Zika Virus in the Americas

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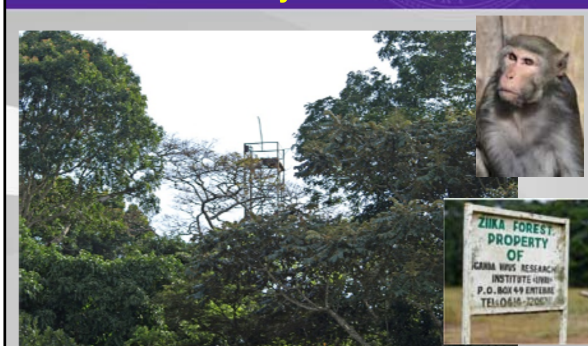
Zika virus: Discovery

Rockefeller Foundation dedicated to arbovirus discovery 1947 (sentinel macaque),
1948 (mosquito),
1954 (human)

Adapted from National Academy presentation by R. Rosenberg

Zika virus: Discovery



Adapted from National Academy presentations by R. Rosenberg (platform photo by B. Beard)
And presentation by Scott Weaver

Zika virus: Genetics

A member of the Flaviviridae family of RNA viruses

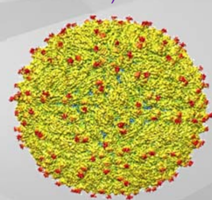
Genome is single positive strand of RNA ~ 10,600 nt Transmitted by mosquitoes

Virus particle contains a lipid bilayer, one genome RNA, and three distinct types of viral proteins, : 1. E - envelope protein 2. M - membrane protein/prM – premembrane protein 3. C - capsid or core protein

Adapted from National Academy presentation by R. Kuhn

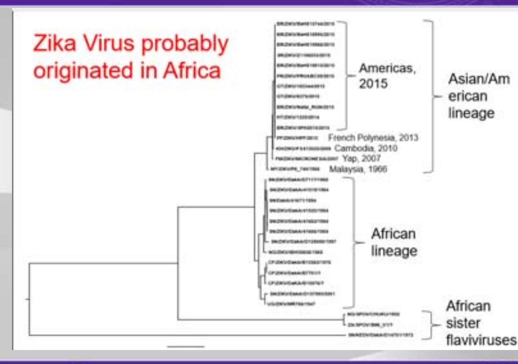
Zika virus: Genetics

Sequence:
Kuno & Chang, January, 2007 (Arch. Virol. 152:687)

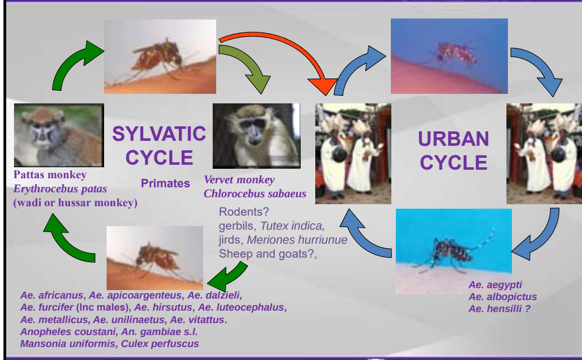


A representation of the surface of the Zika virus. (Image courtesy of Kuhn and Rossman research groups, Purdue University/Released)

Zika virus: Genetics



ZIKV transmission cycles



ZIKV Getting to the Americas 1947 to 2014

Zika virus: Spread

1947 Discovery

Adapted from National Academy presentation by R. Rosenberg

Zika virus: Spread

1947 Discovery | 1954 1st Human

Adapted from National Academy presentation by R. Rosenberg

Zika virus: Spread

1947 Discovery | 1954 1st Human | 1954-2007 Asia

Adapted from National Academy presentation by R. Rosenberg

Zika virus: Spread

1947 Discovery | 1954 1st Human | 1954-2007 Asia | 2007 Pacific

Adapted from National Academy presentation by R. Rosenberg

Zika virus: Yap Island

Adapted from National Academy presentation by R. Rosenberg

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Zika virus: Yap Island (2007)

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Zika Virus Outbreak on Yap Island, Federated States of Micronesia

Mark R. Duffy, D.V.M., M.P.H., Tai-Ho Chen, M.D., W. Thane Hancock, M.D., M.P.H., Ann M. Powers, Ph.D., Jacob L. Kool, M.D., Ph.D., Robert S. Lanciotti, Ph.D., Moses Pretrick, B.S., Maria Marfel, B.S., Stacey Holzbauer, D.V.M., M.P.H., Christine Dubray, M.D., M.P.H., Laurent Guillaumot, M.S., Anne Griggs, M.P.H., Martin Bel, M.D., Amy J. Lambert, M.S., Janeen Laven, B.S., Olga Kosoy, M.S., Amanda Panella, M.P.H., Brad J. Biggerstaff, Ph.D., Marc Fischer, M.D., M.P.H., and Edward B. Hayes, M.D.

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Zika virus: Yap Island

49 confirmed and 59 probable cases of Zika virus disease. Most patients had mild illness.

Rash, fever, arthralgia, and conjunctivitis were common symptoms. No hospitalizations, hemorrhagic manifestations, or deaths due to Zika virus were reported.

Estimated that 73% of Yap residents 3 years of age or older were infected with Zika virus (more than 900 people in total).

The mosquito vector was not identified but *Aedes hensilli* was the predominant mosquito species identified.

Adapted from National Academy presentation by R. Rosenberg

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Zika virus: Yap Island

PLOS

Aedes hensilli as a Potential Vector of Chikungunya and Zika Viruses

Jeremy P. Ledermann, Laurent Guillaumot, Lawrence Yug, Steven C. Saweyog, Mary Tided, Paul Machieng, Moses Pretrick, Maria Marfel, Anne Griggs, Martin Bel, Mark R. Duffy, W. Thane Hancock, Tai Ho-Chen, Ann M. Powers

Abstract

VIRUS	INFECTION RATE	DISSEMINATION RATE
ZIKA	86%	23%
CHIKUNGUNYA	62%	80%
DENGUE	20%	17%

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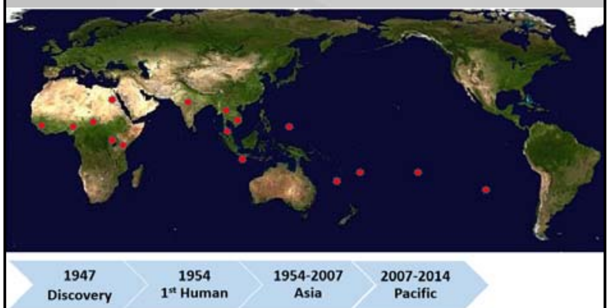
Zika virus: Spread



Adapted from National Academy presentation by R. Rosenberg

Zika virus: South Pacific Outbreaks

2013 – French Polynesia

- Estimated 28,000 (11% population)
  - clinically similar to Yap, but…
- First suspect association Guillan-Barré syndrome
- 2015 retrospective case review: increase in microcephaly
- 2014 – New Caledonia, Cook Islands, Solomons, Easter Island
- Asian genotype – Yap, Cambodia

Adapted from National Academy presentation by R. Rosenberg

Zika virus: Perinatal transmission

RAPID COMMUNICATIONS

Evidence of perinatal transmission of Zika virus, French Polynesia, December 2013 and February 2014

A Zika virus (ZIKAV) outbreak started in October 2013 in French Polynesia, South Pacific. We describe here the clinical and laboratory features of two mothers and their newborns who had ZIKAV infection as confirmed by ZIKAV RT-PCR performed on serum collected within four days post-delivery in date. The infants' infection most probably occurred by transplacental transmission or during delivery. Attention should be paid to ZIKAV-infected pregnant women and their newborns, as data on the impact on them are limited.

