

## Winning the Evolutionary Arms Race: Mosquito Reproductive Strategies

Most ecologists agree that the value of an individual in a population lies at least partially in the number of offspring it can produce. Since predation (being eaten) limits the number of progeny an organism can produce, most plants and animals have evolved strategies to avoid becoming a meal. Mechanisms such as protective coloration (green frogs on green leaves), armor (turtles, crabs), thorns (roses) and speed (gazelles running from lions) are some common examples of these defenses. Other species have developed more complex ways of avoiding predators. For example, some cicadas have evolved 7, 13 and 17 year life cycles. These are not only very long lives for insects, but the life span (in years) is also a prime number, thus making it difficult for any would-be predator species to synchronize its life cycle to that of the cicada.

Mosquitoes have also developed diverse approaches to avoid predation. Many species breed in areas where predators are rare or absent. Floodwater species (mosquitoes that breed in salt marshes, groves and pastures) lay their eggs on dry or moist substrate that is subject to flooding with rains or tides. Since most predators (fish and other insect larvae) do not live in ephemeral water, mosquito larvae can develop relatively unmolested. This strategy does have a negative side for the mosquito because the larvae must be able to develop quickly before the water dries. Other species of mosquitoes have taken different routes to avoid being eaten. One genus (*Deinocerites*) only breeds in crab holes and the genus *Wyomia* restricts its egg deposition to the leaf axils of bromeliads. Since the water in such habitats tends to be more permanent, these species tend to have longer larval stages (several weeks), which offer an evolutionary advantage. Container breeding mosquitoes (domestic mosquitoes such as yellow fever mosquitoes and tiger mosquitoes) and tree hole mosquitoes are attracted to water filled vessels such as tires, bird baths, and rain gutters. These habitats are largely devoid of predators, thus offering a relatively secure refuge for larval development. Roadside ditches, sewer plants, wastewater lagoons and other areas of poor water quality present an excellent breeding sites for *Culex* mosquitoes and their kin. The low water quality makes it difficult for most predators to survive and at the same time can provide an excellent food supply for the larvae to develop. Other groups of mosquitoes develop in water where predators are present. Mosquitoes reproducing in these environments have had to evolve other approaches to avoid being eaten. Larvae of the genus *Anopheles* tend to look more like a floating twig than that of a typical mosquito. This strategy apparently fools enough predators that a large number of larvae are able to survive. Other genera (*Mansonia* and *Coquillettidia*) associate with floating aquatic vegetation such as water lettuce. Their larvae actually attach themselves to the roots of these plants and probably obtain their oxygen from the tissue of the plants. Because their color and shape are similar to the plant root structures, they tend to be unnoticed by predators.

When mosquitoes emerge as adults, they have an entirely different set of problems to overcome. Two major challenges are desiccation (drying out) and predation. Like all insects, mosquitoes have a tracheal system (small air tubes going directly to body cells) for respiration. Tracheal systems offer a strong advantage for active flying because oxygen is delivered directly to the cells rather than going through an intermediate step of respiratory pigments such as hemoglobin (in mammals and other groups) or hemocyanin

(crustaceans). Unfortunately (for insects), the tracheal system is also very efficient at removing moisture from the body. Because of this, many insects, including mosquitoes tend to more active in the nighttime and seek shelter in shady areas or under leaf litter during the heat of the day to avoid dehydration. Day-active mosquitoes tend to rest in moist areas and only emerge into the light when the prospect of a blood meal is nearby. This behavior is not only advantageous for preserving moisture but also is helpful in avoiding predators since many mosquitoes are taken when they are actively flying while seeking a meal or a mate. Predators of adult mosquitoes are other insects, spiders, and small reptiles such lizards and small snakes. Mosquitoes have also been collected from stomach contents of some insectivorous birds and bats but most studies suggest that mosquitoes make up only a small fraction of these organisms diets. Because of the transient nature of mosquito populations, few organisms (except for a few specialized parasitic species) have developed a dependence on mosquitoes as a sole food source. Rather, mosquitoes serve as a minor food source for opportunistic predators during periods of high mosquito populations.