest to them, at the very least procedures to determine what are reported as infection rate, dissemination rate, and transmission rate should be standardized.

While there is a clear influence of the microbiota on arboviral infection, the relative importance of mosquito genetics and microbial diversity, including the interplay between these factors, on vector competence remains largely unknown and deserves attention from the scientific community.

Acquisition of arboviruses by mosquitoes is a by-product of blood-feeding, which is a necessary physiological process for egg production. Even during active arboviral epidemics, the frequency of mosquitoes infected with the pathogenic virus is usually around 1%, but can vary from 0.05% to >10% (Chow et al., 1998; Pham Thi et al., 2017; Perez-Castro et al., 2016; Medeiros et al., 2018). In addition to these human pathogenic viruses, blood-feeding exposes mosquitoes to a broad range of entities, including bacteria, fungi and other symbionts and parasites. Considering the essential role of blood-feeding, mosquitoes must be able to withstand these microbial challenges to survive. In this context, co-evolution between mosquitoes and viruses should be viewed as a by-product of diverse and possibly broad-range physiological processes. Some of these interactions may be deterministic and selection-driven while others may be stochastic (e.g., genetic drift) or indirect. In any case, it is clear that the genetic heterogeneity both within and among mosquito populations need to be considered in any attempts to identify genetic elements contributing to vector competence for arboviruses.

These studies have both basic science and applied importance. Unravelling the genetic components of vector competence means investigating the co-evolutionary processes between arboviruses and vectors, with the potential to identify factors that may be co-opted for genetic-based vector control strategies or identify steps in the transition from ISVs to arbovirus capable of infecting vertebrates. This should be possible in light of the fact that some ISVs are phylogenetically ancestral to arboviruses in the same virus family (Marklewitz et al., 2015). Additionally, a better knowledge of the variability and interaction between mosquitoes and their microbiota could lead to novel vector control methods based on native and introduced mosquito symbionts (i.e. *Asaia* and *Wolbachia* spp.) (Rossi et al., 2015; Ritchie et al., 2018).

**Figure Subtitles**
Figure 1. Natural and technical confounding factors related to arbovirus vector competence studies in *Aedes aegypti*. Despite progress in the understanding of the interplay between arboviruses and vectors, the genetic and environmental elements that control vector competence in *Ae. aegypti* populations have yet to be fully understood. Further elucidation is needed especially of co-evolutionary processes between arboviruses and vectors, as well as their symbionts. On the other hand, procedures used in vector competence studies should be standardized in order to improve reproducibility and comparability of scientific outputs. Together these will result in better understanding of genetic and microbial factors influencing arboviral transmission, which can lead to the development of new public health interventions.
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Table 1. Summary of vector competence estimates across *Ae. aegypti* geographic populations to 1) DENVs, 2) ZIKV, 3) YFV; 4) CHIKV; 5) dual-infections and 6) infections with arboviruses other than DENVs, YFV, ZIKV and CHIKV. Abbreviations: BM, mosquitoes offered an infectious blood meal; IT, mosquitoes were infected by intrathoracic inoculation; dpi, days post infection; IR, percentage of engorged females with viral particles in the head, legs and/or salivary glands; TR, transmission rate calculated as percentage of engorged females with viral particles in the saliva at 14 dpi, unless otherwise stated; PFU, plaque forming units; FFU, fluorescent focus units; L, lentivirus; TCID, tissue culture infectious dose; MID, mosquito infectious dose for 50 of *Ae. aegypti* individuals; EIP, extrinsic incubation period; MX, Mexico; NC, New Caledonia; Col, Colombia; Viet, Vietnam; NG, New Guinea; FG, French Guiana; Thai, Thailand; S, S, FR, PR, BR, Brazil; Aus, Australia; Chi, China; Philippines, Phi, FL, Florida; South Africa, SA; Texas, TX; California, CA; isol., isolate; human serum, hs; lab. strain, laboratory strain.

