Where did Zika virus come from?

The Zika virus (ZIKV) was first discovered in 1947 in the Zika Forest of Uganda. Shortly thereafter, it was isolated from mosquitoes in the area and then humans in 1968. ZIKV is a flavivirus similar to yellow fever, dengue, Japanese encephalitis, and West Nile virus. Prior to 2007, it had only been detected in Central Africa and throughout Southeast Asia. However in 2007, it was associated with a disease outbreak on Yap Island in the south Pacific representing the first time it had spread outside of Asia. From there, it spread to South America with human cases beginning in 2014. Today, there is active transmission of the virus throughout south and Central America and the Caribbean Islands. Please refer to Figure 1.

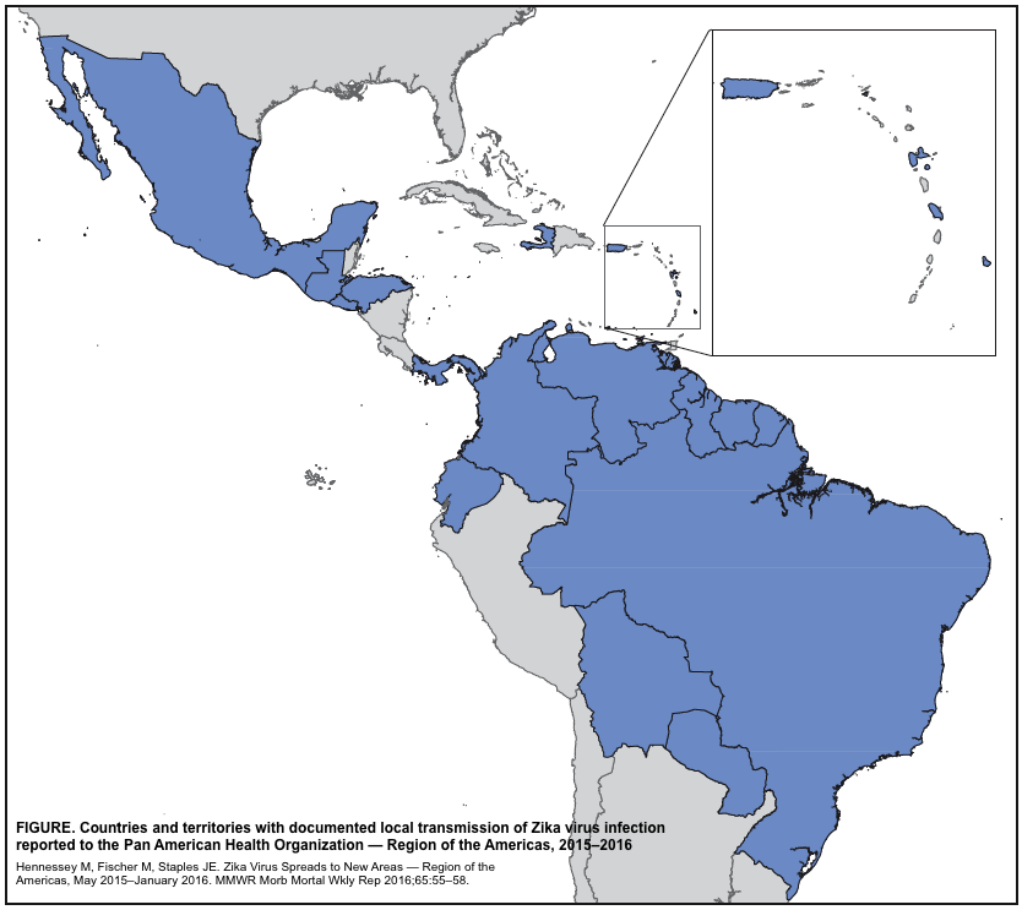


FIGURE. Countries and territories with documented local transmission of Zika virus infection reported to the Pan American Health Organization — Region of the Americas, 2015–2016

Hennessey M, Fischer M, Staples JE. Zika Virus Spreads to New Areas — Region of the Americas, May 2015–January 2016. MMWR Morb Mortal Wkly Rep 2016;65:55–58.

