MOSQUITO VECTORS OF INFECTIOUS DISEASES: ARE THEY NEGLECTED HEALTH DISASTER IN EGYPT?

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Abstract

In spite of the great technological progress achieved worldwide, still arthropod
borne infectious diseases is a puzzle disturbing the health authorities. Among these
arthropods, mosquitoes from medical, veterinary and economic point of view top
all groups. They are estimated to transmit disease to more than 700 million people
annually worldwide mainly in Africa, South America, Central America, Mexico
and much of Asia with millions of deaths. In Europe, Russia, Greenland, Canada,
the United States, Australia, New Zealand, Japan and other temperate and deve-
loped countries, mosquito bites are now mostly an irritating nuisance; but still cause
some deaths each year. Mosquito-borne diseases include Malaria, West Nile Virus,
Elephantiasis, Rift Valley Fever, Dengue Fever, Yellow Fever and Dog Heart-
worm….etc. Apart from diseases transmission, mosquitoes can make human life
miserable.

The successful long term mosquito control requires the ecological and biological
knowledge of where and how they develop. The importance of mosquitoes is given
herein to clarify the problem and to think together what one must do?

Keywords: Egypt, Mosquito-borne diseases, Health disaster.

Introduction

The mosquitoes are insect vectors responsible for the transmission of para-
sitic and viral infections to millions of people worldwide, with substantial
morbidity and mortality. An understanding of the mosquito classification,
distinguishing features, and the insect life cycle is important for disease sur-
veillance for designing and implementing effective feasible measures for the
disease control and prevention (White, 2002).

Classification

Mosquitoes belong to the Class In-
secta (= Hexapoda), Order Diptera and
family Culicidae. Two important sub-
families are Anophelinae (which in-
cludes the genus Anopheles, the mos-
quito vector for malaria) and Culicinae
(includes the genera Aedes, Culex,
Mansonina and Haemagogus, the mos-
quito vectors for arboviruses). Each
subfamily has hundreds of species within it, although only a few dozen bite humans and therefore are capable of serving as disease vectors.

Anopheline mosquitoes are oriented with head, thorax and abdomen in a straight line at an acute angle to the surface. Culicine mosquitoes rest with the head and body angled, with the abdomen directed back to the surface.

Planning disease surveillance and control measures requires identification of the mosquito genus or genera in a particular geographic region based upon the distinguishing features of each life cycle stage. The following discussion highlights the characteristic features of the mosquito subfamilies Anophelinae and Culicinae, to facilitate identification of Anopheline malaria vectors from other mosquitoes. Techniques for distinguishing among the Culicinae genera are beyond the scope of this discussion and require more detailed entomologic expertise.

### Important mosquito vector species in malaria’s areas

<table>
<thead>
<tr>
<th>Region</th>
<th>Anopheles species</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>Tropics (sub-genera Cellia and Nyssorhynchus)</td>
<td></td>
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<tr>
<td>Tropical Africa</td>
<td>An. gambiae complex</td>
<td>Highly anthropophilic &amp; abundant in villages very efficient vectors.</td>
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<tr>
<td></td>
<td>An. funestus</td>
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<tr>
<td>South East Asia</td>
<td>An. dirus, An. minimus</td>
<td>Anthropophilic but breed in jungle pools &amp; streams</td>
</tr>
<tr>
<td>Indian subcontinent</td>
<td>An. culicifacies, An. stephensi</td>
<td>An. culicifacies rural; An. stephensi mainly urban.</td>
</tr>
<tr>
<td>Brazilian Amazon</td>
<td>An. darlingi</td>
<td>Biting time varies regionally.</td>
</tr>
<tr>
<td>Central America</td>
<td>An. albimanus</td>
<td>Bites in evening. Multiple insecticide resistance.</td>
</tr>
<tr>
<td>New Guinea</td>
<td>An. punctulatus</td>
<td>Transmission in lowlands as intense as in Africa.</td>
</tr>
<tr>
<td>China</td>
<td>An. sinensis group</td>
<td>Breeds in rice fields.</td>
</tr>
<tr>
<td>Turkey &amp; Central Asia</td>
<td>An. maculipennis complex</td>
<td>Vectors of malaria in Europe and still present today</td>
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</table>

Life cycle (Lane and Crosskey, 1993):

The mosquito progresses through four distinct stages: egg, larva, pupa and adult. The full life cycle usually takes about 14 days, but the duration varies with temperature and species. Outside of tropical climates, most mosquito species overwinter as eggs, although some overwinter as larvae or adults.