Since October 2013, French Polynesia has experienced the largest outbreak of Zika virus (ZIKAV) infection ever reported, with an estimate of 28,000 ZIKAV infections in early February 2014 (about 11% of the population) [1,2]. We report here evidence of perinatal transmis-

for premature newborns was started due to hypoglycaemia and breastfeeding was started, in addition, from the third day post-delivery (day 3). On day 3, the mother presented a mild fever (37.5–38 °C) with pruritic rash and myalgia. The following day, after a three-hour ultraviolet light session for neonatal jaundice, the newborn presented transiently an isolated diffuse rash. Both mother and infant evolved favourably.

Laboratory features

All available samples collected from Mother 1 and Newborn 1 until day 3 and from Mother 2 and Newborn 2 until day 13 were tested for ZIKAV and dengue virus (DENV). No other pathogens were tested for, given the co-circulation of DENV (serotypes 1 and 3) [3] and ZIKAV.

Zika virus: Guillain-Barre

RAPID COMMUNICATIONS

Zika virus infection complicated by Guillain-Barré syndrome – case report, French Polynesia, December 2013

Zika fever, considered as an emerging disease of arboviral origin, because of its expanding geographic area, is known as a benign infection usually presenting as an influenza-like illness with cutaneous rash. So far, Zika virus infection has never led to hospitalisation. We describe the first case of Guillain–Barré syndrome (GBS) occurring immediately after a Zika virus infection, during the current Zika and type 1 and 3 dengue fever co-epidemics in French Polynesia.

elevated distal motor latency, elongated F-wave, conduction block and acute denervation, without axonal abnormalities. The administration of intravenous polyvalent immunoglobulin (0.4 g/kg/day for 5 days) allowed a favourable evolution, with no respiratory impairment necessitating tracheotomy or intensive care unit monitoring, and the patient was discharged home at Day 15. Paraparesis persisted after the end of hospitalisation, that imposed the use of a walking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journal homepage: www.elsevier.com/locate/jcv

ELSEVIER

Short communication

Detection of Zika virus in saliva

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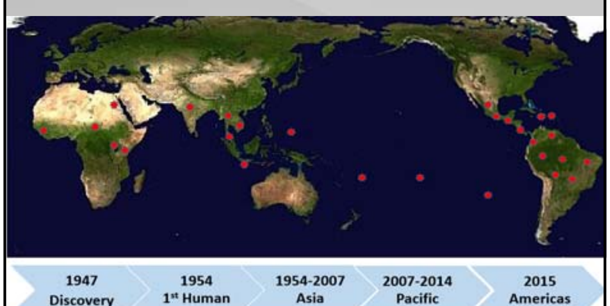
PCR
Saliva
French Polynesia
Arbovirus

ABSTRACT

Background: During the largest Zika virus (ZIKV) outbreak ever reported that occurred from October 2013 to March 2014 in French Polynesia, we observed that several patients presenting the symptoms of acute phase Zika fever were tested negative in blood by ZIKV real-time PCR (RT-PCR).
Objectives: As we have previously detected ZIKV RNA in the saliva of a young child, we investigated the use of saliva as an alternative sample for routine ZIKV RNA detection.
Study design: Over a 6 month period, 1,067 samples collected from 855 patients presenting symptoms of Zika fever (saliva only, blood only or both samples) were tested using a specific ZIKV RT-PCR. A medical questionnaire was available for most of the patients.
Results: ZIKV was more frequently detected in saliva compared to blood. For the 182 patients with both samples collected, tests were positive for 35 (19.2%) in saliva while negative in blood and tests were positive for 16 (8.8%) in blood while negative in saliva; the difference in mean days after symptoms onset and the percentage of the main symptoms of Zika fever for patients only positive in saliva or in blood was not significant.
Conclusion: The use of saliva sample increased the rate of molecular detection of ZIKV at the acute phase of the disease but did not enlarge the window of detection of ZIKV RNA. Saliva was of particular interest when blood was difficult to collect (children and neonates especially).

ZIKV
2015 to Present

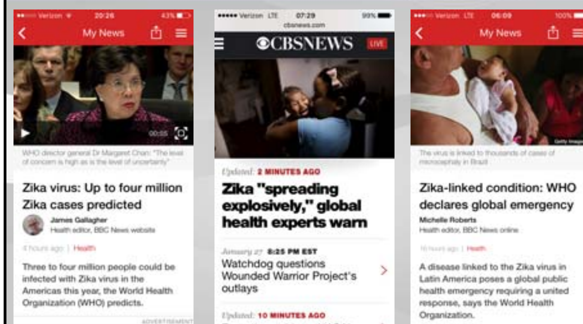
Zika virus: Spread



Adapted from National Academy presentation by R. Rosenberg

Zika Virus in Brazil, May 2015

Zika Case Distribution: February 3, 2016



Zika virus: Human infections

Potential Sexual Transmission of Zika Virus

Didier Musso, Claudine Roche, Emilie Robin, Tuxuan Nhan, Anita Teissier, Van-Mai Cao-Lormeau

In December 2013, during a Zika virus (ZIKV) outbreak in French Polynesia, a patient in Tahiti sought treatment for hematospermia, and ZIKV was isolated from his semen. ZIKV transmission by sexual intercourse has been previously suspected. This observation supports the possibility that ZIKV could be transmitted sexually.

2011 Zika virus: Human infections

DOI: 10.3201/eid1705.101939

Suggested citation for this article: Foy BD, Kobylinski KC, Foy JLC, Blitvich BJ, Travassos da Rosa A, Haddow AD, et al. Probable non–vector-borne transmission of Zika virus, Colorado, USA. Emerg Infect Dis. 2011 May; [Epub ahead of print]

Probable Non–Vector-borne Transmission of Zika Virus, Colorado, USA

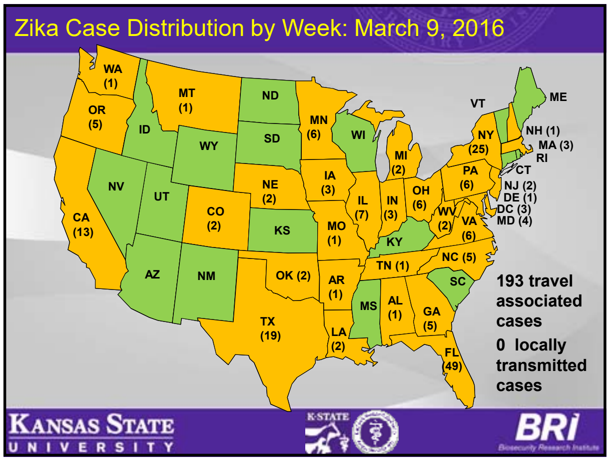
Brian D. Foy, Kevin C. Kobylinski, Joy L. Chilson Foy, Bradley J. Blitvich, Amelia Travassos da Rosa, Andrew D. Haddow, Robert S. Lanciotti, and Robert B. Tesh

