Anopheles quadrimaculatus 简体中文 正體中文

System: Terrestrial

Kingdom	Phylum	Class	Order	Family
Animalia	Arthropoda	Insecta	Diptera	Culicidae

Common name common malaria mosquito (English), Gabelmüche (German)

Synonym *Anopheles annulimanus* , Wulp, 1867

Similar species *Anopheles diluvialis, Anopheles inundatus, Anopheles maverlius, Anopheles smaragdinus*

Summary *Anopheles quadrimaculatus* a mosquito is the chief vector of malaria in North America. This species prefers habitats with well-developed beds of submergent, floating leaf or emergent aquatic vegetation. Larvae are typically found in sites with abundant rooted aquatic vegetation, such as rice fields and adjacent irrigation ditches, freshwater marshes and the vegetated margins of lakes, ponds and reservoirs.

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Species Description
Anopheles quadrimaculatus is described as a large, dark brown mosquito. The tarsus is entirely dark (The Ohio State University Mosquito Pest Management Bulletin,1998). O'Malley (1992) reports that, \"All Anopheles adults are characterized by an evenly rounded scutellum and palpi about as long as the proboscis. *A. quadrimaculatus* is a medium-sized species. Wings are entirely dark scaled and 4 mm or more in length. Scutal bristles are short and wings are spotted with patches of dark scales. The tip of the wing is dark without copper-colored fringe scales. The palpi have dark scales and are unbanded, and the wing has 4 distinct dark-scaled spots ..\" Rafferty et al. (2002) found, \"A simple method for rapid identification of large numbers of Anopheles mosquitoes based on polymerase chain reaction (PCR) amplification of rDNA.\" The authors state that, \"This method allows rapid analysis of large numbers of mosquitoes without robotic equipment and should enable rapid and extensive PCR analysis of field-collected samples and laboratory specimens.\"

Notes
Levine *et al.* (2004) report that, \"*A. quadrimaculatus* was considered to be a single species until biological evidence necessitated subdividsion into a species complex in the late 1900s. A combination of genetic crossing, isozyme, and ctytological information convincingly showed that there are at least five species in the group and they include: *A. quadrimaculatus*, *A. smaragdinus*, *A. diluvialis*, *A. inundatus*, and *A. maverlius*.\" The *A. quadrimaculatus* complex as a whole is often referred to as *A. quadrimaculatus* (sensu lato), whereas *A. quadrimaculatus* (sensu stricto) refers to the individual species (Rios and Connelly, 2008). The authors state that *A. quadrimaculatus* is the most widely distributed of the species complex in the eastern United States and southeastern Canada (Seawright *et al.* 1991).\"
In the United States, O'Malley (1992) states that, \"*A. quadrimaculatus* is a clean water-loving mosquito. The current wetlands regulations could be seen as actually impeding our efforts to control this mosquito. By improving water quality within water management project sites per the regulations, we are actually increasing the number of habitats available.\"

Lifecycle Stages
Floore (2004) states that, \"The mosquito goes through four separate and distinct stages of its life cycle: egg, larva, pupa, and adult. Each of these stages can be easily recognized by its special appearance.\" Egg stage: Eggs are laid one at a time or attached together to form \"rafts.\" They float on the surface of the water. In the case of *Culex* and *Culiseta* species, the eggs are stuck together in rafts of up to 200. *Anopheles*, *Ochlerotatus* and *Aedes* , as well as many other genera, do not make egg rafts, but lay their eggs singly. *Culex*, *Culiseta*, and *Anopheles* lay their eggs on the water surface while many *Aedes* and *Ochlerotatus* lay their eggs on damp soil that will be flooded by water. Most eggs hatch into larvae within 48 hours; others might withstand subzero winters before hatching. Water is a necessary part of their habitat.
Larval stage: The larva (plural - larvae) lives in the water and comes to the surface to breathe. Larvae shed (molt) their skins four times, growing larger after each molt. Most larvae have siphon tubes for breathing and hang upside down from the water surface. *Anopheles* larvae do not have a siphon and lie parallel to the water surface to get a supply of oxygen through a breathing opening. *Coquillettidia* and *Mansonia* larvae attach to plants to obtain their air supply. The larvae feed on microorganisms and organic matter in the water. During the fourth molt the larva changes into a pupa (Floore, 2004).
Pupal stage: The pupal stage is a resting, non-feeding stage of development, but pupae are mobile, responding to light changes and moving (tumble) with a flip of their tails towards the bottom or protective areas. This is the time the mosquito changes into an adult. This process is similar to the metamorphosis seen in butterflies when the butterfly develops - while in the cocoon stage - from a caterpillar into an adult butterfly. In *Culex* species in the southern United States this takes about two days in the summer. When development is complete, the pupal skin splits and the adult mosquito (imago) emerges (Floore, 2004).
Adult:: The newly emerged adult rests on the surface of the water for a short time to allow itself to dry and all its body parts to harden. The wings have to spread out and dry properly before it can fly. Blood feeding and mating does not occur for a couple of days after the adults emerge (Floore, 2004).