One of the factors making Zika's spread throughout the Americas so rapid is perhaps the fact that it does not appear to require an animal reservoir host, like West Nile virus. In fact to date, there has been no evidence of a non-primate reservoir of ZIKV. In other words, non-infected mosquitoes are able to acquire the virus after feeding directly on infected humans. In essence, there is no "middle man" in the endemic cycle of ZIKV, allowing it to spread quite rapidly where abundant, competent vector mosquitoes and humans are present together.

Currently, all US cases have been imported.* Essentially, people on vacation or visiting areas in Latin and South America have gotten infected, but are not symptomatic until they come back to the states. So, it is highly likely that imported cases will continue, and that we will continue to hear about new cases in the media.

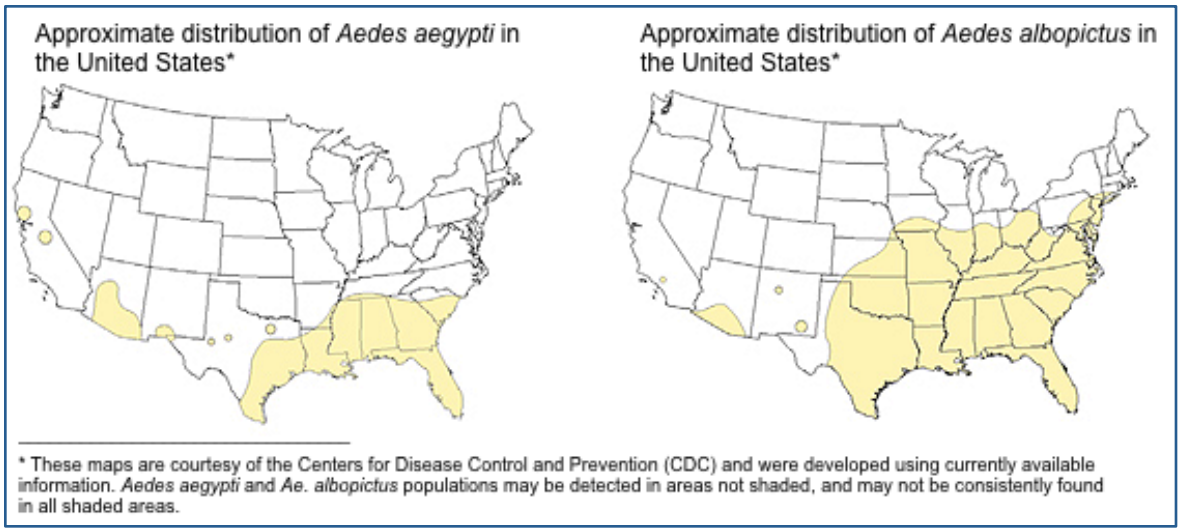
**Note:* There have been 2 cases of ZIKV infection in the US that are suspected to have been sexually transmitted. The evidence for sexual transmission is circumstantial. In each instance, an individual had traveled outside the US and developed symptoms of ZIKV infection upon returning to the US. Their spouses then reported symptoms of infection, although they had no travel history, and in both cases there was reported direct contact including sexual contact with the previously infected partner. Hence, sexual transmission is implicated as the most likely route of transmission.

Mosquito Vectors of Zika virus

ZIKV is transmitted by *Aedes* mosquitoes. However, in the Americas, it has only been linked to transmission by *Aedes aegypti.* *Ae. aegypti* is a container-breeding species that is also responsible for the transmission of Dengue virus, Yellow Fever virus and Chikungunya virus. Recently in Senegal and again in Gabon, the virus was detected in *Aedes albopictus* (the Asian tiger mosquito) and it is likely that *Ae. albopictus* could vector the virus in the Americas. Elsewhere in Africa and Southeast Asia, it has been isolated from several species of *Aedes* that are not found anywhere in the US.