ZIKV 2016 in US

Zika virus; First case in US January 11, 2016

Traveler from El Salvador to Harris County, Houston, Texas

First sexually transmitted case in US February 2, 2016


Zika Case Distribution by Week: March 9, 2016
WA (1)
OR (5)
MT (1)
ID
ND
SD
WY
MN (6)
WI
MI (2)
VT
NY (25)
ME
NH (1)
MA (3)
RI
CT
NV
UT
CO (2)
NE (2)
KS
IA (3)
IL (7)
IN (3)
OH (6)
PA (6)
NJ (2)
DE (1)
DC (3)
MD (4)
CA (13)
AZ
NM
MO (1)
KY
WV (2)
VA (6)
OK (2)
AR (1)
TN (1)
NC (5)
SC
TX (19)
MS
AL (1)
GA (5)
LA (2)
FL (49)
193 travel associated cases
0 locally transmitted cases
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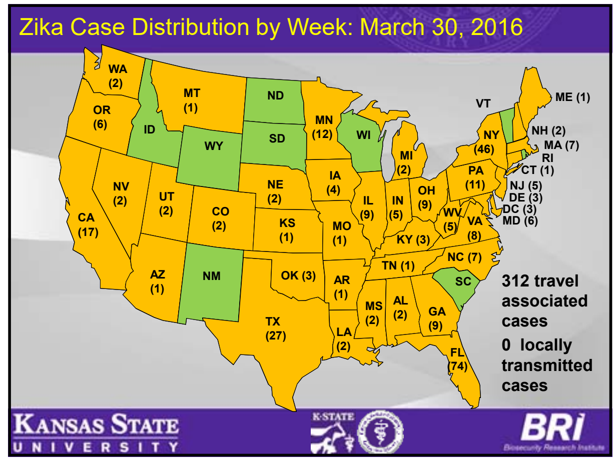
Zika Case Distribution by Week: March 30, 2016
WA (2)
OR (6)
MT (1)
ID
ND
SD
WY
MN (12)
WI
MI (2)
VT
NY (46)
ME (1)
NH (2)
MA (7)
RI
CT (1)
NV (2)
UT (2)
CO (2)
NE (2)
KS (1)
IA (4)
IL (9)
IN (5)
OH (9)
PA (11)
NJ (5)
DE (3)
DC (3)
MD (6)
CA (17)
AZ (1)
NM
MO (1)
KY (3)
WV (5)
VA (8)
OK (3)
AR (1)
TN (1)
NC (7)
SC
TX (27)
MS (2)
AL (2)
GA (9)
LA (2)
FL (74)
312 travel associated cases
0 locally transmitted cases
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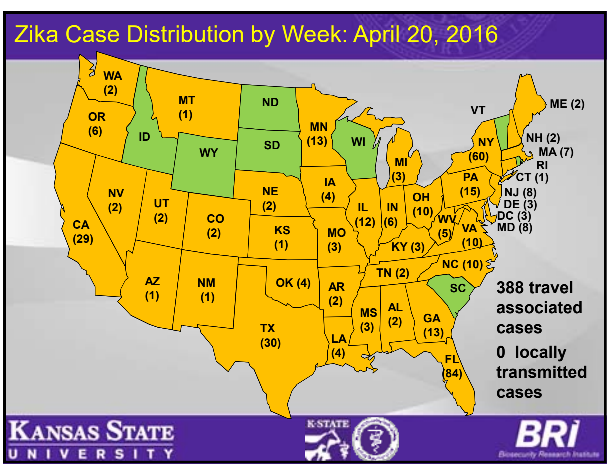
Zika Case Distribution by Week: April 20, 2016
WA (2)
OR (6)
MT (1)
ID
ND
SD
WY
MN (13)
WI
MI (3)
VT
NY (60)
ME (2)
NH (2)
MA (7)
RI
CT (1)
NV (2)
UT (2)
CO (2)
NE (2)
KS (1)
IA (4)
IL (12)
IN (6)
OH (10)
PA (15)
NJ (8)
DE (3)
DC (3)
MD (8)
CA (29)
AZ (1)
NM (1)
MO (3)
KY (3)
WV (5)
VA (10)
OK (4)
AR (2)
TN (2)
NC (10)
SC
TX (30)
MS (3)
AL (2)
GA (13)
LA (4)
FL (84)
388 travel associated cases
0 locally transmitted cases
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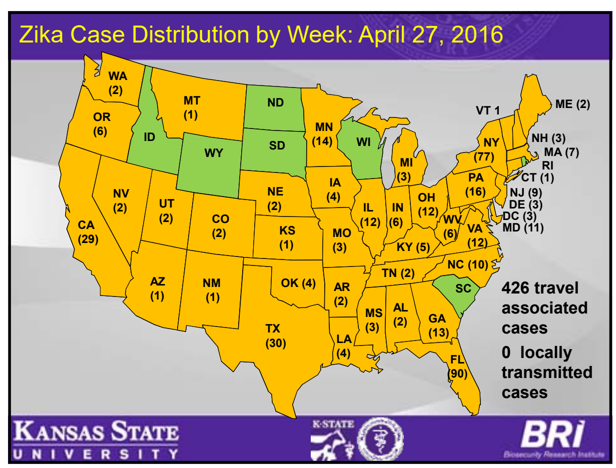
Zika Case Distribution by Week: April 27, 2016
WA (2)
OR (6)
MT (1)
ID
ND
SD
WY
MN (14)
WI
MI (3)
VT 1
NY (77)
ME (2)
NH (3)
MA (7)
RI
CT (1)
NV (2)
UT (2)
CO (2)
NE (2)
KS (1)
IA (4)
IL (12)
IN (6)
OH (12)
PA (16)
NJ (9)
DE (3)
DC (3)
MD (11)
CA (29)
AZ (1)
NM (1)
MO (3)
KY (5)
WV (6)
VA (12)
OK (4)
AR (2)
TN (2)
NC (10)
SC
TX (30)
MS (3)
AL (2)
GA (13)
LA (4)
FL (90)
426 travel associated cases
0 locally transmitted cases
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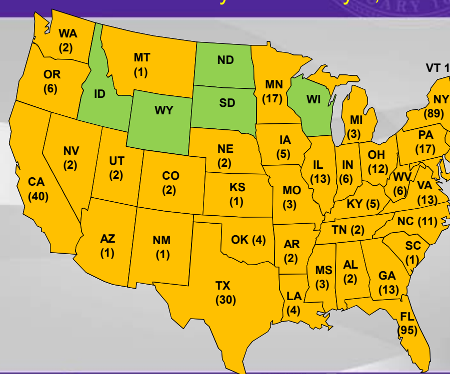
Zika Case Distribution by Week: May 4, 2016



472 travel associated cases

0 locally transmitted cases

15 July 2016

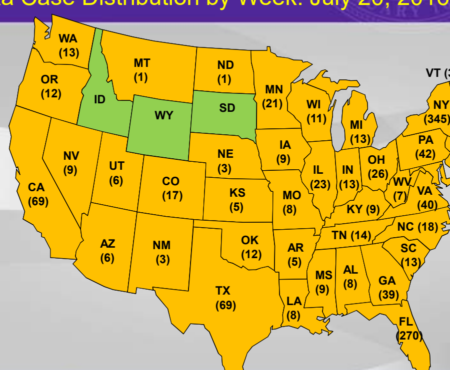
ZIKA

New York reports first female-to-male Zika transmission via sex

Published July 15, 2016 · Reuters

New York City's health department on Friday reported the first female-to-male transmission of the Zika virus, which is most typically spread by the bite of an infected mosquito.