| Reference | Mosquito origin | Virus genotype and strain | Infection Route, virus dose | Vector Competence |
|-----------|-----------------|---------------------------|-----------------------------|------------------|
| Calvez et al., 2018 | Noumea, NC | DENV-1 NC14-17022014-806 | BM, 10^6 | IR in bodies 50 at 7 dpi, 60 at 7 dpi, 100 at 14 dpi; TR 35 at 21 dpi |
| Ouvea, NC | DENV-1 NC14-17022014-806 | BM, 10^6 | IR in bodies 53 at 7 dpi, 100 at 7 dpi, 87 at 14 dpi; TR 13 at 21 dpi |
| Poridemie, NC | DENV-1 NC14-17022014-806 | BM, 10^6 | IR in bodies 33 at 7 dpi, 70 at 7 dpi, 100 at 14 dpi; TR 13 at 21 dpi |
| Papeete, Thaiti Island | DENV-1 NC14-17022014-806 | BM, 10^6 | IR in bodies 47 at 21 dpi |
| Serrato et al., 2017 | Valle Grande, Col | DENV-2 NG | BM, 10^6.1.10^7 | IR 68 at 15dpi |
| Paso del Comercio, Col | DENV-2 NG | BM, 10^6.1.10^7 | IR 55 at 15 dpi |
| Siloe, Col | DENV-2 NG | BM, 10^6.1.10^7 | IR 52 at 15 dpi |
| Mariano Ramos | DENV-2 NG | BM, 10^6.1.10^7 | IR 52 at 15 dpi |
| Ho Chi Minh City, Viet | DENV-2 strain 6H, Hanoi Viet | BM, 2.8x10^7 | IR 4.2 at 25ºC; 9.1 at 27ºC |
| Hanoi, Viet | DENV-2 strain 434S, Long An Province, Viet | BM, 3.77x10^7 | IR 8.1 at 25ºC; 13 at 27ºC |
| Vazeille et al., 2016^a | Center Cayenne, FG | DENV-2 strain 6H, Hanoi Viet | BM, 2.8x10^7 | IR 10.8 at 25ºC; 2.8 at 27ºC |
| | DENV-2 strain 434S, Long An Province, Viet | BM, 3.77x10^7 | IR 24.6 at 25ºC; 9.8 at 27ºC |
| | DENV-1 isol. from a 2009 patient living in Cayenne | BM, 10^6.10^6 | IR 20 at 8dpi, 35 at 10dpi, 70 at 14dpi, 35 at 15dpi; TR 3 at 14dpi, 13 at 15dpi |
| | DENV-4 isol. from a 2009 patient living in Cayenne | BM, 10^6.10^6 | IR 40 at 8dpi, 60 at 10dpi, 13 at 14dpi, 100 at 15dpi; TR 0 at 14dpi, 3 at 15dpi |
| | DENV-1 isol. from a 2009 patient living in Cayenne | BM, 10^6.10^6 | IR 20 at 8dpi, 50 at 10dpi, 70 at 14dpi, 50 at 15dpi; TR 0 at 14dpi, 13 at 15dpi |
| | DENV-4 isol. from a 2009 patient living in Cayenne | BM, 10^6.10^6 | IR 20 at 8dpi, 50 at 10dpi, 70 at 14dpi, 50 at 15dpi; TR 0 at 14dpi, 13 at 15dpi |
| Guo et al., 2016 | Hainan province | DENV-2-FJ10 | BM, 1.75x10^5 | IR 0 (B3 viral strain, experiment 1); IR 0 (K1 viral strain, experiment 1); IR 10 (B76 viral strain, experiment 1) |
| | Center Cayenne, FG | DENV-2-FJ11 | BM, 2x10^5 | IR 0 at 7dpi, 74.9 at 14dpi, 90 at 21dpi |
| Fansiri et al., 2016 | Bangkok, Thai | 14 DENV-1 Thai isol. | BM, 1.5x10^5-8.5x10^6 | IR 0 at 14dpi, 67.5 at 21 dpi |
| Kamphaeng Phet Province, Thai | 14 DENV-1 Thai isol. | BM, 1.5x10^5-8.5x10^6 | IR 0 at 14dpi, 67.5 at 21 dpi |
| Fernandes da Moura et al., 2015 | Santiago Island, Cape Verde | DENV-1 42735/BR PE | BM, 5x10^5-2x10^5 | IR 0 at 14dpi, 67.5 at 21 dpi |
| Country                      | City                   | Virus Strain/Isolate | Log$_{10}$ (Mean) | IR | TR |
|-----------------------------|------------------------|----------------------|------------------|----|----|
| Kifili, Kenya               |                        |                      |                  |    |    |
| Nairobi, Kenya              |                        |                      |                  |    |    |
| Phet Province, Thai         |                        |                      |                  |    |    |
| Key West, FL                |                        |                      |                  |    |    |
| Dakar, S                    |                        |                      |                  |    |    |
| Bignona, S                  |                        |                      |                  |    |    |
| Mont Rolland, S             |                        |                      |                  |    |    |
| Fatick, S                   |                        |                      |                  |    |    |
| Bignona, S                  |                        |                      |                  |    |    |
| Rufisque, S                 |                        |                      |                  |    |    |
| Sylvic Aedes aegypti formosus from Dakar, S | DENV-2 ET-300 strain isol. in Timor-Leste in 2000 | 6.8 ± 0.5 | IR 28 at 7 dpi, 14 dpi in whole body | TR 55 at 14 dpi |
| Sylvic Aedes aegypti formosus from Dakar, S | DENV-3 H87 | 7.1 ± 1.2 | IR 28 at 7 dpi, 14 dpi in whole body | TR 55 at 14 dpi |
| Sylvic Aedes aegypti formosus from Dakar, S | DENV-1 IbH28328 | 5x 10$^{-3.3}$ | IR 40 at 7 dpi, 30 at 15 dpi |    |
| DENV-3 ET-300 strain isol. in Timor-Leste in 2000 | 5x 10$^{-3.3}$ | IR 40 at 7 dpi, 30 at 15 dpi |    |
| DENV-2 ET-300 strain isol. in Timor-Leste in 2000 | 5x 10$^{-3.3}$ | IR 40 at 7 dpi, 30 at 15 dpi |    |
| DENV-2 ET-300 strain isol. in Timor-Leste in 2000 | 5x 10$^{-3.3}$ | IR 40 at 7 dpi, 30 at 15 dpi |    |
| DENV-2 ET-300 strain isol. in Timor-Leste in 2000 | 5x 10$^{-3.3}$ | IR 40 at 7 dpi, 30 at 15 dpi |    |
| Study/Strain/Location | Virus Strain | BM Concentration | Midgut Infection Rate | Abdominal Death Rate | Leg Death Rate |
|-----------------------|--------------|------------------|----------------------|---------------------|---------------|
| Guo et al., 2013      | Haiku strain, Chi | DENV-2 NG C | $10^{8.08}$ | 0% | 0% |
| Sim et al., 2013$^3$ | Rockefeller strain | DENV-2 NG C strain | $10^{8.7}$ | 100% | 0% |
|                       | Orlando strain | DENV-2 NG C strain | $10^{8.7}$ | 100% | 0% |
|                       | Waco strain | DENV-2 NG C strain | $10^{8.7}$ | 100% | 0% |
|                       | PR, field | DENV-2 NG C strain | $10^{8.7}$ | 100% | 0% |
|                       | Saint Kitts, field | DENV-2 NG C strain | $10^{8.7}$ | 100% | 0% |
|                       | Por Fin, field | DENV-2 NG C strain | $10^{8.7}$ | 100% | 0% |
|                       | Puerto Triunfo, field | DENV-2 NG C strain | $10^{8.7}$ | 100% | 0% |
|                       | Singapore, field | DENV-2 NG C strain | $10^{8.7}$ | 100% | 0% |
|                       | Bangkok, field | DENV-2 NG C strain | $10^{8.7}$ | 100% | 0% |
| Buckner et al., 2013  | Key West, FL, Kamphaeng Phet Province, Thai | DENV-1 (strain BOLKW010) | $6.3 \pm 0.2 \times 10^5$ | 93% | 80 in vivo |
| Carrington et al., 2013 | Lourenco-de-Oliveira et al., 2013 | DENV-1 | $3.09 \times 10^5$ | 28% | 0% |
|                      | Corrientes, Argentina | DENV-2 Thai 1974 | $10^7$ | 53.3% | 6.7% |
|                      | Salto, Uruguay | DENV-2 Thai 1974 | $10^7$ | 36.4% | 17.9% |
| Richards et al., 2012 | Key West, FL | DENV-1 isol. BOL-KW010 | $3.7 \times 10^5$ | 75 in the abdomen, 30% at 30°C | 0% |
|                      | Key West, FL | DENV-1 isol. BOL-KW010 | $3.7 \times 10^5$ | 75 in the abdomen, 30% at 30°C | 0% |
|                      | Stock Island, FL | DENV-1 isol. BOL-KW010 | $3.7 \times 10^5$ | 75 in the abdomen, 30% at 30°C | 0% |
|                      | Stock Island, FL | DENV-1 isol. BOL-KW010 | $3.7 \times 10^5$ | 75 in the abdomen, 30% at 30°C | 0% |
| Carvalho-Leandro et al., 2012$^3$ | Petrolina, BR | DENV-2 3808/BR-PE | $10^{6.7}$ | 0 at 14 dpi, 100 at 21 dpi | 0% |
|                      | Recife, BR | DENV-2 3808/BR-PE | $10^{6.7}$ | 0 at 14 dpi, 100 at 21 dpi | 0% |
|                      | Rec-L Recife Lab. strain | DENV-2 3808/BR-PE | $10^{6.7}$ | 0 at 14 dpi, 100 at 21 dpi | 0% |
| Sylla et al., 2009    | D2MEB | DENV-2 JAM1409 | $3.1 \times 10^{7.8}$ | 51.2% | 0% |
|                      | D2S3 | DENV-2 JAM1409 | $3.1 \times 10^{7.8}$ | 92.3% | 0% |
| Study                  | Location           | Virus Strain                        | BM, ntd | IR Value       |
|-----------------------|--------------------|------------------------------------|---------|----------------|
| Schneider et al., 2007| Bangkok, field     | DENV-2 JaM1409                     | BM, ntd | 32.22 +/- 8.56 |
|                       | DS3                | DENV-2 JaM1409                     | BM, ntd | 45.95 +/- 17.76|
| Form, Flavivirus      | Nigeria            | DENV-2 JaM1409                     | BM, ntd | 48.42 +/- 6.68 |
| refractory strC2:C83ain from |            | DENV-2 JaM1409                     | BM, ntd | 27.44 +/- 6.03 |
| Ghana, field          | Ibo 11, Dengue     | DENV-2 JaM1409                     | BM, ntd | 31.55 +/- 2.44 |
| refractory strain from| Nigeria            | DENV-2 JaM1409                     | BM, ntd | 30.23 +/- 3.14 |
| Mombasa, field        | MOYO-R             | DENV-2 JaM1409                     | BM, ntd | 19.54 +/- 9.73 |
| MOYO-S, RED, mutant marker stock |            | DENV-2 JaM1409                     | BM, ntd | 53.60 +/- 14.16|
| Triniad, field        | MOYO-R             | DENV-2 JaM1409                     | BM, ntd | 38.79 +/- 14.17|
|                       |                   |                                    |         | 34.92 +/- 29.27|
| Diallo et al., 2008   | Barkedji, S        | sylvatic DENV-2 AdR 140875         | BM^4, 1.6x10^7-10^6.5 | 7.4          |
|                       | Dakar, S           | epidemic DENV-2 ArA 6894           | BM^3, 1.6x10^7-10^6.5 | 1.74         |
|                       | Ngoye, S           | sylvatic DENV-2 AdR 140875         | BM^3, 1.6x10^7-10^6.5 | 7.8          |
|                       | Ndougoubene, S     | epidemic DENV-2 ArA 6894           | BM^3, 1.6x10^7-10^6.5 | 0            |
|                       | Kedougou, S        | sylvatic DENV-2 AdR 140875         | BM^3, 1.6x10^7-10^6.5 | 9.3          |
|                       | Koung Koung, S     | epidemic DENV-2 ArA 6894           | BM^3, 1.6x10^7-10^6.5 | 1.57         |
|                       |                   |                                    |         | 1.46          |
| Knox et al., 2003     | Torres Strait, Aus | DENV-2 92T                         | BM^3, 10^6.4 | 96 at 8 dpi, 100 at 12 dpi, 128 at 16 dpi |
|                       | Charters Towers,   | DENV-4 97B                         | BM^3, 10^7 | 80 at 8 and 12 dpi, 84 at 16 dpi, 84 at 20 dpi, 84 at 24 dpi, 96 at 32 dpi |
|                       | Aus                | DENV-2 92T                         | BM^3, 10^6.4 | 52 at 8 dpi, 60 at 8 dpi, 64 at 12 dpi, 64 at 16 dpi |
|                       | Townsville, Aus    | DENV-4 97B                         | BM^3, 10^7 | 36 at 8 dpi, 48 at 12 dpi, 48 at 16 dpi, 48 at 20 dpi, 48 at 24 dpi, 48 at 32 dpi |
|                       | Cairns, Aus        | DENV-2 92T                         | BM^3, 10^6.4 | 72 at 8 dpi, 90 at 8 dpi, 96 at 12 dpi, 96 at 16 dpi, 96 at 20 dpi, 96 at 24 dpi |
|                       |                   |                                    |         | 1.85          |