Both *Ae. aegypti* and *Ae. albopictus* are limited in their distribution in the US. Therefore, it is unlikely that ZIKV will become a disease that is circulating in the local mosquito populations throughout the US like WNV. Please refer to Figure 2 for a map depicting each mosquito's US distribution.

Ae. Aegypti, the yellow fever mosquito, is a medium-sized blackish mosquito easily distinguished from *Ae. albopictus* by a silvery-white “lyre-shaped" pattern of scales on its scutum. Although there are some distinct differences in the habits of these species, both species are peridomestic species found not far from human dwellings and are particularly abundant in towns and cities. They are primarily early morning or late afternoon feeders, but females can also take a bloodmeal at night under artificial illumination. *Aedes aegypti* is reported to fly only a few hundred yards from breeding sites. Larvae can be found in a variety of artificial containers including buckets, tires, cans, flower pots, etc.



Symptoms of Zika infection

Typically, people with ZIKV infection begin showing symptoms with a mild headache. Within a day or two, a maculopapular rash may appear and can cover many parts of the body (arms, hands, face, chest). Following the rash, people generally report continued fever, malaise, and body aches. Other symptoms can include diarrhea, constipation, abdominal pain, and dizziness. These symptoms typically last from 4-7 days. The incubation period of the virus (the time from infected mosquito bite to symptoms) is approximately 3-12 days. However, 60% - 80% of individuals infected with the pathogen remain asymptomatic.

Concerns with Pregnancy and Perinatal Infections

One of the reasons this mosquito-borne disease is generating great concern is the potential ability of the virus to cross the placenta. If a pregnant woman is infected it may result in a birth defect in new-borne children, microcephaly, which causes underdevelopment of the head and brain. However, at this point in time, the link between ZIKV and infant microcephaly is poorly understood. The primary data supporting its involvement in birth defects is the fact that, since Brazil's first case was documented in May of 2015, the incidence of microcephaly cases in Brazil have increased dramatically with nearly 4,000 cases being documented in recent months. However, there is a very recent study demonstrating, for the first time, 2 cases of fetal microcephaly as diagnosed via amniocentesis and subsequent PCR confirmation for ZIKV, most likely representing the first diagnoses of intrauterine transmission of the virus.

Because of this, the CDC and WHO have issues warnings as a precautionary measure, while they continue to search for further scientific data supporting intrauterine transmission. Furthermore, it is always a good idea for anyone, including pregnant women, to avoid getting mosquito bites, especially in tropical regions.

Treatment of Zika Infection

Like most mosquito-borne viruses, there is no prophylaxis, treatment or vaccine to protect against ZIKV infection. Treatment is considered symptomatic and supportive, including rest and the use of acetaminophen to relieve fever. Patients should also be advised to drink plenty of fluids to replenish fluid lost from sweating, vomiting and other insensible losses.

If anyone has traveled to a known endemic area recently and are displaying any of the symptoms described above, they should consult their physician immediately. Diagnostic tests for ZIKV infection include a standard PCR test on acute-phase serum samples, which detects viral RNA, and other tests to detect specific antibodies against the virus in serum. An ELISA has also been developed by the CDC to detect immunoglobulin (Ig) M to ZIKV.