Habitat Description
Chase and Knight (2003) state that, \"Many species of mosquitoes are habitat generalists which breed, grow as larvae and emerge from a wide variety of aquatic habitats ..\" O'Malley (1992) reports that, \"In North America, most anophelines prefer habitats with well-developed beds of submergent, floating leaf or emergent aquatic vegetation. Larvae are typically found in sites with abundant rooted aquatic vegetation, such as rice fields and adjacent irrigation ditches, freshwater marshes and the vegetated margins of lakes, ponds and reservoirs. Investigators have suggested that aquatic vegetation promotes anopheline production because it provides a refuge for larvae from predators, such as *Gambusia affinis*. Additional hypotheses for the beneficial effects of aquatic vegetation include: enhanced food resources in vegetated regions, shelter from physical disturbance and favorable conditions for oviposition (Orr and Resh 1989).\"
Comparing and contrasting different mosquito species, Chase and Knight (2003) state that, \"Although these species have somewhat distinct habitat preferences, they readily lay eggs in, and emerge from wetlands of all types (Carpenter & LaCasse 1955). Although *A. quadrimaculatus* will also breed in smaller water-filled habitats (e.g. containers, ditches), which are often associated with humans, wetlands provide a much greater area for potential larval habitats, and often produce many more adult mosquitoes, than the smaller habitats traditionally associated with mosquito control.\" The Ohio State University Mosquito Pest Management Bulletin (1998) reports that, \"These mosquitoes breed chiefly in permanent freshwater pools, ponds and swamps that contain aquatic vegetation or floating debris. Common habitats include borrow pits, sloughs, city park ponds, sluggish streams and shallow margins of reservoirs and lakes. During the daytime, adults remain inactive, resting in cool, damp, dark shelters such as buildings, and caves.\"

Reproduction

The Ohio State University Mosquito Pest Management Bulletin (1998) reports that, \"*Anopheles quadrimaculatus* eggs are laid singly on the water surface with lateral floats to keep them at the surface. One hundred or more eggs are laid at a time. A single female may lay as many as 12 batches of eggs and a total of more than 3,000 eggs.\" O'Malley (1992) reports that, \"Mating occurs as soon as the females emerge. Males wait in nearby vegetation and seek females as they begin to fly. Copulation is completed in flight and takes 10-15 seconds. One insemination is usually sufficient for the fertilization of all eggs.\"

