

Human Malaria ¹

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Malaria in humans is a disease transmitted by mosquitoes in the genus *Anopheles* and caused by any one of four species of microscopic protozoan parasites in the genus *Plasmodium* (*P. vivax*, *P. falciparum*, *P. malariae* and *P. ovale*) distributed throughout the world. Malaria was one of the major endemic diseases in the United States for more than four centuries (Russell, 1968). As recently as 1935, malaria caused 4,000 deaths every year in the United States. However, by the 1940s, the annual death toll had been reduced to 400, and by 1952 it was down to 25 with little or no local transmission. In the United States and elsewhere, malaria was eradicated by draining larval habitats, treating patients with antimalarial drugs, applying mosquito larvicides and adulticides, and screening doors and windows.

Symptoms of Malaria

Symptoms of malaria vary depending on the *Plasmodium* species, but the initial attack may start with exhaustion, headache, anorexia, and occasional nausea and vomiting. The fever comprises a cold stage (shivering and a feeling of intense cold), a hot stage (distressing heat, dryness, burning, intense headache, nausea and vomiting), and finally a profuse sweating stage. The typical attack often begins in the

early afternoon and lasts from eight to twelve hours.

Persons experiencing these symptoms and having been in an area with malaria should see a doctor immediately.

Clinically, malaria infections vary from moderately severe to fatal illness, depending on the species of parasite, the individuals' health condition, and how soon the patient receives treatment. Malaria caused by *P. falciparum* is particularly severe and often fatal in infants and young children; *P. vivax* generally is less severe and has a lower mortality rate. Persons may be infected over and over again, usually developing a tolerance for the parasite which prevents severe illness from reoccurring.

If insufficiently treated, a malaria infection may persist in a person for many months or years and have a continuing or periodically renewed ability to infect mosquitoes, often in the absence of symptoms or with a less severe illness. *Plasmodium vivax* and *P. ovale* parasites may persist in the liver cells for years and give rise to relapses of the disease by reinvading the red blood cells during times of stress.

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How Malaria is Transmitted by Mosquitoes

The malaria parasite is transmitted from person to person by the bite of *Anopheles* mosquitoes, and ONLY *Anopheles* mosquitoes (Figure 1). The malaria parasite inhabits the human red blood cells, where it multiplies asexually. After reaching maturity in 48-72 hours, the red blood cells burst and release large numbers of new parasites, most of which enter new red blood cells, thus, reinitiating the cycle. Others enter liver cells. Before the asexual cycle in red cells is established, the parasite must complete a 5-10 day period of multiplication in liver cells. The typical malaria symptoms, chills and fever, are associated with this rupturing of infected red blood cells.

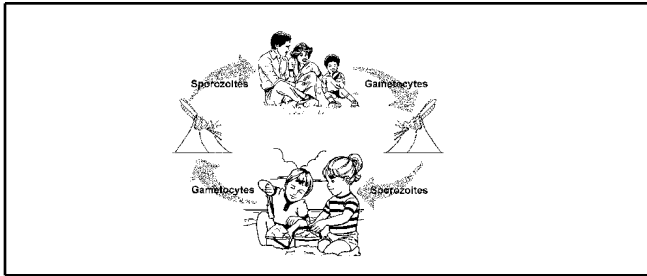


Figure 1. Malaria cycles from infected *Anopheles* mosquitoes to humans. Uninfected mosquitoes can then pick up the parasite during blood feeding on infected humans.

Some of the malaria parasites develop into sexual forms: the male and female gametocytes. Infection of the mosquito takes place when an *Anopheles* female feeds on an infected person who is carrying gametocytes. The parasite then undergoes a sexual cycle in the mosquito for the next 7-20 days. Numerous microscopic, spindle-shaped forms, known as sporozoites, then invade the mosquito salivary glands. The human infection is initiated when sporozoites are released during the bite of the infected mosquito.

Florida's *Anopheles* Mosquitoes

Worldwide, there are approximately 400 described species of *Anopheles*, but only 30 of them are of major importance in malaria transmission. Of the 75 plus species of mosquitoes occurring in Florida, 14 are in the genus *Anopheles*. It is easy to recognize adult *Anopheles* by the way they rest on a

flat surface, like the skin. Unlike mosquitoes of other genera, *Anopheles* rest with their heads pointed downward and their bodies slanted at a steep angle upward (Figure 2). Other mosquitoes hold their bodies parallel to the resting surface. *Anopheles* adults also have three long mouth parts protruding from the head; other mosquitoes have one long and two short mouth parts. The immature stages of *Anopheles* are not easily recognized in the water as the larvae lie near the surface and are easily confused with floating debris.