Huber et al., 2003

| Study                  | Location           | Virus Strain                        | BM, ntd | IR Value       |
|-----------------------|--------------------|------------------------------------|---------|----------------|
|                       | Ho Chi Minh City,  | DENV-2, strain not defined         | BM, ntd | 94.8 +/- 3.61  |
|                       | (mosquitoes        |                                    |         |                |
|                       | collected from 1975|                                    |         |                |
|                       | to 1998)           |                                    |         |                |
|                       | Ho Chi Minh City,  | DENV-2, strain not defined         | BM, ntd | 97.7 +/- 2.39  |
|                       | (mosquitoes        |                                    |         |                |
|                       | collected from 1975|                                    |         |                |
|                       | to 1998)           |                                    |         |                |
| Location                               | Virus Strain          | BM, ntd | IR       |
|----------------------------------------|-----------------------|---------|----------|
| Paea strain, Thaiti                    | DENV-2, strain not defined |         | 93.84 +/-4.38 |
| Belém, BR                              | DENV-2 Bangkok 1974   | BM, ntd | 96.3     |
| Ananindeua, BR                         | DENV-2 Bangkok 1974   | BM, ntd | 94.23    |
| Rio Branco, BR                         | DENV-2 Bangkok 1974   | BM, ntd | 81.43    |
| Porto Velho                            | DENV-2 Bangkok 1974   | BM, ntd | 83.19    |
| Boa Vista, BR                          | DENV-2 Bangkok 1974   | BM, ntd | 95.75    |
| Salvador, BR                           | DENV-2 Bangkok 1974   | BM, ntd | 81.48    |
| Sao Luis, BR                           | DENV-2 Bangkok 1974   | BM, ntd | 97.38    |
| Feira de Santana, BR                   | DENV-2 Bangkok 1974   | BM, ntd | 74.74    |
| Milha, BR                              | DENV-2 Bangkok 1974   | BM, ntd | 25.79    |
| Pacuja, BR                             | DENV-2 Bangkok 1974   | BM, ntd | 73.62    |
| Quixeramobin, BR                       | DENV-2 Bangkok 1974   | BM, ntd | 82.10    |
| Represa dp Cigano, BR                  | DENV-2 Bangkok 1974   | BM, ntd | 98.24    |
| Tingua, BR                             | DENV-2 Bangkok 1974   | BM, ntd | 84.85    |
| Higienopolis, BR                       | DENV-2 Bangkok 1974   | BM, ntd | 75.32    |
| Moqueta, BR                            | DENV-2 Bangkok 1974   | BM, ntd | 93.40    |
| Rocinha, BR                            | DENV-2 Bangkok 1974   | BM, ntd | 92.86    |
| Comendador Soares, BR                  | DENV-2 Bangkok 1974   | BM, ntd | 91.15    |
| Cariacica, BR                          | DENV-2 Bangkok 1974   | BM, ntd | 81.81    |
| Potim, BR                              | DENV-2 Bangkok 1974   | BM, ntd | 83.62    |
| Leandro Ferreira, BR                   | DENV-2 Bangkok 1974   | BM, ntd | 85.95    |
| Foz de Iguacu, BR                      | DENV-2 Bangkok 1974   | BM, ntd | 62.43    |
| Maringa, BR                            | DENV-2 Bangkok 1974   | BM, ntd | 73.6     |
| Campo Grande, BR                       | DENV-2 Bangkok 1974   | BM, ntd | 72.73    |
| Paea Lab. strain                       | DENV-2 Bangkok 1974   | BM, ntd | 93.34 +/-4.63 |

Paupy et al., 2003

- Phon Penh City Center (Cambodia), mosquitoes collected in February
- Phon Penh City Center (Cambodia), mosquitoes collected in July
- Phon Penh City suburbs north (Cambodia), mosquitoes collected in February
- Phon Penh City suburbs west (Cambodia), mosquitoes collected in February
- Phon Penh City suburbs south (Cambodia), mosquitoes collected in February

DENV-2 from a hs sample collected in Bangkok Thai in 1974

- BM $^3$, $10^{8.2}$, IR 79.39 +/-11.01
- BM $^3$, $10^{8.2}$, IR 77.76 +/-8.31
- BM $^3$, $10^{8.2}$, IR 90.65 +/-8.77
- BM $^3$, $10^{8.2}$, IR 87 +/-4.82
- BM $^3$, $10^{8.2}$, IR 95.30 +/-0.14
| Location                  | Strain                  | Virus Type | BM, 10^8.2 | BM, 10^8.1 | IR | TR |
|---------------------------|-------------------------|------------|------------|------------|----|----|
| Paea strain, Haiti        | DENV-2 from a hs sample collected in Bangkok Thai in 1974 | BM, 10^8.2 | IR 78.52 +/- 7.64 |
| Chiang Rai, Thai          | DENV-1 16007            | BM, 10^8.1 | IR 19.4    |
|                           | DENV-2 16681            | BM, 10^10  | IR 48.7    |
|                           | DENV-3 16562            | BM, 10^8.1 | IR 17.8    |
|                           | DENV-4 1036             | BM, 10^10  | IR 25      |
| Nakhon Phanom, Thai       | DENV-1 16007            | BM, 10^8.1 | IR 16      |
|                           | DENV-2 16681            | BM, 10^10  | IR 15      |
|                           | DENV-3 16562            | BM, 10^8.1 | IR 15      |
|                           | DENV-4 1036             | BM, 10^10  | IR 15.6    |
| Satun, Thai               | DENV-1 16007            | BM, 10^8.1 | IR 8.1     |
|                           | DENV-2 16681            | BM, 10^10  | IR 43.8    |
|                           | DENV-3 16562            | BM, 10^8.1 | IR 13.1    |
|                           | DENV-4 1036             | BM, 10^10  | IR 12.5    |
| Hermosillo, Sonora, MX    | DENV-2 JAM1409          | BM, 10^7.5 to 10^8.5 | IR 45 |
| Guymas, Sonora, MX        | DENV-2 JAM1409          | BM, 10^7.5 to 10^8.5 | TR 60 |
| Culiacan, Sinaloa, MX     | DENV-2 JAM1409          | BM, 10^7.5 to 10^8.5 | TR 60 |
| Mazatlan, Sinaloa, MX     | DENV-2 JAM1409          | BM, 10^7.5 to 10^8.5 | TR 65 |
| Puerto Valarta, Jalisco, MX | DENV-2 JAM1409     | BM, 10^7.5 to 10^8.5 | TR 30 |
| Manzanillo, Colima, MX    | DENV-2 JAM1409          | BM, 10^7.5 to 10^8.5 | TR 55 |
| Lazaro Cardenas, Michoacan, MX | DENV-2 JAM1409 | BM, 10^7.5 to 10^8.5 | TR 45, with a large standard deviation |
| Ixtapa Zihuatanejo, Guerrero, MX | DENV-2 JAM1409 | BM, 10^7.5 to 10^8.5 | TR 42, with a large standard deviation |
| Coyuca de Benitez, Guerrero, MX | DENV-2 JAM1409 | BM, 10^7.5 to 10^8.5 | TR 70 |
| Puerto Excondido, Oaxaca, MX | DENV-2 JAM1409 | BM, 10^7.5 to 10^8.5 | TR 60 |