Zika Case Distribution by Week: July 20, 2016



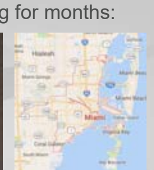
1,404 travel associated cases

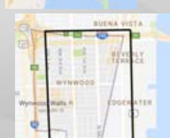
0 locally transmitted cases

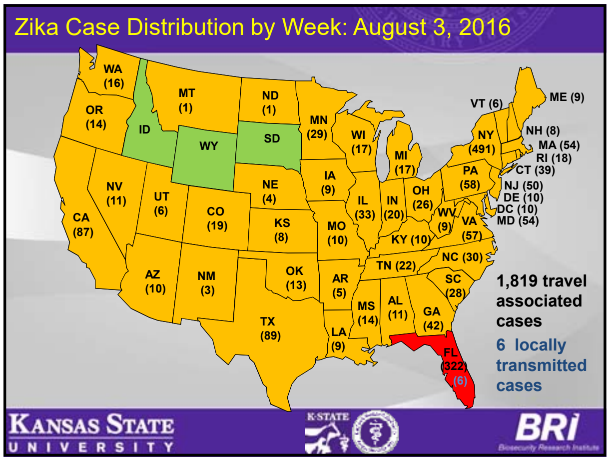
August 3, 2016 Local transmission of Zika in Miami

Last week, the Centers for Disease Control and Prevention reported something it had been anticipating for months:

Carlos Varas, a Miami-Dade County mosquito inspector, sprays around homes in the Wynwood area of Miami on Tuesday. Emily Michot/Miami Herald/TNS via Getty Images






Zika Case Distribution by Week: August 3, 2016
WA (16)
OR (14)
ID
MT (1)
ND (1)
SD
WY
MN (29)
WI (17)
MI (17)
VT (6)
ME (9)
NY (491)
NH (8)
MA (54)
RI (18)
CT (39)
NJ (50)
DE (10)
DC (10)
MD (54)
PA (58)
OH (26)
IN (20)
IL (33)
IA (9)
NE (4)
KS (8)
MO (10)
CO (19)
UT (6)
NV (11)
CA (87)
AZ (10)
NM (3)
OK (13)
TX (89)
AR (5)
LA (9)
MS (14)
AL (11)
GA (42)
SC (28)
NC (30)
TN (22)
KY (10)
WV (9)
VA (57)
FL (322) (6)
1,819 travel associated cases
6 locally transmitted cases
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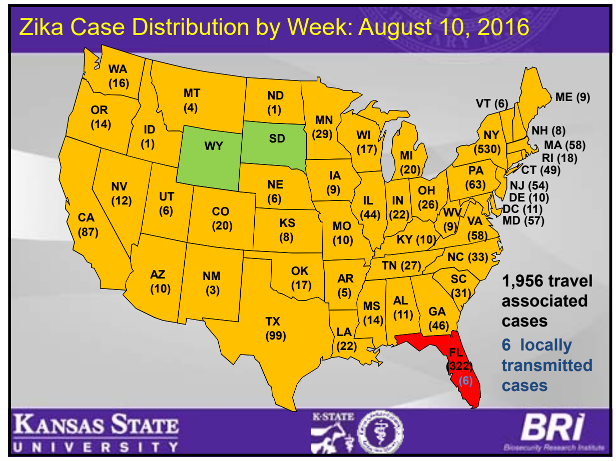
Zika Case Distribution by Week: August 10, 2016
WA (16)
OR (14)
ID (1)
MT (4)
ND (1)
SD
WY
MN (29)
WI (17)
MI (20)
VT (6)
ME (9)
NY (530)
NH (8)
MA (58)
RI (18)
CT (49)
NJ (54)
DE (10)
DC (11)
MD (57)
PA (63)
OH (26)
IN (22)
IL (44)
IA (9)
NE (6)
KS (8)
MO (10)
CO (20)
UT (6)
NV (12)
CA (87)
AZ (10)
NM (3)
OK (17)
TX (99)
AR (5)
LA (22)
MS (14)
AL (11)
GA (46)
SC (31)
NC (33)
TN (27)
KY (10)
WV (9)
VA (58)
FL (322) (6)
1,956 travel associated cases
6 locally transmitted cases
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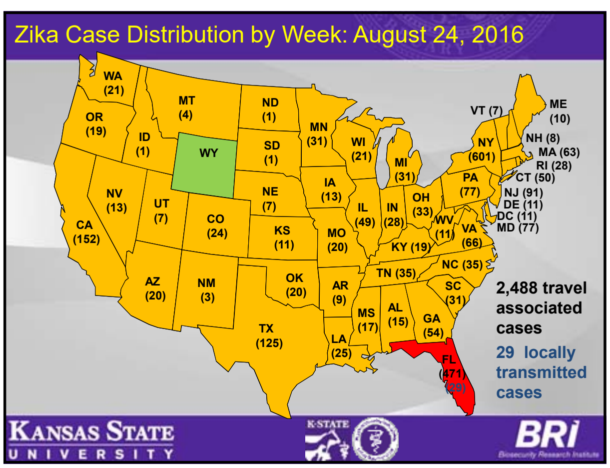
Zika Case Distribution by Week: August 24, 2016
WA (21)
OR (19)
ID (1)
MT (4)
ND (1)
SD (1)
WY
MN (31)
WI (21)
MI (31)
VT (7)
ME (10)
NY (601)
NH (8)
MA (63)
RI (28)
CT (50)
NJ (91)
DE (11)
DC (11)
MD (77)
PA (77)
OH (33)
IN (28)
IL (49)
IA (13)
NE (7)
KS (11)
MO (20)
CO (24)
UT (7)
NV (13)
CA (152)
AZ (20)
NM (3)
OK (20)
TX (125)
AR (9)
LA (25)
MS (17)
AL (15)
GA (54)
SC (31)
NC (35)
TN (35)
KY (19)
WV (11)
VA (66)
FL (471) (29)
2,488 travel associated cases
29 locally transmitted cases
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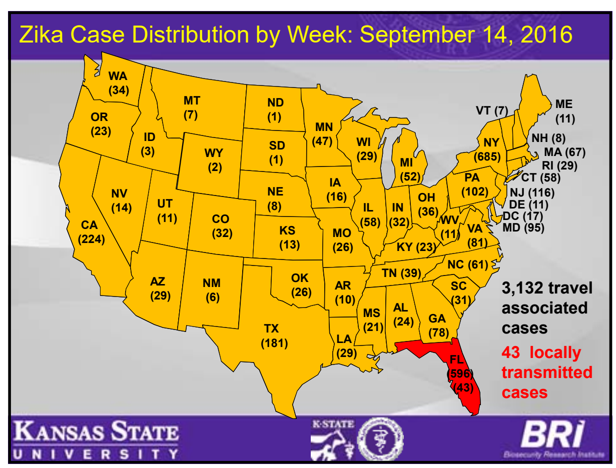
Zika Case Distribution by Week: September 14, 2016
WA (34)
OR (23)
ID (3)
MT (7)
ND (1)
SD (1)
WY (2)
MN (47)
WI (29)
MI (52)
VT (7)
ME (11)
NY (685)
NH (8)
MA (67)
RI (29)
CT (58)
NJ (116)
DE (11)
DC (17)
MD (95)
PA (102)
OH (36)
IN (32)
IL (58)
IA (16)
NE (8)
KS (13)
MO (26)
CO (32)
UT (11)
NV (14)
CA (224)
AZ (29)
NM (6)
OK (26)
TX (181)
AR (10)
LA (29)
MS (21)
AL (24)
GA (78)
SC (31)
NC (61)
TN (39)
KY (23)
WV (11)
VA (81)
FL (596) (43)
3,132 travel associated cases
43 locally transmitted cases
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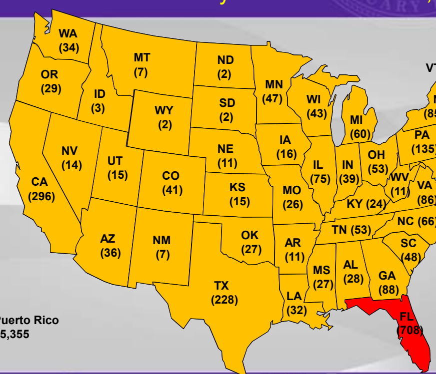
Zika Case Distribution by Week: October 12, 2016



3,808 travel associated cases (66 NC)

128 locally transmitted cases

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MOSQUITO INFECTIONS

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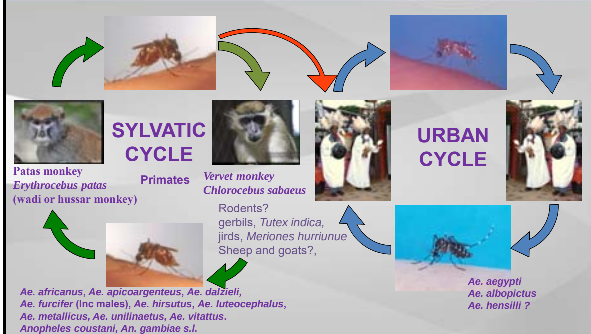
ZIKV transmission cycles

ASTMH



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Zika virus: Vectors

The first isolation of Zika virus from mosquito samples was made in 1948 from *Aedes africanus*.,

Lately, many other *Aedes* species have been surveyed for the detection of Zika virus, and thus far, Zika virus has been detected by RT-PCR or isolated from many mosquito species, human beings, and non-human primates.