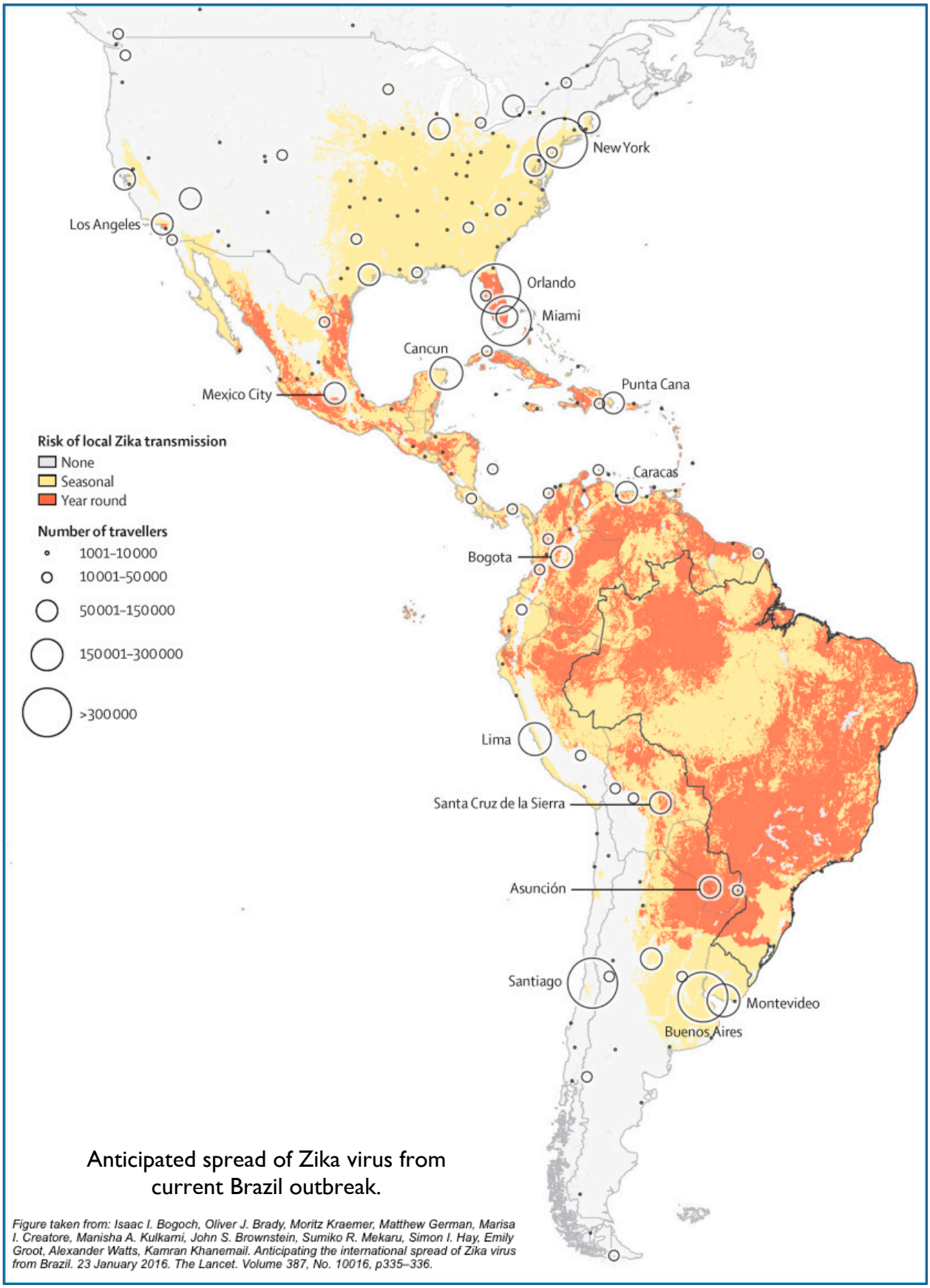
Preventive personal measures are recommended to avoid mosquito bites during the daytime, because that is when *Ae. aegypti* are most active. As always, we urge residents to reduce mosquito-breeding on the property by discarding or draining sources of standing water. In the case of ZIKV, individuals that are traveling, or planning to travel, to countries where ZIKV or other mosquito-borne viruses are found are urged to take the precautions as listed on the CDC's website <http://www.cdc.gov/zika/prevention/index.html>.

Surveillance for Mosquito Vectors

Surveillance of adult mosquitoes should include the deployment of BG Sentinel traps and/or Ovi traps. Adult mosquito surveillance will determine the mosquito distribution, density, and species composition throughout the target area. Furthermore, it will provide direct evidence of an increased transmission risk of Zika virus. The placement of these traps will also be crucial for the efficient and precise control efforts in residential properties. Each site that is trapped should be recorded with handheld GPS units. All trap collections should also be returned to a taxonomic lab to be sorted, counted, and processed for RT-PCR testing.