Thongrungkiet et al., 2003

Bennet et al., 2002\(^9\)
Tapachula, Chiapas, MX  
Chetumal, Quintana Roo, MX  
Cancun, Quintana Roo, MX  
Merida, Yucatan, MX Campeche,  
Ciudad del Carmen, Campeche, MX Villahermosa, Tabasco, MX  
Moloacan, Veracruz, MX  
Miguel Aleman, Tamaulipas, MX Nuevo Ladero, Tamaulipas, MX Monterey, Nuevo Leon, MX Huston, TX Tucson, Arizona Mahaleja,  
Vazeille et al., 2001 Madagascar Jeffreville, Madagascar Paëa Lab. strain Durban, SA  
Watson & Kay, 199912 Queensland, Aus Lab. strain Townsville in 1990  
Tran et al., 1999 Ho Chi Minh City  
Jupp & Kemp, 199312 Empangeni, SA Palm Beach, SA Durban, SA  
Richards Bay, SA Ndumu, SA Skukuza, SA  
Chen et al., 1993 Kaohsiung, southern  
DENV-2 JAM1409 BM3, 107.5 to 108.5 TR 70 (two collections from 60, one of 80)  
DENV-2 JAM1409 BM3, 107.5 to 108.5 TR 80  
DENV-2 JAM1409 BM3, 107.5 to 108.5 TR 70  
DENV-2 JAM1409 BM3, 107.5 to 108.5 TR 69  
DENV-2 JAM1409 BM3, 107.5 to 108.5 TR 42  
DENV-2 JAM1409 BM3, 107.5 to 108.5 TR 42  
DENV-2 JAM1409 BM3, 107.5 to 108.5 TR 58  
DENV-2 JAM1409 BM3, 107.5 to 108.5 TR 58  
DENV-2 JAM1409 BM3, 107.5 to 108.5 TR 60  
DENV-2 JAM1409 BM3, 107.5 to 108.5 TR 48  
DENV-2 JAM1409 BM3, 107.5 to 108.5 TR 56  
DENV-2 JAM1409 BM3, 107.5 to 108.5 TR 40, with a great standard deviation of 60, one of 80)  
DENV-2 JAM1409 BM3, 107.5 to 108.5 TR 68  
DENV-2 Bangkok 1974 BM3, 108.2 TR 27.8  
DENV-2 Bangkok 1974 BM3, 108.2 TR 32.5  
DENV-2 Bangkok 1974 BM3, 108.2 TR 94  
DENV-1 from hs of a patient in Townsville in 1990 BM3, 0.6-3.6 Log10 TR 31 +/- 23.34  
DENV-1 from hs of a patient in Townsville in 1992 BM3, 1.2-4.2 Log10 TR 35.5 +/- 25.67  
DENV-3 h87 BM3, 0.9-3.9 Log10 TR 42 +/- 27.72  
DENV-4 h241 BM3, 0.6-3.6 Log10 TR 36 +/- 22.02  
DENV-1 Cassim strain from Durban, SA BM3, 7.2 Log10 TR 100 at 8-10 dpi  
DENV-1 Cassim strain from Durban, SA BM, 6.1-7.1 Log10 TR 10 at 17-19  
DENV-2 BC 5007 strain from Taipei BM3, 7.2-7.9 Log10 TR 15.5 and TR 50 at 17-19  
DENV-1 Cassim strain from Durban, SA BM3, 6.3-7.1 Log10 TR 62.8, TR 92 at 17-19  
DENV-2 BC 5007 strain from Taipei BM, 7-7.5 Log10 TR 46, TR 75 at 14-15 dpi  
DENV-1 Cassim strain from Durban, SA BM3, 6.1-7.1 Log10 TR 38, TR 69.5 at 17-19  
DENV-2 BC 5007 strain from Taipei BM3, 7.2-7.5 Log10 TR 29.5; TR 69 at 14-20  
DENV-1 Cassim strain from Durban, SA BM3, 6.3-7.1 Log10 TR 36.5; TR 75 at 18-19  
DENV-2 BC 5007 strain from Taipei BM, 7.1 Log10 TR 41.67; TR 82 at 14-15  
DENV-1 Cassim strain from Durban, SA BM3, 6.9-8.4 Log10 TR 12.5; TR 100 at 14-20  
DENV-2 BC 5007 strain from Taipei BM3, 7-7.9 Log10 TR 28; TR 66.5 at 16-19  
DENV-1 from a dengue patient IT TR 50 at 14 dpi, 83.3 at
2) ZIKV

Calvez et al., 2018  
French Polynesia  
NC-2014-5132, NC  
NC  
BM, 10^7.6 TCID50/mL  
IR: 53 at 6 dpi; 94 at 9 dpi; 96 at 14 dpi.

Main et al., 2018  
Los Angeles, CA  
PRVABC59, PR  
BM, 5.4-6.4 log10  
IR: 86 at 6 dpi; 96 at 14 dpi; 100 at 21 dpi.

Garcia-Luna et al., 2018  
Apodaca, MX  
PRVABC59, PR  
BM, 1.5-1.8x10^5  
IR: 97 at 7 dpi; 93 at 14 dpi; 99 at 21 dpi.