Female mosquitoes lay up to 200 eggs per reproductive cycle, and with sufficient nutrition can lay eggs as frequently as every three days. The eggs hatch into larvae in about 48 hours.

Mosquito eggs are cigar shaped and about 1 mm long. Anopheine eggs can be distinguished from culicine eggs by the presence of "floats" (little air filled sacs on the side of the egg). *Anopheles* and *Aedes* mosquitoes lay their eggs individually. Female *Culex* mosquitoes lay their eggs in groups ("egg rafts"), which are typically 3 to 4 mm long and 2 to 3 mm wide.

*Anopheles* mosquitoes oviposit (e.g., lay eggs) in clean water (such as rain puddles, water tanks and irrigation ditches). In contrast, Culicine mosquitoes have a broader range of breeding sites than *Anopheles* mosquitoes. *Culex* mosquitoes can tolerate high levels of organic pollution; *Cx. quinquefasciatus* in particular is associated with areas of human habitation and can lay eggs in dirty water (such as pit latrines, cess
pits and blocked drains). The eggs of *Aedes* mosquitoes can withstand desiccation for many months so that breeding sites can remain dormant until there is rainfall or flooding; *Ae. aegypti* in particular species can lay their eggs in domestic water pots, tires, and garbage.

The eggs hatch into larvae that live in the water and come to the surface to breathe. Culicine larvae maintain a position vertical to the water surface and breathe via siphon tubes extending to the water surface; the *Culex* siphon is longer than the *Aedes* siphon. In contrast, Anophelines larvae lie in a horizontal position parallel to the water surface and do not have a siphon. The larvae develop through four stages; also known as instars, which lasts 7 to 10 days (at tropical temperatures) before reaching the pupa stage.

Pupae float on the water surface. In the pupa head and thorax are fused to form a comma-shaped cephalothorax; during the pupa stage there are no distinguishing characteristics between the genera. Pupae breathe, but do not feed, so larvicide cannot be ingested during this stage, although surface oil can induce suffocation. Metamorphosis from pupa into an adult mosquito takes about two days.

The newly emerged adult mosquito must rest briefly on the surface of still water until its parts have dried and hardened before it can fly. Males are able to mate 24 hours after emergence. Females are able to mate immediately; they blood feed at 3 days old and lay eggs about two days after a blood meal. Both the male and female feed on flower nectar for food, but only female mosquitoes bite humans or animals to obtain protein needed for producing eggs. Mosquitoes usually feed in the mornings and evenings, avoiding the heat of the day.

The head appendages of the adult mosquito consist of one proboscis (the elongated feeding apparatus), a pair of antennae, and a pair of maxillary palps; these features require a microscope for visualization (show figure 2). Female mosquitoes use their proboscis to cut through the skin and take blood feeds. Male mosquitoes do not have a proboscis suitable for extracting blood. The antennae of males are bushier than female mosquitoes and are visible with the naked eye. The unique palp characteristics are the most reliable for differentiation between *Anopheles* and *Culex* mosquitoes. Anopheles female palps are about the same length as the proboscis, while *Anopheles* male palps are club-shaped at the ends. *Culex* female palps are shorter than the proboscis, and *Culicine* male palps are long with a tapered point.

Living adult mosquitoes can also be recognized by their stance, without a microscope. *Anopheles* mosquitoes are oriented with head, thorax and abdomen in a straight line at an acute angle to the surface, while *Culicine* mosquitoes rest with the head and body angled and the abdomen directed back to the surface.

**Disease Control:**

The attempts at mosquito control measures have targeted both adult and larval stages of the life cycle. The adult mosquito has been targeted by using
insecticides in the form of indoor insecticide spraying or insecticide treated bed nets. In addition, insect repellant applied directly to exposed skin has been attempted. The larvae may be targeted by applying insecticides to the water, applying a layer of oil or polystyrene beads to breeding site water surfaces to induce suffocation of larvae or pupae, and releasing larvivorous fish and copepods to consume larvae. Genetic control measures to prevent eggs from hatching, larvae from surviving, or adults from transmitting human disease have also been attempted (Pates and Curtis, 2005).

In general, measures to control the adult stage are more effective since breeding sites can be difficult to map. Targeting adult mosquitoes reduces insect longevity and hence disease transmission, while larvae from missed breeding sites mature into adults with normal survival and capacity for disease transmission. In addition, larval control for an entire region is difficult to achieve, since mosquitoes can fly in from uncontrolled breeding sites up to a few kilometers away. However, in regions where gaining access to individual homes is difficult, larval control may be more appropriate.