BG Sentinel Traps are lightweight, portable, battery operated traps that are essentially a collapsible, white fabric container with a white gauze covering its opening. Air is sucked into the trap through a black catch pipe by an electrical fan. This trap is especially attractive for *Ae. aegypti* and *Ae. albopictus*. These traps should be sampled weekly throughout the mosquito-breeding season.

Ovi traps are used to collect eggs of container-breeding species such as *Ae. aegypti*. Typically, at each surveillance site a black, plastic cup is placed in a shaded area. These cups contain water and a paper towel. The paper towel is replaced each week and transported to a taxonomic laboratory where they are examined with a microscope for the presence of mosquito eggs. When present, eggs are carefully removed, added to water and resultant larvae reared to the adult stage.



Anticipated spread of Zika virus from current Brazil outbreak.

Figure taken from: Isaac I. Bogoch, Oliver J. Brady, Moritz Kraemer, Matthew German, Marisa I. Creatore, Manisha A. Kulkarni, John S. Brownstein, Sumiko R. Mekaru, Simon I. Hay, Emily Groot, Alexander Watts, Kamran Khanemail. Anticipating the international spread of Zika virus from Brazil. 23 January 2016. The Lancet. Volume 387, No. 10016, p335–336.

Controlling *Aedes aegypti/albopictus* and Zika virus

In order to properly contain a disease, outbreak efforts must target the mosquito vector, as well as target community involvement initiatives. VDCI recommends a 3-pronged approach for an effective *Ae. aegypti* and *Ae. albopictus* control strategy that is designed to target all phases of the mosquitoes life cycle: (1) Public Education – focusing on the removal of mosquito breeding sources; (2) Larval Mosquito Control – focusing on the application of environmentally safe larvicides for the control of immature mosquitoes; and (3) Adult Mosquito Control – focusing on the targeted application of products for the effective reduction of pestiferous and disease-causing mosquitoes.

(1) Public Education – Given that these mosquito vectors live in and around urban settings, laying eggs in water-holding containers that homeowners have created, community understanding of the sources of these mosquitoes and how to properly "mosquito-proof" their homes is critical. Furthermore, educational pieces that encourage individuals and families to seek prompt medical care when Zika virus is detected in a community should be distributed. Outreach to neighbors, work colleagues, and members of social clubs can reinforce messages disseminated through the mass media regarding symptoms of DHF and appropriate home-based care of cases of dengue fever.

VDCI has developed numerous brochures, door hangars and fact sheets for various mosquito-borne diseases. In conjunction with door-to-door larvicide efforts, these materials can be delivered to homes and residents throughout affected neighborhoods.

(2) Larval Mosquito Control – Only insecticides approved by the Environmental Protection Agency (EPA) for the control of mosquitoes should be used for all control applications. When mosquito larvae are detected in an area, trained and experienced ground crews preferentially apply *Bacillus thuringiensis var israelensis* (Bti) to all areas of standing water, stagnant pools and water-holding containers. Bti is available in liquid, granular, and time-release formulations and poses little threat of resistance development and has minimal environmental impact.

Our crews work in two person teams, canvassing a neighborhood inspecting and treating all appropriate habitats via backpack and hand-delivered applications of larvicide. With the advent of time-release Bti formulations, water holding containers, that cannot be emptied can be safely and effectively treated at 30, 90 or 180 day intervals depending upon the habitat and time of year.

(3) Adult Mosquito Control – Due to the flight behavior of the primary target species, *Ae. aegypti* and *Ae. albopictus*, truck-mounted and aerial ULV applications have limited efficacy. For this reason, VDCI recommends the deployment of two person teams to conduct targeted ULV applications combined with residual "barrier" applications via back pack applicators to mosquito harborage areas near homes and other structures. When combined with our larvicide efforts, these applications have proven highly effective at significantly reducing local populations of *Ae. albopictus*.