San Nicolas, MX  
PRVABC59, PR  
BM, 4x10^5-2x10^7  
IR: 84 at 14 dpi; 87 at 21 dpi.
| Location                | Strain                      | Source         | Midgut Titer | Salivary Gland Titer | Notes                                      |
|------------------------|-----------------------------|----------------|--------------|---------------------|--------------------------------------------|
| Monterey, MX           | PRVABC59, PR                | BM, 8x10⁵-4x10⁷ |              |                     | IR 83 at 7 dpi; 63 at 14 dpi               |
|                        |                             |                |              |                     | 7 dpi; 14 at 14 dpi                       |
|                        |                             |                |              |                     | IR 53 at 7 dpi; 60 at 14 dpi              |
|                        |                             |                |              |                     | 7 dpi; 17 at 14 dpi                       |
|                        |                             |                |              |                     | IR 100 at 7-14 dpi; DR 52 at 14 dpi       |
|                        |                             |                |              |                     | IR 91 at 7 dpi, 81 at 14 dpi              |
|                        |                             |                |              |                     | 7 dpi; 29 at 14 dpi                       |
|                        |                             |                |              |                     | IR 92 at 7 dpi, 98 at 14 dpi              |
|                        |                             |                |              |                     | 7 dpi; 51 at 14 dpi                       |
|                        |                             |                |              |                     | IR 99 at 7 dpi, 96 at 14 dpi              |
|                        |                             |                |              |                     | 7 dpi; 42 at 14 dpi                       |
|                        |                             |                |              |                     | IR 100 at 7-14dpi; DR 93 at 14 dpi        |
|                        |                             |                |              |                     | 23 at 14 dpi                             |
|                        |                             |                |              |                     | IR 98 at 7, 93 at 14dpi                   |
|                        |                             |                |              |                     | 42 at 14 dpi                             |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
| Cd. Madero, MX         | PRVABC59, PR                | BM, 6.2-8x10⁵  |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
| Poza Rica, MX          | PRVABC59, PR                | BM, 1.4x10⁵-1.8x10⁷ |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
| Minatitlan, MX         | PRVABC59, PR                | BM, 6.2x10⁵-1.6x10⁶ |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
| Coatzacoalcos, MX      | PRVABC59, PR                | BM, 1.4x10⁵-1.7x10⁶ |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
| Merida, MX             | PRVABC59, PR                | BM, 8x10⁵-4.4x10⁷ |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
| Mazatan, MX            | PRVABC59, PR                | BM, 1.12-4.4x10⁷ |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
| Guerrero, MX           | PRVABC59, PR                | BM, 2x10⁶-1.8x10⁷ |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
| Dobson et al., 2018    | Rockefeller strain         | PRVABC59, PR   | 2x10⁸       |                     |                                           |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
|                        |                             |                |              |                     |                                           |
| Roundy et al., 2017    | Salvador, BR                | DAK AR 41525, S | BM/murine², 10⁴-6 |                     | IR 100; TR100                             |
|                        |                             | FSS 13025, Cambodia |               |                     | IR 75; TR 0                                |
|                        |                             |                |              |                     |                                           |
| Dominican Republic     | DAK AR 41525, S             | BM, 2x10⁶      |              |                     | IR 75; TR 0                                |
|                        |                             |                |              |                     |                                           |
|                        |                             | FSS 13025, Cambodia | BM, 2x10⁶      |                     | IR 75; TR 0                                |
|                        |                             |                |              |                     |                                           |
|                        |                             | MEX1-7, MX     | BM, 2x10⁶    |                     | IR 75; TR 0                                |
|                        |                             |                |              |                     |                                           |
| Rio Grande Valley      | DAK AR 41525, S             | BM, 2x10⁶      |              |                     | IR 75; TR 0                                |
|                        |                             |                |              |                     |                                           |
|                        |                             | FSS 13025, Cambodia | BM, 2x10⁶      |                     | IR 75; TR 0                                |
|                        |                             |                |              |                     |                                           |
|                        |                             | MEX1-7, MX     | BM, 2x10⁶    |                     | IR 75; TR 0                                |
|                        |                             |                |              |                     |                                           |
| Poza Rica, MX, Lab.    | PRV ABC59                  | IT, 10⁶       |              |                     | IR 100; TR 67                              |
| strain                 |                             |                |              |                     |                                           |
| Bayer company, Lab.    |                             |                |              |                     |                                           |
| strain                 |                             |                |              |                     |                                           |
| Kenney et al., 2017    |                             |                |              |                     |                                           |
| Heitmann et al., 2017  |                             |                |              |                     |                                           |
| Fernandes et al., 2017 |                             |                |              |                     |                                           |
| Guedes et al., 2017    |                             |                |              |                     |                                           |
| Ciota et al., 2017     |                             |                |              |                     |                                           |
| Li et al., 2017⁹       |                             |                |              |                     |                                           |
| Ryckebush et al., 2017 | Paea strain, Thaiti         | PF-25013-18    | BM², 2.5 x 107 |                     | IR midguts 100 at 2, 4, 6, 8, 10,12, 14, 16, 18, 20 dpi |
|                        |                             |                |              |                     | IR salivary glands 60 at 2, 4, 6, 8, 10, 12, 14, 18, 20 dpi |
|                        |                             |                |              |                     | IR salivary glands 60 at 2, 4, 6, 8, 10, 12, 14, 18, 20 dpi |
|                        |                             |                |              |                     | TR 11 at 8 dpi, 33 at 10 dpi               |
| Authors               | Location          | Strain/Description                                                                 | BM Concentration | Results                                                                 |
|-----------------------|-------------------|-------------------------------------------------------------------------------------|------------------|-------------------------------------------------------------------------|
| Costa-da-Silva et al., 2017 | Rockefeller lab. strain | ZIKVBR Isolated from a clinical case                                                | BM: $2.2 \times 10^6$ | IR 95 in body and head dpi, IR 60 in body, 50 in head dpi, TR 0 at 7dpi, 35 at 14dpi, IR 95 in body and 70 heads dpi, TR 0 at 7 dpi, 5 at 14 dpi |
|                       | HWE Lab. strain   |                                                                                     | BM: $2.2 \times 10^6$ |                                                                         |
|                       | RED lab. strain   |                                                                                     | BM: $2.2 \times 10^6$ |                                                                         |
| Weger-Lucarelli et al., 2016 | Poza Rica, MX     | PRV ABC59, PR                                                                       | BM, fresh $10^6.3$ | IR 95, TR 70                                                             |
|                       |                   | PRV ABC59, PR                                                                       | BM, frozen 4hr $10^6.3$ | IR 95, TR 65                                                             |
|                       |                   | PRV ABC59, PR                                                                       | BM, frozen 1 week $10^6.3$ | IR 60, TR 22                                                             |
|                       |                   | DAKAR 41525, S                                                                      | BM, frozen $0^7.2$ | IR 75, TR 55                                                             |
|                       |                   | MR 766, Uganda                                                                       | BM, frozen $10^7.2$ | IR 58, TR 37                                                             |
| Richard et al., 2016  | Poza Rica, MX     | PRV ABC59, PR                                                                       | BM: $10^7$       | IR 85; TR 36                                                             |
| Hall-Mendelin et al., 2016 |                   | PRV ABC59, PR                                                                       | BM: $10^6.7$     | IR 57; TR 27                                                             |
|                       |                   | PRV ABC59, PR                                                                       | BM: $10^6.4$     | IR 40; TR 40                                                             |
| Di Luca et al., 2016  |                   | PRV ABC59, PR                                                                       | BM, fresh $5\times10^6$ | IR 100, TR 100                                                           |
| Dutra et al., 2016    |                   | PRV ABC59, PR                                                                       | BM: $10^6.8$     | IR 100; TR 24                                                             |
| Aliota el., 2016      |                   | PRV ABC59, PR                                                                       | BM: $10^6.46$    | IR 50; TR 38                                                             |
| Boccoli et al., 2016  |                   | H/PF/2013 French Polynesia                                                          | BM: $10^7$       | 7 dpi: IR 100, TR 0                                                      |
| Chouin-Carneiro et., 2016 | FG, Guadeloupe    | NC-2014-5132, NC                                                                    | BM: $10^7$       | 7 dpi: IR 87, TR 0                                                      |
|                       | Martinique        | NC-2014-5132, NC                                                                    | BM: $10^7$       | 7 dpi: IR 90, TR 0                                                      |
|                       | Orlando, FL       | NC-2014-5132, NC                                                                    | BM: $10^7$       | 7 dpi: IR 93, TR nd                                                    |
|                       | Tubiacacanga, BR  | NC-2014-5132, NC                                                                    | BM: $10^7$       | 7 dpi: IR 83, TR nd                                                    |
| Li et al., 2012       |                   | MR 766, Uganda                                                                       | BM: $10^7$       | IR 100; TR 100                                                          |
| Diagne et al., 2015   |                   | ArD 128000 and 132912, Kedougou                                                     | BM 6.4-7.6 log$_{10}$ | IR+, DR+, TR 0                                                          |
|                        |                  | IT dose unknown 7-28 dpi                                                            | BM 6.4-7.6 log$_{10}$ | IR+, DR+, TR 0                                                          |
| Cornet et al., 1979   |                   | ArD 24280, S                                                                         | BM, $10^6.7$ LD50 60 dpi | IR 100; TR 50                                                          |
| Boorman & Porterfield, 1956 | Dakar, S, domestic | Kedougou                                                                           | BM, $10^6$       | IR 0 at 3dpi, 25 at 7dpi, TR 0 at 3dpi, 0 at 7dpi, 0 at 14dpi, 0 at 14dpi |
|                        |                   | Kedougou                                                                           | BM, $10^6$       | IR 0 at 3dpi, 25 at 7dpi, TR 0 at 3dpi, 0 at 7dpi, 0 at 14dpi, 0 at 14dpi |
|                        |                 | IT dose unknown 7-28 dpi                                                            | BM, $10^6$       | IR 0 at 3dpi, 25 at 7dpi, TR 0 at 3dpi, 0 at 7dpi, 0 at 14dpi, 0 at 14dpi |
| Dickson et al., 2014  |                   | Fatick                                                                               | BM, $10^6$       | IR 59                                                                   |
|                        |                   | DAK -1279- West African Genotype I, Nigeria                                           | BM, $7.9 \times 10^6$ | IR 17                                                                  |
|                        |                   | DAK -1279- West African Genotype II, S                                               | BM, $10^6$       | IR 13                                                                   |
|                        |                   | DAK -1279- West African Genotype I, Nigeria                                           | BM, $6.1 \times 10^7$ | IR 33                                                                  |
|                        |                   | BA-55- West African Genotype I, Nigeria                                               | BM, $2 \times 10^6$ | IR 10                                                                   |
| Location          | Genotype                         | Virus Strain         | BM    | IR  |
|-------------------|----------------------------------|----------------------|-------|-----|
| Richard Toll      | Genotype II, S                   | BM, 7.9 x10^5       | IR 57 |
| Goudiry           | Genotype II, S                   | BM, 10^6             | IR 0  |
| Ae aegypti formosus PK10, S, sylvatic | BA-55- West African Genotype I, Nigeria | BM, 2x10^5       | IR 0  |
| Ae aegypti formosus PK10, S, sylvatic | DAK-1279- West African Genotype I, S, BM | BM, 7.9 x10^5       | IR 10 |
| PK10, S, sylvatic | Genotype II, S                   | BM, 7.9 x10^5       | IR 10 |
| PK10, S, sylvatic | Genotype II, S                   | BM, 10^6             | IR 3  |
| Mont Rolland      | Genotype II, S                   | BM, 2x10^6           | IR 0  |
| Rufisque          | Genotype II, Senegal             | BM, 7.9 x10^5       | IR 11 |
| Ellis et al., 2012 | Nairobi, Kenya                   | BM, 6.7–7.5 log10   | IR 7  |
| Mariakani, Kenya  | East African genotype (Sudan 2003) | BM, 6.7–7.5 log10 | IR 41 |
| Kerio Valley, Kenya | East African genotype (Sudan 2003) | BM, 6.7–7.5 log10   | IR 11 |
| van den Hurk et al., 2011 | Cairns, Aus | BM, 6.7–7.5 log10 | IR 23 |
| Johnson et al., 2002 | Santos, Brazil                   | BM, 7-7.8 log10     | IR 35, TR 25.5 |
| Lourenco-de-Oliveira et al., 2002 | Feira de Santana, BR | FIOCRUZ 74018/MG/01 | BM^3, 10^8.7 | IR 0 |
| Soares, BR        | FIOCRUZ 74018/MG/01               | BM^3, 10^8.7        | IR 0.9 |
| Quixeramobim, BR  | FIOCRUZ 74018/MG/01               | BM^3, 10^8.7        | IR 0.9 |
| Rocinha, BR       | FIOCRUZ 74018/MG/01               | BM^3, 10^8.7        | IR 3.3 |
| Tinguá, BR        | FIOCRUZ 74018/MG/01               | BM^3, 10^8.7        | IR 4.9 |
| Pacuia, BR        | FIOCRUZ 74018/MG/01               | BM^3, 10^8.7        | IR 5.6 |
| Salvador, BR      | FIOCRUZ 74018/MG/01               | BM^3, 10^8.7        | IR 6.3 |
| Higienópolis, BR  | FIOCRUZ 74018/MG/01               | BM^3, 10^8.7       | IR 6.7 |
| Moquetá, BR       | FIOCRUZ 74018/MG/01               | BM^3, 10^8.7          | IR 7.6 |
| Feira de Santana, BR | FIOCRUZ 74018/MG/01 | BM^3, 10^8.7        | IR 10.6 |
| Rio Branco, BR    | FIOCRUZ 74018/MG/01               | BM^3, 10^8.7        | IR 11.1 |
| Leandro Ferreira, BR | FIOCRUZ 74018/MG/01 | BM^3, 10^8.7        | IR 12.0 |
| Caraciaca, BR     | FIOCRUZ 74018/MG/01               | BM^3, 10^8.7        | IR 12.8 |
| Boa Vista, BR     | FIOCRUZ 74018/MG/01               | BM^3, 10^8.7        | IR 12.9 |
| Represa do Cigano, BR | FIOCRUZ 74018/MG/01 | BM^3, 10^8.7        | IR 16.1 |
| Location            | Source Code          | Resistance Level | IR Value |
|---------------------|----------------------|------------------|----------|
| São Luis, BR        | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 19.6     |
| Maringá, BR         | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 22.7     |
| Porto Velho, BR     | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 24.4     |
| Campo Grande, BR    | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 25       |
| Potim, BR           | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 27.1     |
| Belém, BR           | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 33.9     |
| Ananindeua, BR      | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 46.4     |
| Foz do Iguaçu, BR   | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 48.6     |
| Maringá, BR         | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 22.7     |
| Porto Velho, BR     | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 24.4     |
| Campo Grande, BR    | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 25       |
| Potim, BR           | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 27.1     |
| Belém, BR           | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 33.9     |
| Ananindeua, BR      | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 46.4     |
| Foz do Iguaçu, BR   | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 48.6     |
| Phnom Penh, Cambodia| FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 64.4     |
| Ho Chi Minh         | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 48.05    |
| Maracay, Venezuela  | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 13.6     |
| West Palm Beach, FL | FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 24.8     |
| Ae. aegypti formosus| FIOCRUZ 74018/MG/01  | BM, 10^8.7       | 3.3      |