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Adapted from National Academy presentation by T. Monath

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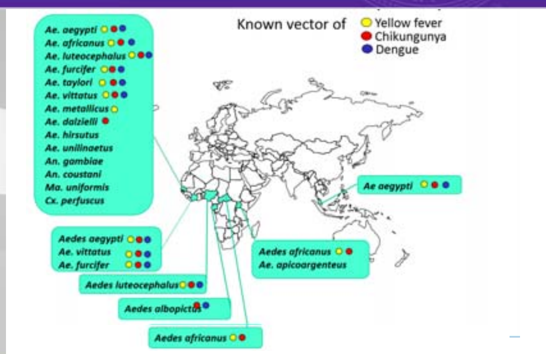
Zika virus: Vectors

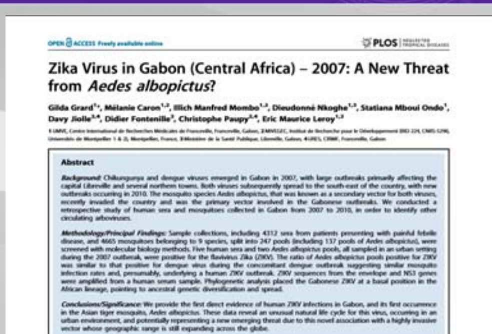


Adapted from National Academy presentation by T. Monath

Zika virus: Vectors

Aedes aegypti the Yellow Fever Mosquito (photo S. Higgs)

Zika virus: Vectors



OPEN ACCESS Freely available online PLOS | NEGLECTED TROPICAL DISEASES

Zika Virus in Gabon (Central Africa) – 2007: A New Threat from *Aedes albopictus*?

Gilda Grard[1*], Mélanie Caron[1,2], Illich Manfred Mombo[1,2], Dieudonné Nkoghe[1,3], Statiana Mboui Ondo[1], Davy Jiolle[2,4], Didier Fontenille[2], Christophe Paupy[2,4], Eric Maurice Leroy[1,2]

Abstract

Background: Chikungunya and dengue viruses emerged in Gabon in 2007, with large outbreaks primarily affecting the capital Libreville and several northern towns. Both viruses subsequently spread to the south-east of the country, with new outbreaks occurring in 2010. The mosquito species Aedes albopictus, that was known as a secondary vector for both viruses, recently invaded the country and was the primary vector involved in the Gabonese outbreaks. We conducted a retrospective study of human sera and mosquitoes collected in Gabon from 2007 to 2010, in order to identify other circulating arboviruses.

Methodology/Principal Findings: Sample collections, including 4312 sera from patients presenting with painful febrile disease, and 4665 mosquitoes belonging to 9 species, split into 247 pools (including 137 pools of Aedes albopictus), were screened with molecular biology methods. Five human sera and two Aedes albopictus pools, all sampled in an urban setting during the 2007 outbreak, were positive for the flavivirus Zika (ZIKV). The ratio of Aedes albopictus pools positive for ZIKV was similar to that positive for dengue virus during the concomitant dengue outbreak suggesting similar mosquito infection rates and, presumably, underlying a human ZIKV outbreak. ZIKV sequences from the envelope and NS3 genes were amplified from a human serum sample. Phylogenetic analysis placed the Gabonese ZIKV at a basal position in the African lineage, pointing to ancestral genetic diversification and spread.

Conclusions/Significance: We provide the first direct evidence of human ZIKV infections in Gabon, and its first occurrence in the Asian tiger mosquito, Aedes albopictus. These data reveal an unusual natural life cycle for this virus, occurring in an urban environment, and potentially representing a new emerging threat due to this novel association with a highly invasive vector whose geographic range is still expanding across the globe.

Zika virus: Vectors

Aedes albopictus the Asian Tiger Mosquito (photo S. Higgs)

Introduced into: Europe (Albania, 1979), US (Houston, 1985), Brazil (86), Continental Africa, (Nigeria,1991), Italy (from US?, 1990), France (1999), UK (2014).

What about *Culex* species?

October 10, 2016

CDC Centers for Disease Control and Prevention
CDC 24/7: Saving Lives, Protecting People™

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ISSN: 1080-6059

EID journal · October 2016 · *Culex pipiens* and *Aedes triseriatus* Mosquito Susceptibility to Zika Virus · Table · Manuscript Submission · About the Journal · Past Issues · Subscribe · Ahead of Print / In Press · Author Resource Center · Medscape CME · Podcasts · Announcements

CDC › EID journal › October 2016 › Culex pipiens and Aedes triseriatus Mosquito Susceptibility to Zika Virus

Volume 22, Number 10—October 2016

Letter

Culex pipiens and *Aedes triseriatus* Mosquito Susceptibility to Zika Virus

Matthew T. Aliota, Stephen A. Peinado, Jorge E. Osorio, and Lyric C. Bartholomay
Author affiliations: University of Wisconsin, Madison, Wisconsin, USA

Main Article

Table

Competence of mosquitoes, by species, as Zika virus vectors, 14 days after peroral infection, United States*

Competence of mosquitoes, by species, as Zika virus vectors, 14 days after peroral infection, United States*

No. virus-positive/no. tested (%)

Mosquito species	Biological replicate 1, mean 6.02 log_{10} PFU/mL ± SD 0.67			Biological replicate 2, mean 4.74 log_{10} PFU/mL ± SD 0.06			Biological replicate 3, mean 6.83 log_{10} PFU/mL ± SD 0.45		
	I	D	T	I	D	T	I	D	T
Culex pipiens†	0/20 (0)	0/20 (0)	0/20 (0)	0/10 (0)	0/10 (0)	0/10 (0)	0/30 (0)	0/30 (0)	0/30 (0)
Aedes triseriatus‡	ND	ND	ND	0/20 (0)	0/20 (0)	0/20 (0)	4/13 (31)	0/4 (0)	0/4 (0)
Ae. albopictus§	9/9 (100)	6/9 (67)	2/9 (22)	1/6 (17)	0/1 (0)	0/1 (0)	ND	ND	ND
Ae. aegypti¶	ND	ND	ND	ND	ND	ND	17/17 (100)	12/17 (71)	4/17 (24)

*Zika virus strain PRVABC59 (GenBank accession no. KU501215) was originally isolated from a traveler to Puerto Rico in December 2015. I, infected; D, disseminated; ND, no data; T, transmitted.
†Originated from egg rafts collected in Iowa in 2002 and colonized at the Iowa State University Medical Entomology Laboratory.
‡Originated from eggs collected in Iowa in 2002 and 2003 and colonized at the Iowa State University Medical Entomology Laboratory.
§Originated from eggs collected in Missouri in 2002 and colonized at the Illinois Natural History Survey.
¶Black-eyed Liverpool strain.

