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OREGON PUBLIC HEALTH DIVISION • OREGON HEALTH AUTHORITY

A TASTE FOR HUMAN BLOOD: ARBOVIRAL INFECTIONS

Mosquitoes are two-winged, blood-sucking flies of the family *Culicidae*, order *Diptera*. Fortunately for *homo sapiens*, few of the approximately 3,500 mosquito species that (for some reason) exist prefer human to avian, reptilian, amphibian, or other mammalian blood. However, when they do bite humans, they can transmit some nasty microbes.

MOSQUITO BIOLOGY 101

Only the female mosquito bites; she needs the iron and protein of a blood meal to lay her eggs. Her saliva contains anticoagulants that provoke the allergic responses that so plague the camper. She lays her eggs in stagnant water—at the edges of lakes or streams, or in tin cans, beer bottles, barrels, flower vases, tanks, tubs, tires, storm drains, cisterns, cesspools, catch basins or fish ponds.

NATURE'S DRONES

Mosquitoes have a battery of sensors designed to track their prey:

- Chemical sensors. Mosquitoes are attracted by perspiration, body odor, lactic acid and carbon dioxide, which they sense at up to 100 feet away.
- Visual sensors. Mosquitoes are attracted to light and movement; if you are moving and wearing light-colored clothing that contrasts with the background, they can zero in on you.
- Heat sensors. Mosquitoes can easily find anything warm-blooded.

TERRIBLE BEAUTIES

Adult *Aedes* mosquitoes are eerily beautiful: jet black, with white spots on the thorax and white rings on their legs. Yet *Aedes* are among the deadliest creatures on earth. Before a vaccine was developed in the 1930s, *Aedes aegypti* transmitted the yellow fever virus to millions of people. A savage epidemic in 1793 doomed the supremacy of the city of Philadelphia — then the nation's largest as well as the national capital.[1] In 1801, Napoleon sent an army of 25,000 men to put down an insurrection by blacks in Haiti and thence to occupy New Orleans and Louisiana; but after thousands of French succumbed to yellow fever, the black patriots triumphed, and Napoleon decided to sell the entire Louisiana Territory to the United States.[1] During the 1898 Spanish-American War, for every soldier who was killed in combat, yellow fever killed 13.[2]

Whilst Ebola has focused the world's attention on West Africa, Chikungunya virus (CHIKV) infection has ravaged the Americas.[3,4] As of June 5, 10,512 confirmed cases of CHIKV, >350,000 suspect cases and 13 deaths have been reported from across the Americas, excepting Argentina, Chile and Peru. CHIKV infection can lead to debilitating and chronic joint pain.[5]

Humans are the reservoir, and autochthonous CHIKV transmission has been documented during 2014 in Puerto Rico, the U.S. Virgin Islands, and Florida.[6] Key features of arboviruses are shown in the Table (*verso*).

CLINICAL GUIDE TO MOSQUITO-BORNE DISEASES

Chikungunya: Acute onset of high fever, headache, myalgia, rash, arthralgia, arthritis, lymphopenia. Treatment is supportive. Pearl: "Chikungunya" comes from the Kimakonde language, meaning "to become contorted," and describes the stooped appearance of sufferers with joint pain.

Dengue: Causes a severe flu-like illness also known as "break-bone fever." It may be complicated by the potentially lethal dengue hemorrhagic fever, for which there is no specific treatment, but appropriate supportive medical care can be life-saving. Pearl: Dengue is the most common cause of fever among returning travelers.

West Nile: Fever, headache, encephalitis, transverse myelitis, rash. Treatment is supportive. Pearl: Only this disease is indigenous to Oregon; Malheur County's "misfortune" is that two-thirds of our cases occur there.

Yellow Fever: Fever, headache, backache, nausea, vomiting, jaundice, renal failure, hemorrhage. 15% hemorrhagic type; 50% mortality without care. Counsel patients on vaccine as indicated by travel itinerary. Treatment is supportive. Pearl: *Aedes aegypti*, absent from the island of Oahu for more than 63 years, has returned thither.

Zika: Fever, conjunctivitis, transient arthritis or arthralgia, maculopapular rash starting on the face and spreading over the body including the palms and soles, lasts 2–7 days. Treatment is supportive. Pearl: There has been one report of possible spread of the virus through blood transfusion and one report of possible spread through sexual contact.

Malaria: (an arthropod-borne parasite, included for comparison) Flu-like, recurrent fevers, headache, malaise, mylagia, anemia, jaundice, seizures, kidney failure, respiratory distress, coma. Treatment depends on type. Pearl: Coinfection with different species is possible, so consider longer treatment to eradicate liver forms where *P. vivax* and *ovale* exist.