Mitchel et al., 1987
Rexville strain from PR
Soufriere, Dominica West Africa Sylvan,
Dakar S, lab. strain West Africa Sylvan,
N'Gove S, lab. strain West Africa Sylvan,
Gambia, lab. strain West Africa Sylvan,
Kampala Uganda lab. strain East Africa Sylvan,
East Africa Sylvan, Kombeni, Kenya; lab. strain East Africa Sylvan,
East Africa Domestic, Kwa Dzivo Kenya; isofemale lines East Africa Domestic, Majengo Kenya; isofemale lines East Africa Domestic, Kwa Dzivo Kenya; isofemale lines
Asibi strain BM, ntd IR 11
Asibi strain BM, ntd IR 7
Asibi strain BM, ntd IR 27
Asibi strain BM, ntd IR 8
Asibi strain BM, ntd IR 34
Asibi strain BM, ntd IR 57
Asibi strain BM, ntd IR 29
Asibi strain BM, ntd IR 11
Asibi strain BM, ntd IR 23
Asibi strain BM, ntd IR 21
Asibi strain BM, ntd IR 32
Asibi strain BM, ntd IR 30
Asibi strain BM, ntd IR 28
Asibi strain BM, ntd IR 22
Asibi strain BM, ntd IR 29
Asibi strain BM, ntd IR 16

Wallis et al., 1985
Soufriere, Dominica West Africa Sylvan,
Dakar S, lab. strain West Africa Sylvan,
N'Gove S, lab. strain West Africa Sylvan,
Gambia, lab. strain West Africa Sylvan,
Kampala Uganda lab. strain East Africa Sylvan,
East Africa Sylvan, Kombeni, Kenya; lab. strain East Africa Sylvan,
East Africa Domestic, Kwa Dzivo Kenya; isofemale lines East Africa Domestic, Majengo Kenya; isofemale lines East Africa Domestic, Kwa Dzivo Kenya; isofemale lines
Asibi strain BM, ntd IR 11
Asibi strain BM, ntd IR 7
Asibi strain BM, ntd IR 27
Asibi strain BM, ntd IR 8
Asibi strain BM, ntd IR 34
Asibi strain BM, ntd IR 57
Asibi strain BM, ntd IR 29
Asibi strain BM, ntd IR 11
Asibi strain BM, ntd IR 23
Asibi strain BM, ntd IR 21
Asibi strain BM, ntd IR 32
Asibi strain BM, ntd IR 30
Asibi strain BM, ntd IR 28
Asibi strain BM, ntd IR 22
Asibi strain BM, ntd IR 29
Asibi strain BM, ntd IR 16