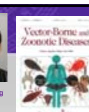
Main Article

The conclusions, findings, and opinions expressed by authors contributing to this journal do not necessarily reflect the official position of the U.S. Department of Health and Human Services, the Public Health Service, the Centers for Disease Control and Prevention, or the authors' affiliated institutions. Use of trade names is for identification only and does not imply endorsement by any of the groups named above.

October 27, 2016

Dr. D. Vanlandingham CVM

Dr. S. Huang CVM



ORIGINAL ARTICLE

Culex Species Mosquitoes and Zika Virus

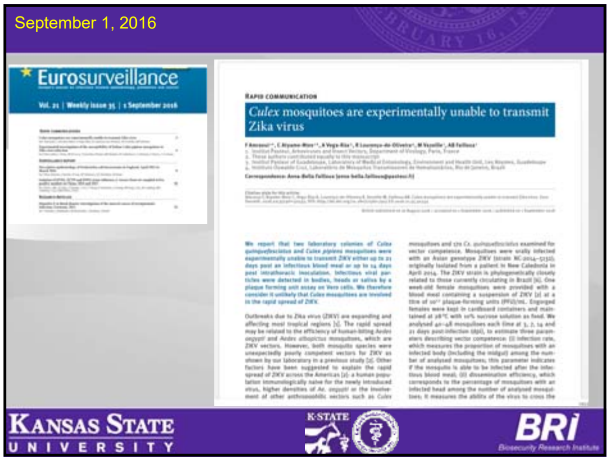
Culex p. quinquefasciatus (Vero Beach, Florida), collected August 2015, 7th generation.

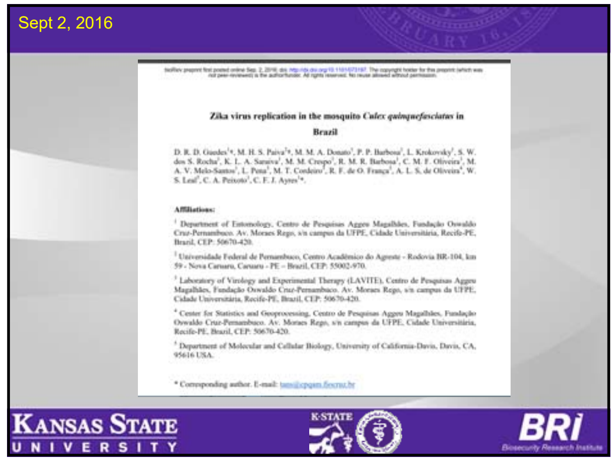
Fed with blood meal containing 6.95$log_{10}TCID_{50}$/mL of ZIKV strain PRVABC59, Asian lineage (human isolate from Puerto Rico). Approximately 10 million virus particles per mL

None became infected

Also tested: *Cx. pipiens* from Mercer Count, NJ, F_7 and *Cx. pipiens* from Anderson, CA, F_{15}. None became infected

Vero beach is 140 miles from Miami beach


September 1, 2016
Eurosurveillance
Vol. 21 | Weekly issue 35 | 1 September 2016
Rapid communication
Culex mosquitoes are experimentally unable to transmit Zika virus
Kansas State University
K-State
BRI
Biosecurity Research Institute


Sept 2, 2016
Zika virus replication in the mosquito Culex quinquefasciatus in Brazil
D. R. D. Guedes, M. H. S. Paiva, M. M. A. Donato, P. P. Barbosa, L. Krokovsky, S. W. dos S. Rocha, K. L. A. Saraiva, M. M. Crespo, R. M. R. Barbosa, C. M. F. Oliveira, M. A. V. Melo-Santos, L. Pena, M. T. Cordeiro, R. F. de O. França, A. L. S. de Oliveira, W. S. Leal, C. A. Peixoto, C. F. J. Ayres
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Center for Statistics and Geoprocessing, Centro de Pesquisas Aggeu Magalhães, Fundação Oswaldo Cruz-Pernambuco. Av. Moraes Rego, s/n campus da UFPE, Cidade Universitária, Recife-PE, Brazil, CEP: 50670-420.
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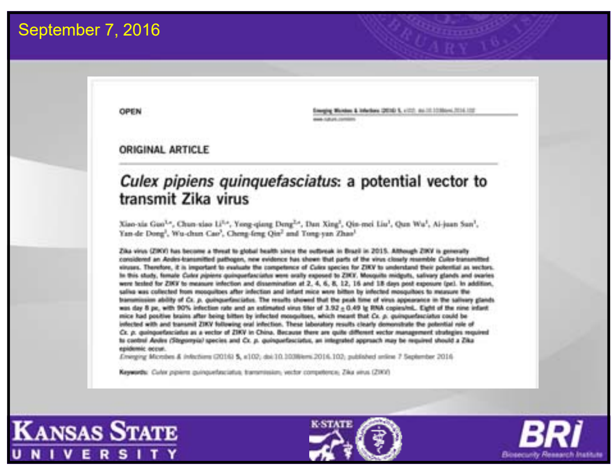
* Corresponding author.
Kansas State University
K-State
BRI
Biosecurity Research Institute


September 6, 2016
PLOS Neglected Tropical Diseases
Culex quinquefasciatus from Rio de Janeiro Is Not Competent to Transmit the Local Zika Virus
Abstract
Background
Methodology/Principal Findings
Kansas State University
K-State
BRI
Biosecurity Research Institute


September 7, 2016
OPEN
ORIGINAL ARTICLE
Culex pipiens quinquefasciatus: a potential vector to transmit Zika virus
Kansas State University
K-State
BRI
Biosecurity Research Institute

ZIKV: WHAT IS LEFT TO DO?

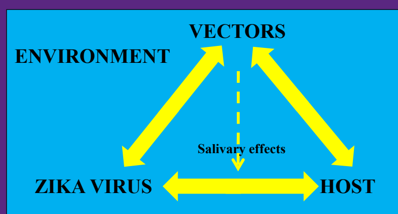
Surveillance
Predictive models

New vectors in the Americas
New control (RIDL, *Wolbachia*)
Insecticides
Repellants

Reagents

Detection

Diagnostics (differential)



New Vertebrates (NW primates, rodents, livestock)

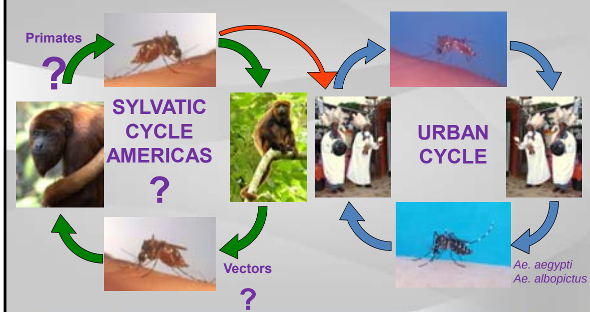
Viral genetics:
Asian vs African
infectivity
pathogenicity

Disease
Guillain-Barre
microcephaly
sexual transmission
persistence

Treatments
Vaccines

Animal Models

ZIKV transmission cycles in the Americas?

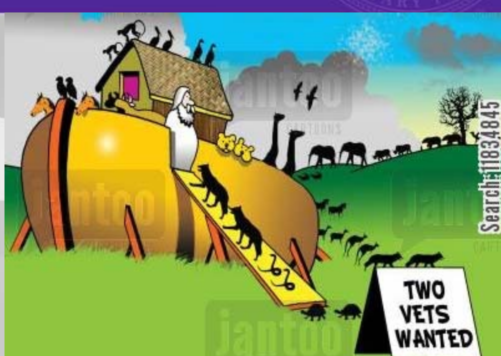


New World Primates (135 spp.)

