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Mosquitoes

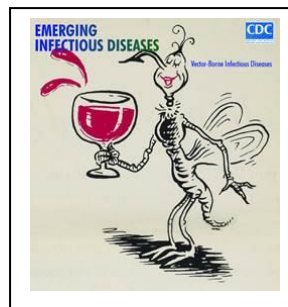
When thinking of animals dangerous to humans, images may range from other humans, crocodiles and dogs to snakes and spiders. But the deadliest animal is the mosquito. Through its bite a mosquito, specifically a female mosquito, can transmit diseases that are responsible for hundreds of thousands of human deaths a year.

Mosquito-borne Infections

Disease transmission from mosquitoes was first proposed in 1881 when Dr. Carlos Finlay theorized a connection between yellow fever and mosquitoes, demonstrated 20 years later by Major Walter Reed. The highest mosquito-related disease burden is in tropical and semitropical climates. Some affected regions may not have rapid access to diagnostic testing. As a result, global case counts and associated deaths are often estimated, with wide ranges.

The most significant diseases mosquitoes carry are malaria, dengue, and yellow fever. Humans are the main reservoir for these diseases, with some disease spillover from other primates in addition to a sylvatic cycle for yellow fever. Each disease may be associated with one or more mosquito species. The most commonly involved mosquito genera, which have various environmental requirements, are *Aedes* (mainly *Ae. aegypti* and *Ae. albopictus*), *Anopheles*, *Culiseta*, and *Culex*.

Malaria is caused by *Plasmodium*, protozoan parasites carried by *Anopheles* mosquitoes. Severe cases can result in seizures, shock, and coma. Age under 5 years or being pregnant carries the highest risk for complications. The disease was epidemic in ancient Egypt, Asia, Greece, and Rome, with Roman troops carrying the infection into Europe with subsequent introduction into the Americas. In North America, malaria spread from the rural South through river watersheds into the Midwest and Plains areas. During the 20th century malaria caused an estimated 150 million to 300 million deaths worldwide, with over 200 million cases and over 600,000 deaths a year. Almost half the global population is living in areas where there is a risk for acquiring malaria.



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Dengue is a flavivirus with four serotypes and is carried mainly by *Aedes aegypti*. Initial infections may be mild but a subsequent infection with a different serotype can result in a severe case with hemorrhage and organ failure. Globally there are over 100,000 dengue cases annually and it is one of the few mosquito-borne infections that has been steadily increasing. Recently there have been locally acquired US cases in Texas, Florida, and Hawaii.

Yellow fever is a flavivirus carried by *Aedes* species and other mosquitoes. Severe cases can develop jaundice, hemorrhage, and shock. Worldwide over 200,000 cases and 30,000 deaths occur a year. In 1648, the Yucatan Peninsula had the first documented North American outbreak. By 1800 large outbreaks were occurring in colonial cities, such as New York, Boston, and Philadelphia. The last major US outbreak was in 1905 in New Orleans.

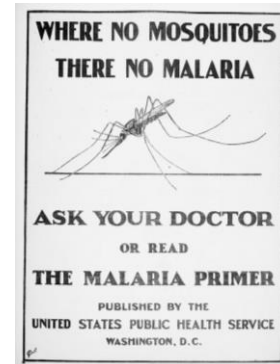
West Nile virus, a flavivirus mainly transmitted by *Culex* species, is the most common mosquito-borne arboviral agent reported in this country. Most infections are mild or cause no symptoms of disease. However, there are low numbers of severe cases, such as encephalitis. A number of other rare mosquito-borne agents occurring within the United States can cause encephalitis.

Mosquito Control

Attempts at mosquito control started historically due to the nuisance factor. Swamps and ditches were drained, but other control measures depended on a better understanding of the mosquito species and populations, the agents, and human cases. Additional actions were then taken such as removing breeding sites (planters, ditches, privies, old mines) and treating standing water in ponds or ditches with chemicals like kerosene, Paris Green, or oil.