What about Egypt:


As an example in Sharkia Governorate, larvae were Cx. pipiens (68.77%), Ae. caspius (15.75%), Culiseta sp. (=Theobaldia) and Cx. pusillus. In Greater Cairo, parts of Qalyoubia G., Cx. pipiens was the most dominant and the least was C. perexiguus. In parts of Giza G., Cx. pipiens was the most dominant and least was Cs. longiareolata. In Cairo G., Cx. pipiens was the most dominant and least was Ae. caspius. The overall in Greater Cairo was Cx. pipiens (61.74%), Cs. longiareolata (15.56%), Ae. caspius (15.3%), Cx. pusillus (4.0%) and Cx. perexiguus (3.16%).


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Mostafa et al. (2002) studied the abundance and distribution of mosquito species monitored by three phases. The first was in 1999 in five governorates, Qalyobia, Menoufia, Behaira, Al Fayium and Assuit. The second was in 2000 in Kafr El Sheikh, Giza, Sharkia, Menia and Aswan. The third was in 2001 in Kena, El Wady El Gadeed, Dakahlia and South Sinai. Culex species were the commonest mainly Cx. pipiens, Cx. antennatus and Cx. univittatus. Cx. thelerei was found only in El Kharga Oasis. Culiseta sp. was found in Qalyoubia, Menoufia, Behaira, El Fayium, El Wady El Gadeed, Dakahlia and South Sinai and as larvae in Kafr El Sheikh, Giza, and El Menia. Aedes detritus was found in Assiut, Al Fayium, Giza, Aswan, El Wady El Gadeed and South Sinai. Ae. caspius was found in Assiut and Aswan and as larvae in Kena and El Wady El Gadeed. An. pharoensis was found in Behaira and El Fayium, while An. algeriensis in Aswan. An. multicolor and An. серенти were found in El Fayium, Aswan and El Wady El Gadeed; but in Kena An. серенти was found as larvae and A. multicolor as adults.

Morsy et al. (2003, 2004) in Qalyouibia Governorate (G.) reported four mosquito larvae in a fixed site during August 2002. These were Cx. pipiens (52.08%), Cs. longiareolata (27.08%), Cx. perexiguus (12.5%) and Ae. caspius (8.33%). In December 2002, the collected larvae from same site were only two species; C. pipiens (64.7%) and Ae. caspius (35.29%). This indicated that Cx. pipiens was the most

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<tr>
<th>Genus</th>
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<td>detali</td>
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<td>gambiae (formerly)</td>
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<td>Hispoinosal</td>
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<td>tarkhadi</td>
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<td>tenebrosus (=antennatus costani)</td>
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<td>quinquefasciatus</td>
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<td>thelerei</td>
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<td>univittatus</td>
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<td>caspius</td>
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<td>detritus</td>
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<tr>
<td>Culiseta (=Theobaldia)</td>
<td>longiareolata</td>
<td>Mostafa et al, 2002, Morsy et al, 2003, 2004</td>
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</table>
common and most predominant species followed by *Ae. caspius*. Besides, *Cx. perexiguus* and *Cs. longiareolata* were found only in August. *Cx. pipiens* and *Ae. caspius* have a bimodal life cycle, while *Cx. perexiguus* and *Cs. longiareolata* have a unimodal life cycle. In Giza G. four species of mosquito larvae were encountered during August 2002. In a descending order were *Cx. pipiens* (64.6%), *Cx. pusillus* (15.92%), *Ae. caspius* (11.5%) and the least was *Cs. longiareolata* (7.96%). During December 2002, from the same site only two species were recovered; *Cx. pipiens* (69.69%) and *Ae. caspius* (30.3%), but neither *Cx. pusillus* nor *Cs. longiareolata* was detected. The overall recovered larvae showed that *Cx. pipiens* was the most dominant one (65.75%), then *Ae. caspius* (15.75%), *Cx. pusillus* (12.32%) and lastly *Cs. longiareolata* (6.16%).

In Cairo G., only two species were detected during August 2002; *Cx. pipiens* (61.9%) and, *Cs. longiareolata* (38.09%). During December of the same year, *Cx. pipiens* were (69.56%) and *Ae. caspius* were (30.43%). The overall number of larvae was *Cx. pipiens* (63.95%), *Cs. longiareolata* (27.9%) and *Ae. caspius* (8.13%). This proved that *Cx. pipiens* has a bimodal life cycle, while *Cs. longiareolata* has a unimodal life cycle.