FAMILY	COMMON NAME	NUMBER of SPECIES
Family Callitrichidae	Marmosets and Tamarins	20 marmosets 22 tamarins
Family Cebidae	Capuchins and Squirrel monkeys	9 capuchins 5 squirrel
Family Aotidae	Night/Owl monkeys	11
Family Pitheciidae	Titis, Sakis and Uakaris	29 titis 10 sakis 5 uakari
Family Atelidae	Howler, Spider, Wooly spider & Wooly	10 howler 7 spider 2 wooly spider 5 woolly

INFECTIONS of “OTHER” VERTEBRATES

The Animals Board Noah's Ark. Artist: Bassano, Jacopo, il vecchio (ca. 1510-1592)



Zika virus in animals: 1983

442

Transactions of the Royal Society of Tropical Medicine and Hygiene, Vol. 77, No. 4, 442-445 (1983)

A sero-epidemiological survey for certain arboviruses (Togaviridae) in Pakistan

Medhat A. Darwish[1]*, Harry Hoogstraal[2]**, Thomas J. Roberts[3], Ismat P. Ahmed[3] and Ferial Omar[4]

[1]Faculty of Medicine, Ain Shams University, Cairo, Arab Republic of Egypt; [2]United States Naval Medical Research Unit Number Three (NAMRU-3), American Embassy, Cairo; [3]Vertebrate Pest Control Centre (VPCC), Karachi, Pakistan; [4]Egyptian Organization for Biological Products and Vaccines, Cairo

Summary

Complement-fixation test reactions to eight viruses of the family Togaviridae were studied in 372 serum samples (157 rodents, 172 domestic animals, 43 humans) from Pakistan. Antibodies to each tested virus were detected. The highest over-all prevalence rates were for West Nile (WN) (7·8%), Japanese encephalitis (JE) (3·2%) and Zika (ZIKA) (2·4%) viruses, followed by Sindbis (SIN), Chikungunya (CHIK), Uganda S (UGS) and Royal Farm (RF) viruses (1·6 to 1·3%). One human serum (male, age 58 years) reacted with Dengue-1 (DEN) virus antigen (titre 1:32). Antibodies to each virus except RF were detected in human sera; antibodies to RF virus were detected only in rodent and domestic animal sera. The roles of rodents in the epidemiology of WN, JE and ZIKA viruses should be investigated. At least six of these eight viruses cause fevers in humans (fevers of unknown origin comprise about one third of the febrile episodes recorded in Pakistan).

372 sera:
157 rodents, 172 domestic animals, 43 humans
Complement fixation tests for 8 viruses

Results Over-all prevalence rates were highest for WN, DEN and JE viruses (3.2% to 7.8%) followed by ZIKA (2.4%) and the other four viruses (Table I). CF titres were high (1:16 and/or 1:32) for certain samples of each virus except CHIK (Table II). All ZIKA and RF titres were 1:8 or higher. Between 60% and 7or higher0% of the WN, JE, SIN, and UGS titres were 1:8. In rodent sera, 72% (18 of 25) reacted to one virus and 28% (7 of 25) reacted to two or more (mostlv two) viruses. High eF titres (1: 16 and/or ' 1:32)- were obtained with WN, JE, SIN, ZIKA, and RF viruses (Table III).

Zika virus antibodies in animals: 1983

M. A. DARWISH *et al.* 443

Table I—Antibodies against certain Togaviridae in sera from Pakistan

Sera	No. tested	SIN No. (%)	CHIK No. (%)	WN No. (%)	JE No. (%)	DE No. (%)	ZIKA No. (%)	UGS No. (%)	RF No. (%)
Rodents (Total)	157	4 (2·5)	4 (2·5)	7 (4·5)	7 (4·5)	2 (1·3	6 (3·8)	(1·3)	2 (1·3)
Tatera indica	47	1	1	3	4	1	3		1
Meriones hurrianae	33	0	1	2	2	1	2		0
Rattus rattus	54	3	1	0	1	0	0		1
Rattus norvegicus	9	0	1	1	0	0	0		0
Rattus (Millardia) meltada	2	0	0	1	0	0	0		0
Nesokia indica	7	0	0	0	0	0	0		0
Bandicota bengalensis	2	0	0	0	0	0	1		0
Golunda ellioti	1	0	0	0	0	0	0		0
Funambulus pennanti	0	0	0	0	0	0	0		0
Domestic animals (Total)	172	1 (0·6)	0	17 (9·9)	2 (1·2)	7 (4·1	2 (1·2)	(0·6)	3 (1·7)
Cow	45	0	0	1	0	0	0		2
Buffalo	33	0	0	5	1	2	0		1
Sheep	46	1	0	11	1	5	1		0
Goat	48	0	0	0	0	0	1		0
Man (Total)	43	1 (2·3)	1 (2·3)	5 (11·6)	3 (7·0)	4 (9·3	1 (2·3)	(4·6)	0 (0)
Grand Total	372	6 (1·6)	5 (1·3)	29 (7·8)	12 (3·2)	13 (3·5	9 (2·4)	(1·3)	5 (1·3)

RESULTS

3.8% rodents positive (n=6/157)

3/47 *Tatera* indica, 2/33 *Meriones hurrianae*, 1/2 *Bandicota bengalensis*)

1.2% domestic animals (n=2/172)

1/46 sheep, 1/48 goat)

2.3% humans (n = 1/43)

Zika virus antibodies in animals: 1983

Table II—CF titres in sera tested

Virus	No. sera	Reciprocal of serum end-point dilution 4	8	16	32
West Nile	29	9	11	9	0
Dengue 1	13	8	4	0	1
Japanese encephalitis	12	4	3	1	4
Zika	9	0	4	1	4
Uganda S	5	2	2	1	0
Sindbis	6	2	2	0	2
Chikungunya	5	4	1	0	0
Royal Farm	5	0	2	1	2

Table III—CF titres* in rodent sera

Rodent species (no.)	Virus (no. each titre) WN	DEN	JE	SIN	CHIK	ZIKA	UGS	RF
Tatera indica (10)	16 (3)	4 (1)	16 (1), 8 (1), 4 (2)	8 (1)	8 (1)	32 (1), 8 (2)	8 (1)	32 (1)
Meriones hurrianae (6)	16 (2)	4 (1)	32 (2)	0	4 (1)	32 (1), 8 (1)	0	0
Rattus rattus (5)	0	0	32 (1)	32 (1), 4 (2)	4 (1)	0	4 (1)	8 (1)
Rattus norvegicus (2)	16 (1)	0	0	0	4 (1)	0	0	0
Rattus meltada (1)	8 (1)	0	0	0	0	0	0	0
Bandicota bengalensis (1)	0	0	0	0	0	8 (1)	0	0

*Reciprocal of serum end-point dilution

The reaction of all positive sera with JE antigen was monospecific except that one rodent (*T. indica*) serum was simultaneously positive for another Flavivirus (Zika virus). All other positive sera reacted monospecifically with the respective Flavivirus except from one rodent (*T. indica*) and one human (40-year-old female); these two sera reacted with both Zika and Uganda S viruses

Zika virus in animals: 1983 Conclusions

Antibodies against ZIKA virus were detected in sera from rodents, sheep, goats and one person (without antibodies to other flaviviruses).

These data are the first indication of ZIKA virus infection in rodents and domestic animals.

The natural history of this agent should be investigated in more detail

Gerbils, *Tatera indica*, and jirds, *Meriones hurriunue*, may be reservoirs of JE, WN and ZIKA viruses.