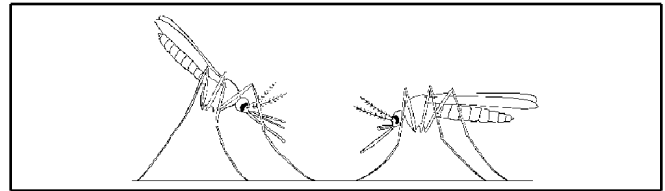


Figure 2. *Anopheles* (left) and non-anopheline (right) resting posture.

Anopheles quadrimaculatus is considered to be the most important malaria vector in Florida. *Anopheles quadrimaculatus* is a species complex consisting of 5 morphologically similar species (Reinert et al., 1997). The adults are dark with four spots on each wing. They typically breed in permanent bodies of fresh water containing emergent or floating vegetation. The eggs are laid singly on the surface and breeding is continuous if temperatures permit. During cold periods, adult females hibernate in protected sites. They feed primarily on large mammals, including humans, mostly at dusk and during the night.

Malaria in Florida in the 21st Century?

A few years ago, one may have expected that malaria would never be a problem again in the United States. However, there are and will continue to be, occasional small outbreaks within the U. S., including Florida. Each year over seven million U.S. business persons and tourists are traveling to areas where malaria is present; also on the rise in the number of visitors to the U.S. from malarious areas.

In 1990, the first Florida case of human malaria (*P. vivax*) in 42 years was acquired presumably through the bite of a mosquito in Gulf County. The woman who came down with malaria had no history

of foreign travel, blood transfusion, or IV use. She had spent the nights of May 19 and 27, 1990, sleeping outdoors at a fish camp at Willis Landing, Gulf County. The mosquito biting activity at night was reportedly intense. No secondary cases were reported. In 1996, two residents of Palm Beach County contracted malaria, and in the same county in 2003, there were 8 reported cases of locally acquired malaria. These patients had never lived in or visited a malarious area.

Economic downturns increase poverty, resulting in more people sleeping in temporary, makeshift shelters, abandoned buildings, outdoors under bridges and overpasses, or in large culverts. These same sites, while providing some protection to the homeless, are also excellent resting sites for adult *Anopheles* mosquitoes. Thus, now and probably for the first time since the depression years of the thirties, a larger segment of our population, including legal and illegal visitors with imported malaria, have an opportunity for increased contact with Anopheline mosquitoes which prefer to blood-feed during sunset and evening hours.

Prevention of Malaria Outbreaks in Florida

Florida's state health and related agencies should:

- Remind physicians and public health workers annually about the importation of malaria among travelers and visitors and the danger of not clinically distinguishing malaria from the more common febrile illnesses
- Inform county health officers and mosquito control directors of imported malaria cases

Mosquito control agencies should:

- Identify the locations of all actual and potential Anopheline breeding sites
- Survey all larval habitats annually during the *Anopheles* breeding season (June - early September)
- Identify and record the seasonal abundance of *Anopheles* in the county using landing rate and trap collections

- Be informed of all imported and introduced malaria cases in the county and Florida

Any malaria case that is not readily explained by foreign travel, visitors, or induced artificially, is strongly suggestive of possible local transmission. When one case of malaria has been verified, the local public should be warned to report immediately any fever to their physician or county public health unit.

In the unlikely event of a major outbreak of malaria, the application of appropriate larvicides at known *Anopheles* breeding sites and adulticides at resting sites is warranted to reduce the human-*Anopheles* contact. In addition, primary efforts should continually be made to reduce the opportunity for *Anopheles* to take a human blood meal by educating the public on the use of protective clothing, screens on windows and doors, repellents, and fans to keep mosquitoes away.

To avoid the risk of malaria, it is critical to avoid mosquito bites. Humans can not get malaria from wild animals, domestic animals or pets. Transmission of malaria from human to human is accomplished by *Anopheles* mosquitoes or by reuse of needles contaminated with the blood of an infected person.

Avoid mosquito bites by staying out of mosquito infested areas, securing window screens and by applying a repellent that has been proven to be effective. Repellents containing DEET (N,N-diethyl-3-methylbenzamide) are effective and should be used only according to the label directions.

References

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