The development of chemical adulticides including DDT expanded control activities. Rates fell from over 300 per 100,000 to about a tenth of that level. In 1946 the Communicable Disease Center, now the Centers for Disease Control and Prevention, was founded in Atlanta with a goal of eradicating malaria in the country. Removal of mosquito breeding sites, DDT application in residences of urban areas, and aerial insecticide spraying in affected premises reduced transmission. By 1951 the disease was considered eliminated in the country. Currently the United States has only cases of introduced malaria due to international travel, numbering about 2,000 cases a year, with rare exceptions such as “airport” exposures from a stowaway mosquito and a small outbreak in Florida during 2003.

As with older methods, any mosquito control measure must be sustained. Monitoring mosquito populations and human cases are necessary to direct interventions. It is important to remove breeding sites, which vary by species, but may include planters, tires, ditches, and irrigation systems. Ovicides (for eggs) are used in specialized traps, particularly for container breeding mosquitoes like *Ae. aegypti*, while larvicides may be applied to water collections in storm drains, rain barrels, and pool covers. Adulticides for mature mosquitoes can be incorporated into bed nets or applied as sprays from a backpack, truck or airplane. While resistance to chemical pesticides does occur, proper application and use of integrated pest management (IPM) methods by trained professionals reduce the likelihood of resistance in target mosquito populations from occurring. Individuals can apply repellents, use screened windows and doors, and empty containers of water.



In addition to existing methods there are even newer mosquito control measures being introduced. Mass release of genetically-modified male mosquitoes that produce daughters with impaired fertility or of sterile male mosquitoes can reduce the vector populations. Releasing mosquitoes carrying the bacteria *Wolbachia* spreads the infection through the wild mosquito population. The bacteria compete with some viruses, reducing the mosquito's ability to carry dengue, Zika, chikungunya and yellow fever. Other states allow release of predators of mosquito larvae, such as *Gambusia* mosquitofish or copepods, into ponds or abandoned swimming pools.

Climate Change

Climate change may result in conditions favoring the spread of mosquito-borne conditions. Higher temperatures and milder winters can increase mosquito geographic range, speed of development, and adult overwintering survival. Precipitation changes are also important. Episodic droughts may result in people storing water in containers and unintentionally increasing mosquito breeding sites. Pooled water after hurricanes and floods can temporarily increase opportunities for mosquitoes to breed, a problem that can be compounded by exposure to mosquitoes due to damaged or lost housing. Neglected backyard swimming pools can also serve as important breeding sites. Inadequate housing for climate refugees, such as tents, can increase their risk of exposure.

Climate change could result in mosquito-borne conditions being introduced into the United States or to new parts of the country, and if competent vectors occur in Washington those conditions could spread to this state. Some mosquito-borne infections elsewhere in country have potential vectors in Washington, and new mosquito species could establish as local climate changes.

It will be important to maintain surveillance for existing and unusual mosquito-borne conditions in humans and to maintain mosquito trapping and testing to determine species distribution and disease risk. The Washington State Department of Health partners with local health jurisdictions and mosquito control districts to collect, speciate, and test mosquitoes in the state for West Nile virus. Arboviral diseases are currently notifiable conditions in Washington. Healthcare providers should also report other rare diseases of public health significance. The Washington State Department of Health can assist with definitive testing when a healthcare provider has a suspected case of an unusual mosquito-borne infections.

Resources

Washington State Department of Health

Mosquitoes: <https://doh.wa.gov/community-and-environment/pests/mosquitoes>

Mosquito Control Districts in Washington State: <https://mrsc.org/Home/Explore-Topics/Governance/Forms-of-Government-and-Organization/Special-Purpose-Districts-in-Washington/Mosquito-Control-Districts.aspx#list>

Centers for Disease Control and Prevention

Climate and vector-borne disease:
<https://www.cdc.gov/climateandhealth/effects/vectors.htm>

Climate effects in the Northwest:
<https://www.cdc.gov/climateandhealth/effects/northwest.htm>

Florida malaria outbreak: <https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5319a2.htm>