In the Greater Cairo during August 2002, five species were recovered. They were *Cx. pipiens* (59.5%), *Cs. longiareolata* (21.68%), *Ae. caspius* (8.36%), *Cx. pusillus* (6.61%) and *Cx. perexiguus* (4.41%). During December of the same year, only two species were collected *Cx. pipiens* (67.28%) and *Ae. caspius* (32.71%). In the Greater Cairo, five species of larvae were detected *Cx. pipiens* (61.74%), *Cs. longiareolata* (15.56%), *Ae. caspius* (15.3%), *Cx. pusillus* (4%) and *Cx. perexiguus* (3.16%).

El-Bahenasawy et al. (2011b) recorded *An. multicolor*, *An. sergentii*, and *An. algeriensis* in Toshka. They added that *An. sergentii* is a malaria-vector and *A. multicolor* is a suspected vector, and that the endemicity of Chloroquine resistant *Plasmodium falciparum* on the Egyptian-Sudanese border paves the way for malignant malaria transmission especially among travelers returning back from Sudan. Abdel Hamed et al. (2011a) reported. *Cx. pipiens*, *Cx. perexiguus* Theobald, *Cx. antennatus*, *Ae. caspius*, *Ae. detritus* and *Culiseta longiareolata*. *Cx. pipiens* was was the commonest species. *W. bancrofti* cases were detected in three districts associated with the abundance of *Cx. pipiens* adults. El-Bahenasawy et al. (2010) reported that 36 patients were admitted to Military fever hospitals, included 20 already diagnosed as malarial patients, who were recruited from Peace Keeping Mission Forces in Africa and 16 presented with prolonged fever coming from different locations, El-Gabal El-Ahmar (Cairo) was the most extensively infested region (37.4%), El-Sharkia G. (18.7%) and El-Fayoum G. (12.5%). *P. vivax* was the main species among locally acquired patients (81.25%), while the imported patients coming back to Egypt from Africa especially (Sudan) had *P. falciparum* (100%). The best
therapeutic response for locally acquired malaria infection was the mono-therapy-based one such as Chloroquine or Mefloquine.

Abdel-Hamid et al. (2011b) in Ismailia Governorate reported: Cx. pipiens, Cx. perexiguus, Cx. antennatus, An. tenebrosus, An. pharoensis, An. multicolor, Ochlerotatus detritus, Oc. caspius and Cs. longiareolata. Cx. pipiens was the predominant species as larvae and adults. For the 3 common species, Cx. pipiens, Cx. perexiguus, and Cx. antennatus were the commonest ones. Ammar et al. (2012) surveyed over one year period in two localities in Cairo representing different levels of urban planning: El-Muqattam (planned) and Abu-Seir (unplanned). Cx. pipiens, Cx. perexiguus, Cx. pusillus, Ochlerotatus caspius, Cs. longiareolata and An. multicolor were the collected species at both sites. The mosquitoes were more common in Abu-Seir than in El-Muqattam, with Cx. pipiens larvae accounted to 81% and 52%, respectively. Five types of the potential breeding habitats were detected of which, the cesspits (El-Muqattam) and the drainage canals (Abu-Seir) were the most common while springs in El-Muqattam and drainage canals in Abu-Seir were the most productive types. Both Cx. pipiens and Cx. perexiguus bred year round with peaks of abundance coinciding with higher temperatures.

Abdel-Hamid et al. (2013) surveyed mosquitoes in 13 centers of El-Dakahlia Governorate, identified Cx. pipiens, Cx. antennatus, Cx. perexiguus, Ochlerotatus detritus, An. pharoensis and An. tenebrosus. Cx. pipiens predominated as larvae and adults. Cx. antennatus and Cx. perexiguus were also common. Of the Four types of the breeding habitats, the drainage canals were the most productive (53.4% larvae). The compiled larval density increased as water temp. increased and decreased as pH increased while adult density increased as temp. and RH increased. Cx. pipiens was associated with Cx. antennatus while Cx. antennatus had a moderate association with Cx. perexiguus. A total of 7.49% were infected with W. bancrofti, associated with high indoor densities of Cx. pipiens females, the main filariasis vector.