FOR MORE INFORMATION

- Dengue. CDC. *wwwnc.cdc.gov/travel/yellowbook/2014/chapter-3-infectious-diseases-related-to-travel/dengue*. Accessed 9 Jun 2015.
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Table. Common arboviruses and malaria: Comparison by reservoirs, vector, distribution, transmission and incubation.

Virus Species, Genus (Family)	Reservoir	Vectors	Transmission	Incubation	Geographic Notes: World	Geographic Notes: U.S.	Geographic Notes: Oregon
Chikungunya, Alphavirus (*Togaviridae*) First isolated in Tanzania, 1952.	Humans, monkeys, rodents, birds	*Aedes aegypti* & *Ae. albopictus* Distribution: East coast, Southeastern U.S., including Texas	Human-to-vector-to-human (anthroponotic)	3–7 (range: 1–12) days	Countries around the Indian Ocean, (Philippines, Caribbean, Africa, Europe, El Salvador)	Puerto Rico, Florida, Virgin Islands	2014: 7 cases; 5 confirmed, all in travelers to Haiti, Puerto Rico, Caribbean
Dengue Viruses 1, 2, 3, or 4, Flavivirus (*Flaviviridae*) First isolated in Japan, 1943. Most common cause of fever in travelers from the tropics.	Humans	*Aedes aegypti* & *Ae. albopictus* Distribution: East coast, Southeastern U.S., including Texas	Human-to-vector-to-human (anthroponotic); bloodborne transmission possible	4–7 days; biphasic 75% asymptomatic	Caribbean, South America, South & Southeast Asia >100 countries affected; urban areas more at risk	Sporadic outbreaks (Florida, Hawaii, and along Texas-Mexico border)	Since 2004, median 4 cases (range 1–9) per year, all in travelers. Peak in 2010.
West Nile Virus, Flavivirus (*Flaviviridae*). First isolated in Uganda, 1937. Most widely distributed arbovirus in the world.	Birds, especially Corvids American robin is a key amplifier	*Culex* spp. Oregon: *Cx. pipiens, Cx. tarsalis* Southern U.S.: *Cx. quinquefasciatus*	Bird-to-vector-to-bird. Horses & humans are dead-end hosts. Organ transplants, bloodborne, mother-to-child.	2–6 (range: 2–14) days ~80% asymptomatic; ~20% mild symptoms; <1% severe	Africa, Middle East, India, Europe, Asia, Russia, Americas	Enzootic throughout continental U.S.	Since 2004, median 10 human cases (range: 0–73) per year. Peak in 2006. Two-thirds in residents of Malheur County.
Yellow fever virus, Flavivirus (*Flaviviridae*). First isolated in West Africa, 1927.	Human and non-human primates	*Aedes* or *Haemagogus* spp. Mostly *Aedes aegypti,* some *Ae. japonicus.* Distribution: Only *Ae. japonicus* in Oregon,	Human-to-vector-to-human (anthroponotic). Dr. Finlay proposed mosquito as vector in 1881.	3–6 days; biphasic	Sub-Saharan Africa, tropical South America	Historic epidemics in Philadelphia, Charleston, New York, New Orleans. Rare viscerotropic disease after vaccination.*	1 case in 2006 in traveler from Congo and Rwanda
Zika, Flavivirus (*Flaviviridae*) First isolated in Uganda, 1947	Monkeys	*Aedes africanus*, *Ae. luteocephalus*, *Ae. aegypti* Distribution: Only *Ae. aegypti* in U.S.	Humans-to-vector-to-human (anthroponotic); bloodborne transmission possible including mother to child.	3–7 days incubation	Africa, Asia: Outbreak in Yap Islands, 2007; Outbreak in French Polynesia, (New Caledonia) 2014; Mexico, Central America and the Caribbean (2015–2016)	Imported cases only	2014: 3 cases confirmed in travelers to Tahiti, Cook Islands
Malaria (not arboviral, included for comparison): *Plasmodium falciparum, vivax, malariae, ovale, knowlesi* First identified in Algeria, 1880	Human and non-human primates	*Anopheles* spp. Potential vectors Oregon: *An. freeborni* Southern U.S.: *An. pseudopunctipennis* Eastern U.S.: *An. quadrimaculatus*	Human-to-vector-to-human (anthroponotic); bloodborne transmission, mother-to-child, organ transplant, "airport" malaria	Usually >14 days since last exposure, but can be 7 days–several months	Africa, Central & South America, Caribbean, South Asia, Southeast Asia, Middle East, Eastern Europe, South Pacific, Mexican states (Durango, Chihuahua, rarely Sonora)	Almost all imported; occasional clusters of local acquisition	Since 2004, median 14 cases (range: 4–23) per year, all in travelers. Peak in 2001. 50% *P. falciparum.*

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Mosquito eggs are one of two types: floodwater or permanent water eggs. Floodwater females lay their eggs on a moist substrate rather than on standing water. Their eggs must dry out before becoming viable: the next rain, flood or high tide triggers their hatching.

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