Tabachnick et al., 1985
West Palm Beach, FL Ae. aegypti formosus
Boulbinet Guinea Rexville strain from PR
788379 BM, 5.0-6.7 Log10 IR 61 at 11 dpi, 80 at 14 dpi
Asibi strain BM, ntd IR 17,17 +/- 13,50
Asibi strain BM, ntd IR 11
Asibi strain BM, ntd IR 7
Asibi strain BM, ntd IR 27
Asibi strain BM, ntd IR 8
Asibi strain BM, ntd IR 34
Asibi strain BM, ntd IR 57
Asibi strain BM, ntd IR 29
Asibi strain BM, ntd IR 11
Asibi strain BM, ntd IR 23
Asibi strain BM, ntd IR 21
Asibi strain BM, ntd IR 32
Asibi strain BM, ntd IR 30
Asibi strain BM, ntd IR 28
Asibi strain BM, ntd IR 22
Asibi strain BM, ntd IR 29
Asibi strain BM, ntd IR 16
| Domestic Location | Strain Type | Observed Units |
|-------------------|-------------|----------------|
| Huston, TX | Asibi strain | BM, ntd | IR 21 |
| Welasco, Texas USA | Asibi strain | BM, ntd | IR 15 |
| Victoria, MX | Asibi strain | BM, ntd | IR 20 |
| Abbeville, Louisiana USA | Asibi strain | BM, ntd | IR 12 |
| Beaumont, TX | Asibi strain | BM, ntd | IR 26 |
| Vero Beach, FL | Asibi strain | BM, ntd | IR 41 |
| Esquitla, Guatemala | Asibi strain | BM, ntd | IR 2 |
| Malaga, Colombia | Asibi strain | BM, ntd | IR 46 |
| Santa Cruz, Bolivia | Asibi strain | BM, ntd | IR 31 |
| Trinidad, West Indies | Asibi strain | BM, ntd | IR 42 |
| Limestone Bay, Anguilla | Asibi strain | BM, ntd | IR 34 |
| Plymouth, Montserrat | Asibi strain | BM, ntd | IR 39 |
| Arecibo, Puerto Rico | Asibi strain | BM, ntd | IR 53 |

4) CHIKV

| Location | Strain Details | Observed Units |
|----------|----------------|----------------|
| Mombasa, Kenya | Lamu001 strain of and East/Central/South Africa lineage | BM, 10^5.6 |
| | | BM, 10^5.9 |
| | | BM, 10^6.9 |
| | | BM, 10^7.5 |
| Kisumu, Kenya | ArB10262 South/Central Africa and Indian Ocean Genotype (Group III), subgroup IIIa and b | BM; 108 |
| | | IR 0 at 5-7 dpi; IR tested in Midgut at 26ºC |
| | | IR 6 at 5-7 dpi and 17 at 10 dpi; IR tested in Midgut at 32ºC |
| | | IR 62 at 5-7 dpi and 75 at 10 dpi; IR tested in legs at 26ºC |
| | | IR 100 at 5-7 dpi and 75 at 10 dpi; IR tested in legs at 32ºC |
| | | IR 0 at 5-7 dpi and 17 at 10 dpi; IR tested in legs at 26ºC |
| | | IR 40 at 5-7 dpi: 50 at 9 dpi; IR tested in legs at 32ºC |
| Nairobi, Kenya | ArB10262 South/Central Africa and Indian Ocean Genotype (Group III), subgroup IIIa and b | BM, 10^5.6 |
| | | BM, 10^5.9 |
| | | BM, 10^6.9 |
| | | BM, 10^7.5 |
| | | IR 0 at 5-7 dpi and 17 at 10 dpi; IR tested in legs at 26ºC, 32ºC |
| | | IR 7 at 5-7 dpi and 10 at 9 dpi; IR tested in legs at 26ºC, 32ºC |
| | | IR 50 at 5-7 dpi and 57 at 9 dpi; IR tested in legs at 26ºC, 32ºC |
| | | IR 71 at 5-7 dpi and 89 at 9 dpi; IR tested in legs at 26ºC, 32ºC |
| | | IR in legs 37 at 2dpi, 71 at 5 dpi, 24 at 12 dpi; IR tested in legs at 32ºC |
| | | IR in legs 90 at 2dpi, 20 at 5 dpi, 50 at 12 dpi; IR tested in legs at 32ºC |
| | | IR in legs 71 at 2dpi, 68 at 5 dpi, 51 at 12 dpi; IR tested in legs at 32ºC |
| | | IR in legs 35 at 2dpi, 22 at 5 dpi, 15 at 12 dpi; IR tested in legs at 32ºC |
| | | IR tested in Midgut at 26ºC; IR tested in legs at 26ºC |
| | | IR tested in Midgut at 32ºC; IR tested in legs at 32ºC |

| Location | Strain Details | Observed Units |
|----------|----------------|----------------|
| Indian River/ St. | | BM, 8 log10 |
| Lucie County, FL | | BM, 8 log10 |
| Monroe County, FL | | BM, 8 log10 |
| Manatee county, FL | | BM, 8 log10 |
| Dominican Republic | | BM, 8 log10 |
| Bangui, Central | | BM; 108 |
| African Republic | | IR 50 at 7 dpi, 27 at 14 dpi |
| | | IR tested in Midgut at 26ºC, 32ºC; IR tested in legs at 26ºC, 32ºC |

| Location | Strain Details | Observed Units |
|----------|----------------|----------------|
| Coastal Kenya | | BM; 7.9 x10^5 |
| | | IR tested in Midgut at 26ºC, 32ºC; IR tested in legs at 26ºC, 32ºC |
| Location                  | Virus Strain | TCID50/mL | IR Tested |
|---------------------------|--------------|-----------|-----------|
| Western Kenya             |              | BM; 7.9 x10⁵ |           |
| Ocean Genotype (Group III), subgroup IIIa and b |              |           |           |
| Belford Roxo, BR          | CHIKV 06.21  | BM 10⁻⁵   | IR 100 at 7 and 10 dpi |
| Vaz Lobo, BR              | CHIKV 05.115 | BM 10⁻⁵   | IR 100 at 7 and 10 dpi |
| Campos Belos, BR          | CHIKV 06.21  | BM 10⁻⁵   | IR 100 at 7 and 10 dpi |
| Campos Grande, BR         | CHIKV 06.21  | BM 10⁻⁵   | IR 100 at 7 and 10 dpi |
| Jurujuba, BR              | CHIKV 05.115 | BM 10⁻⁵   | IR 100 at 7 and 10 dpi |
| Paqueta, BR               | CHIKV 06.21  | BM 10⁻⁵   | IR 100 at 7 and 10 dpi |
| Vaz Lobô, BR              | CHIKV 06.21  | BM 10⁻⁵   | IR 100 at 7 and 10 dpi |
| Belford Roxo, BR          | CHIKV 06.21  | BM 10⁻⁵   | IR 100 at 7 and 10 dpi |
| Santos, BR                | CHIKV 06.21  | BM 10⁻⁵   | IR 100 at 7 and 10 dpi |
| Monteagudo, Bolivia       | CHIKV 06.21  | BM 10⁻⁵   | IR 100 at 7 and 10 dpi |
| Salto del Guaira, Paraguay| CHIKV 06.21  | BM 10⁻⁵   | IR 100 at 7 and 10 dpi |
| Asuncion, Paraguay        | CHIKV 06.21  | BM 10⁻⁵   | IR 100 at 7 and 10 dpi |
| Salto, Uruguay            | CHIKV 05.115 | BM 10⁻⁵   | IR 100 at 7 and 10 dpi |
| Corrientes, Argentina     | CHIKV 06.21  | BM 10⁻⁵   | IR 100 at 7 and 10 dpi |
| Buenos Aires, Argentina   | CHIKV 05.115 | BM 10⁻⁵   | IR 100 at 7 and 10 dpi |
| Noumea, NC, mosquitoes had a 92% susceptibility to pyrethroids (pop 163/11) | CHIKV 05.115 | BM 10⁻⁵ | IR 53.3 at 3 dpi; 54.5 at 10 dpi |
| Noumea, New Caledonia,    | CHIKV 05.115 | BM 10⁻⁵   | IR 50 at 3 dpi; 64.3 at 8 dpi |
|                  | PF14/300914-109 | BM 7 log10 | IR 100 at 7 and 10 dpi |
|                     | NC/2011-568    | TCID50/mL | IR 100 at 7 and 10 dpi |
mosquitoes had an 85% susceptibility to pyrethroids (pop 174/11)
Noumea Laboratory strain, New Caledonia (pop 282/10)

Noumea, NC, mosquitoes had a 92% susceptibility to pyrethroids (pop 163/11)