Nutrition

O'Malley (1992) reports that, \"*A. quadrimaculatus* larvae are indiscriminate feeders whose natural food includes a wide range of aquatic organisms, both plant and animal, as well as detritus. This food may be living or dead at the time of ingestion. The main criterion in selecting food seems to be whether the suspended material is small enough to eat. When feeding, *A. quadrimaculatus* larvae lie horizontally, with the dorsal side just under the surface film. The head rotates 180 degrees horizontally so that it is actually upside down and the venter of the head is dorsal. Feeding is either \"eddy feeding\" or \"interfacial feeding\". Eddy feeding is employed for infusions when the surface contains islets of floating oil materials. Two eddies with converging streams unite in front of the larva to form a current toward the mouth from a distance of about half the length of the larva. Efferent currents flow outward at right angles to the body from the antenna. Particles too large to eat are held by the maxillae, drawn below the surface and discarded as the head is rotated to the normal position. Interfacial feeding on the membranes of algae, bacteria, debris and fungi is common in nature. Feeding in this manner is accomplished by setting up currents which draw particles to the mouth from all directions in a straight line and at nearly equal velocities. Surface tension of the larval habitat determines the type of feeding. Eddy feeding occurs at a surface tension of less than 60 dynes per square cm; interfacial feeding is practiced in habitats with a surface tension above 62 dynes per square cm.\" O'Malley (1992) reports that, \"Mosquito feeding patterns are largely regulated by host availability and preference (Apperson and Lanzaro 1991). Female *A. quadrimaculatus* are primarily mammalian feeders and actively feed on man and on wild and domesticated animals. As noted previously, this is a significant pest species. Females repeatedly seek their hosts, often visiting the same feeding site several times during the course of a bloodmeal.\"
Chase and Knight (2003) state that, \"Larvae of the two most common mosquito species encountered in the natural and artificial wetlands, *A. quadrimaculatus* and *C. pipiens*, and other types of mosquito larvae, utilize different feeding behaviours and have slightly different diets (e.g. Merritt *et al.* 1992). They are both generalists, however, and readily consume detritus, microbes and algae, both from the benthos and the water column. As such, they are likely to compete for resources with several other co-occurring species.\"

General Impacts

Anopheles quadrimaculatus Say is historically the most important vector of malaria in the United States. Malaria was a serious plague in the United States until its eradication in the 1950s (Rutledge *et al*. 2005). However there are still occasional cases of local transmission of malaria in the United States vectored by *A. quadrimaculatus* in the east and *Anopheles freeborni* in the west (CDC 2005 in Rios and Connelly, 2008).
This mosquito is susceptible to infection with malaria causing *Plasmodium falciparum*, *Plasmodium vivax* and *Plasmodium malariae*(Carpenter and LaCasse 1955). The Ohio State University Mosquito Pest Management Bulletin (1998) reports that, *A. quadrimaculatus* is the most important vector of malaria attacking humans in the eastern United States and can be found frequently in houses and other shelters. Their bites are less painful than many other mosquitoes and often go unnoticed.
A. quadrimaculatus can also transmit Cache Valley virus (CV) (Blackmore *et al*), West Nile Virus (CDC, 2007) and transmission of St. Louis encephalitis has been obtained with this species in laboratory experiment (Horsfall 1972 in O'Malley, 1992).
A. quadrimaculatus has been found to be an excellent host for dog heartworm (*Dirofilaria immitis*). According to Lewandowski *et al*. (1980), this is probably one of the most important species involved in the natural transmission of dog heartworm in Michigan. In central New York, this species was also the most efficient host of dog heartworm out of several species tested, both in the laboratory and the wild (Todaro and Morris 1975).
A. quadrimaculatus can be a vector for the myositic parasite *Trachipleistophora hominis*. Weidner *et al.* (1999) found that, Microsporidian spores of *T. hominis* Hollister, isolated from a human, readily infected larval stages of both *A. quadrimaculatus*. The authors state that, \"Nearly 50% of the infected mosquito larvae survived to the adult stage. Spores recovered from adult mosquitoes were inoculated into mice and resulted in significant muscle infection at the site of injection\".

Management Info

Please read Management Information for *Anopheles quadrimaculatus* for a information on the management strategies used to control the species.

Principal source: Shiff, 2002 Integrated Approach to Malaria Control
Levine *et al.* 2003. Distribution of Members of *Anopheles quadrimaculatus* Say s.l. (Diptera: Culicidae) and Implications for Their Roles in Malaria Transmission in the United States.

Compiler: National Biological Information Infrastructure (NBII) and Invasive Species Specialist Group (ISSG)

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