***Rattus rattus* and *R. norvegicus* are also potential sources of human infection by these viruses, especially in rural areas with dense mosquito populations**

Zika virus in animals: 2016 (unpublished)

K·STATE

COLORADO STATE UNIVERSITY

Department of Microbiology, Immunology & Pathology

Dr. Izabela Ragan, Dr. Richard Bowen and PhD student Emily Blizzard

Zika virus in animals: 2016 (unpublished)

- Zika Virus strains
  - PRVA BC59: Puerto Rico December 2015
  - FSS13025: Cambodia 2010
- Inoculation dose: 10^5 PFU/mL subcutaneous and intradermal

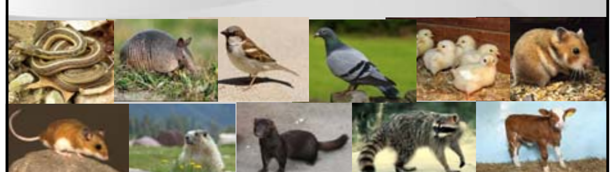
- The study
  - Challenged at day 0 and maintained animals for 28 days
  - Recorded clinical signs, temperatures
  - Collected sera at days post infection 0-5, 7,14,21,28
  - Collected tissues at necropsy
- Serology
  - Plaque reduction neutralization assay
    - PRNT 90
- Virus Isolation
  - Plaque assay on sera and tissues
  - Real Time RT-PCR on sera
- Histopathology and Immunohistochemistry

Zika virus in animals: 2016 (unpublished)

- Results:
  - No clinical signs or febrile state detected
  - Viremia detected in frogs
  - Real time RT-PCR on sera
    - In progress
    - Detection of RNA in frogs and an armadillo

No antibodies in

Armadillo, Pigeon, Chicken, Snake, Hamster, Mink, Ground Hog, Calf, Deer, Mouse, Sparrow



Antibodies detected in:

Antibodies detected in goats, cottontail rabbits, ducklings, pigs, and frogs

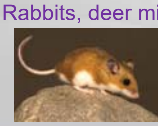




Results of baby rabbits, raccoons, and frogs pending

Zika virus in animals: 2016 (unpublished)

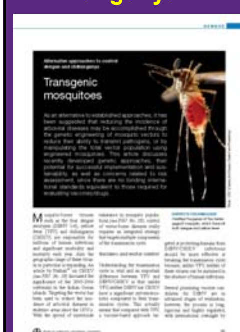
- Puerto Rican strain elicited stronger immune response than Cambodian strain
- No difference in susceptibility between young and adult animals
- No birth defects noted in newborns during study
  - Rabbits, deer mice




Zika virus in animals: 2016 (unpublished)

- **Future work:**
  - **Additional species**
    - **Horses, dogs, cats, guinea pigs, pregnant sows, domestic mice, bats,**
  - **Immunohistochemistry and histopathology**
  - **Real time RT-PCR**
  - **Developing pregnancy model in animals**

"Alternative Approaches to Control Dengue and Chikungunya"



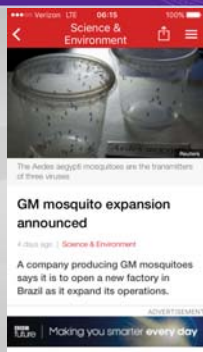
Release of Insects carrying a Dominant Lethal gene (RIDL)

***Wolbachia spp* – infected mosquitoes.** Intracellular bacteria that infects multiple tissues including ovaries and salivary glands.

Photo: © Public Library of Science / Scott O'Neill

Higgs, 2013

Release of Insects with Dominant Lethal (RIDL) mosquitoes



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BIOQUAL, INC http://bioqual.com/index.html

BIOQUAL was initially established in 1981 and incorporated in 1982 to perform medical research and research services. Acquisition of a local contract research laboratory was completed in April of 1982. The diagnostic arm of BIOQUAL was phased out in 1987 and in 1999 all entities became BIOQUAL, Inc. BIOQUAL has 4 locations totaling over 130,000 square feet of state-of-the-art facilities focusing on infectious disease, cancer, and animal models.

KANSAS STATE UNIVERSITY | K-STATE | BRI Biosecurity Research Institute

22 September 2016

Science

Rapid development of a DNA vaccine for Zika virus

KANSAS STATE UNIVERSITY | K-STATE | BRI Biosecurity Research Institute

3 October 2016

ARTICLES

nature medicine

Zika viral dynamics and shedding in rhesus and cynomolgus macaques

Christa E Osuna[1,8], So-Yon Lim[1,8], Claire Deleage[2], Bryan D Griffin[3], Derek Stein[3], Lukas T Schroeder[3], Robert Omage[3], Katharine Best[4], Ma Luo[3], Peter T Hraber[4], Hanne Andersen-Elyard[5], Erwing Fabian Cardozo Ojeda[4], Scott Huang[6], Dana L Vanlandingham[6], Stephen Higgs[6], Alan S Perelson[4], Jacob D Estes[2], David Safronetz[3,8], Mark G Lewis[5,8] & James B Whitney[1,7]

Infection with Zika virus has been associated with serious neurological complications and fetal abnormalities. However, the dynamics of viral infection, replication and shedding are poorly understood. Here we show that both rhesus and cynomolgus macaques are highly susceptible to infection by lineages of Zika virus that are closely related to, or are currently circulating in, the Americas. After subcutaneous viral inoculation, viral RNA was detected in blood plasma as early as 1 d after infection. Viral RNA was also detected in saliva, urine, cerebrospinal fluid (CSF) and semen, but transiently in vaginal secretions. Although viral RNA during primary infection was cleared from blood plasma and urine within 10 d, viral RNA was detectable in saliva and seminal fluids until the end of the study, 3 weeks after the resolution of viremia in the blood. The control of primary Zika virus infection in the blood was correlated with rapid innate and adaptive immune responses. We also identified Zika RNA in tissues, including the brain and male and female reproductive tissues, during early and late stages of infection. Re-infection of six animals 45 d after primary infection with a heterologous strain resulted in complete protection, which suggests that primary Zika virus infection elicits protective immunity. Early invasion of Zika virus into the nervous system of healthy animals and the extent and duration of shedding in saliva and semen underscore possible concern for additional neurologic complications and nonarthropod-mediated transmission in humans.

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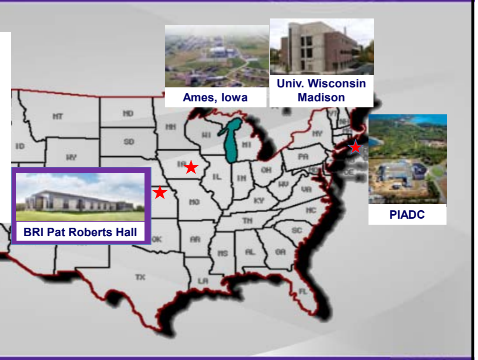
Many of the slides in this presentation were obtained from open source material and PowerPoints from the National Academies website. Slides were from presentations by Albert Ko, Richard Kuhn, Tom Monath, Ron Rosenberg (some original pictures by Ben Beard), and Scott Weaver. Refer to website for original images.

Many journals have provided open access to articles about Zika virus, for example Lancet, and Trans. R.S.T.M.H.

BSL-3Ag Livestock Research Space

- African swine fever
- Akabane
- Cache Valley
- Chikungunya
- Classical swine fever
- HP avian influenza
- Japanese encephalitis
- PRRS
- Rift Valley fever
- Schmallenberg
- Swine influenza
- Yellow fever
- Zika



THANK YOU

BRI Website: http://www.bri.k-state.edu/