Noumea, NC, mosquitoes had an 85% susceptibility to pyrethroids (pop 174/11)
Noumea Lab.strain, NC (pop 282/10)

| Location              | Arbovirus          | BM at 3 dpi | IR at 3 dpi | BM at 7 dpi | IR at 7 dpi | BM at 14 dpi | IR at 14 dpi |
|-----------------------|--------------------|-------------|-------------|-------------|-------------|--------------|--------------|
| Girod et al., 2011    | CHIKV 06.21        | BM 10^7.5   | IR 40 at 3 dpi; 58.8 at 8 dpi    | BM 10^7.5   | IR 33.3 at 3 dpi; 57.1 at 8 dpi |
| Guadaloupe            |                    |             |             |             |             |              |              |
| Poit a Pitre, Carenage, Guadaloupe |                    |             |              |             |             |              |              |
| Fort de France, Ermitage, Martinique Robert, Cafe, Martinique Cayenne, Centre Ville FG Cayenne, Madeleine, FG | CHICK LR2006-OPY1, La Reunion Island | BM 10^7.5 | IR 98 at 14 dpi in 2008; 95.8 at 14 dpi in 2009 | BM 10^7.5 | IR 97.4 at 14 dpi in 2008 |
| Pesko et al., 2009    | Palm Beach, FL     | BM 6.1 log10 | IR at 6 dpi 18.8 and 57.1 for mosquitoes feeding on pletdgets or water jackets membranes, respectively | BM 5.2 log10 | IR at 6 dpi 4.5 and 23.8 for mosquitoes feeding on pletdgets or water jackets membranes, respectively |
| 5) dual-infections    |                    |             |             |             |             |              |              |
| Ruckert et al., 2017  | CHIKV (strain 99659) | BM 3.1x10^7-1.9 x 10^8 | IR 87; TR 20 at 3dpi, 30 at 7 dpi | BM 3x10^7-7.4 x 10^5 | IR 87; TR 0 at 3 dpi, 15 at 7 dpi |
| Poza Rica, Mexico     | DENV-2 (strain Merida) | BM 1.7 x 10^5-5.4x10^5 | IR 48; TR 0 at 3 dpi, 8 at 7 dpi | DENV-2 BM, as single | IR CHIKV 87; DENV-2 IR CHIKV 38; DENV 10; CHIKV 90; ZIKV 45; CHIKV 45; ZIKV 8; at 14 dpi |
| ZIKV (strain PRVABC59) | CHIKV (strain 99659)+DENV-2 (strain Merida) | BM, as single | IR CHIKV 50; DENV-2 80; DENV 20; ZIKV 0; at 14 dpi | BM, as single | IR ZIKV 50; DENV-2 80; DENV 20; ZIKV 0; at 14 dpi |
| Goertz et al., 2017   | CHIKV strain 37997 | BM 2 x 10^6 | IR 47.9, TR 10.4 | BM 2 x 10^6 | IR 66.7, TR 5.9 | BM 2 x 10^6 | IR 81.2, TR 21.2 |
| Rockefeller strain    | ZIK Suriname strain 011V-01621 | BM 2 x 10^6 | IR 65.3, TR 34.7 | BM 2 x 10^6 | IR 92.2, TR 68.6 | BM 2 x 10^7 | IR 100, TR 68.3 |
| ZIKV Suriname strain 011V-01621 | CHIKV (strain 37997)+ZIKV | BM, as single | IR 84.4; TR 11.5 | BM, as single | IR 65 at 6 dpi; 80 at 6 dpi; 80 at 9 dpi-12 dpi; 80 at 15 dpi-18 dpi; 80 at 21 dpi-24 dpi |
| 6) infections with arboviruses other than DENVs, YFV, ZIKV and CHIKV | Mayaro virus, Trinidad strain TRVL 4675 | BM 7.5 log10 | IR 40 at 3 dpi; 57.1 at 8 dpi | BM 7.5 log10 | IR 40 at 3 dpi; 57.1 at 8 dpi | BM 7.5 log10 | IR 40 at 3 dpi; 57.1 at 8 dpi |
| Wiggins et al., 2018  | Miami, FL          |             |             |             |             |              |              |
| Author et al., Year | Location | Virus/Strain Details | TCID<sub>50</sub> or Log ID<sub>50</sub> | Infection Rate | Transmission Rate |
|---------------------|----------|----------------------|---------------------------------|----------------|-----------------|
| Wang et al., 2012   | Haikou strain, China | Western equine encephalomyelitis virus (WEEV), McMillian strain | BM, ntd | IR 25; TR 45 |
| Long et al., 2011   | Iquitos, Peru | Maroyo virus, strain IQT4235 | BM, 5.59-7.34 Log10 | IR 46.67 +/-21.13; TR 8.67 +/- 1.13; |
| Turell et al., 2008 | Kenya, collected as eggs in 1982 | Rift Valley Fever (RVFV) ZH501 from an Egyptian patient | BM, 10<sup>-7.8</sup> | IR 100 at 3-10 dpi; 33 at 11-16 dpi |
| Turell et al., 2001 | Rockefeller strain | Rift Valley Fever ZH501 from an Egyptian patient | BM, 10<sup>-8</sup> | IR 85 at 3-10 dpi; 75 at 11-16 dpi |
| Kay et al., 1979    | Townsville colony, from northern Queensland in 1957 | Sindbis MRM39 | BM, 4-6.5 Log ID<sub>50</sub> | IR 64, TR 28.5, EIP 20 |
|                    |          | Getah N544 | BM, 4.9 Log ID<sub>50</sub> | IR 100, TR 69, EIP 12 |
|                    |          | Ross River T78  | BM, 5.1 Log ID<sub>50</sub> | IR 96, TR 95, EIP 7-10 |
|                    |          | Murray Valley Encephalitis MRM66 | BM, >6.5 Log ID<sub>50</sub> | IR 46, TR 38, EIP 20-23 |
|                    |          | Kunji MRM16 | BM, 2.7 Log ID<sub>50</sub> | IR 100, TR 100, EIP 12 |
|                    |          | Kokobera MRM32 | BM, 2.1-2.9 Log ID<sub>50</sub> | IR 100, TR 5, EIP 10-15 |
| Kramer & Sherer, 1976 | Laboratory strain | Venezuelan Encephalitis virus, epizootic strain subytoe I, variety B, 69T1597 | IT or BM | TR 60 at 14 dpi, 100 at 7 dpi |
| Kramer & Sherer, 1976 | Laboratory strain | Venezuelan Encephalitis virus, enzootic strain subytoe I, variety E, 63Z1 | IT or BM | TR 60 at 14 dpi, 100 at 7 dpi |

1 PFU/ml unless otherwise stated; 2 FFU/ml; 3 MID50/ml; 4 TCID50/mL; 5 CCID50/ml; 6 PFU ingested per mosquito; 7 expressed in unless otherwise stated; 8 mosquitoes were tested for infections within the 9th generation after laboratory colonization; 9 infection and transmission rates reported here were extrapolated from a figure; 10 wild-caught mosquitoes were adapted to the laboratory and tested at generation F10-15; 11 infection rates for DENV2 AdR 140875 are mean over two infections experiments; 12 results are mean over different experiments; 13 mosquitoes were infected by all virus strains and dissemination was studied for both strains; 14 CHIKV 06.21 is the strain with the E1-226V mutation and CHIKV 05.115 is the strain with the E1-226A mutation; 15 experiments were carried out in two consecutive years (2008 and 2009); 16 in 2009, two different concentrations of CHIKV were compared for infection rates at 7 dpi; only data for the highest concentration are shown here; 17 mosquitoes of the F12_F14 after laboratory colonization were used in experimental infections.
Figure 1

Natural determinants of vector competence

- Mosquito genetics
- Virus genetics
- Symbionts

Confounding factors of vector competence studies

- Virus
  - Origin and preparation of stocks
  - Dose at blood meal
  - Quantification method

- Mosquito
  - Route of infection
  - Tissues and body parts surveyed
  - Time-point of dissections

Need scientific elucidation

Need standardization

Improved reproducibility and comparability