In Egypt, Cx. pipiens is the main vector of filariasis which has natural and artificial breeding sites in the endemic and non-endemic villages (Harb et al, 1993). The relative importance of the indoor-vector has a significant risk factor in the transmission of W. bancrofti (Gad et al, 1994). Many factors may be responsible for the increase of Cx. pipiens, in spite of its control measures of which, poor sanitation, the continuous floating of liquid waste and sewage everywhere the presence of water in roofs of many new buildings which create good breeding places (Mahdi et al, 1963; Farid et al, 1997). The larval stages may become more resistant to the usual insecticides used. Other species of mosquitoes were recovered, Cx. antennatus (Gad et al, 1987), Cx. univittatus, Theobaldia longiareolata and Ae. caspius (Gad, 1963); but Cx. pipiens were predominant 99.5% (Mohamed et al, 1981). Under laboratory conditions, Rifaat et al. (1971) found that Cx. antennatus may transmit fila-
ria. Turell et al. (1996) evaluated the ability of Ae. caspius, Cx. pipiens, Cx. antennatus, Cx. perexiguus, Cx. poicilipes, and A. pharoensis collected in Aswan and Cx. pipiens to transmit RVF virus reintroduction into Egypt in 1993. All mosquito species were susceptible to RVF virus infection, with An. pharoensis and Ae. caspius being the most sensitive to infection. But, none of 12 An. pharoensis, including ten with a disseminated infection, transmitted RVF virus by bite. In contrast, nearly all Cx. pipiens (87%, n=15) and Cx. perexiguus (90%, n=10) with a disseminated infection transmitted virus. Overall transmission rates for mosquitoes exposed to hams ters with a viremia $\geq 10^7$ plaque-forming units/ml were Ae. caspius, 20% (n=5); Cx. pipiens, 7% (n=102); Cx. antennatus, 7% (n=30); Cx. perexiguus, 11% (n=9); and A. pharoensis, 0% (n =7). Based on abundance, susceptibility to infection, the ability to transmit virus, and feeding behavior, Ae. caspius was the most efficient vector, while less susceptible than Ae. caspius, Cx. pipiens, Cx. antennatus, and Cx. perexiguus were also potential vectors during this RVF outbreak in Egypt.

Apart from filariasis, Culicini, mainly Cx. pipiens transmit Rift Valley fever (El Gebaly, 1978), Sindbis virus (Wilson, 1991) and Cx. pipiens complex was incriminated as vector of HCV (Hassan et al, 2002, 2003). Jamjoom et al. (2006) in Saudi Arabia documented the endemicity of malaria particularly malignant type. El-Bahnasawy and Morsy (2008) stated that human babesiosis is not in mind at least in the Middle Eastern Countries where many parasitic, bacterial and viral diseases are encountered. Errorneous interpretation of the blood film was confused with malaria, mainly P. falciparum due to the abundant small rings within the RBC. Previously, in 1943 a major malaria epidemic occurred in Egypt associated with the spread of An. arabiensis (a member of the An. gambiae species complex) from Sudan along the Nile Valley (Soper, 1966). This particular outbreak produced some 130,000 deaths within a two-year period until successful control and vector elimination measures were implemented in late 1944. At that time, the limits of the infestation were known and confined to irrigated areas well to the north of the current study area in Asyut Governorate. This facilitated the application of larvicidal agents that were used in the successful eradication campaign (Malcolm et al, 2009). Stresman (2010) stated that the climatic changes are ecologic risk factor for malaria re-transmission added by implications for water resources project planning and management in the Middle East and North Africa (Wasimi, 2010). Fuller et al. (2012) stated land change and species distribution models may be linked to project potential changes in vector habitat distribution and invasion potential, and that An. arabiensis is a particularly opportunistic feeder and efficient vector of P. falciparum in Africa and invaded areas outside its normal range, including areas separated by expanses of barren desert, to new suitable habitat for vectors.
such as *An. arabiensis* into Upper Egypt

Regarding members of genus *Aedes*, in Egypt, *Aedes* species was encountered. Kirkpatrick (1925) reported *Ae. aegypti*. Gad (1963) identified *Ae. aegypti*, *Ae. caspius* and *Ae. detritus*. Holstein (1967) reported complete eradication of *Ae. aegypti* from Egypt. Mostafa et al. (2002) reported *Ae. detritus* in governorates of Assiut, Al Fayium, Giza, Aswan, El Wady El Gadeed and South Sinai. *Ae. caspius* was found in Assiut and Aswan and as larvae in Kenya and El Wady El Gadeed. Morsy et al. (2003, 2004) found *Ae. caspius* in Qalyoubia, Giza and Greater Cairo. Shaalan et al. (2005a,b) in Aswan found *Ae. aegypti* in water sources. Mikhail et al. (2009) reported *Ae. caspius* and *Ae. detritus* in Greater Cairo, Sharkia, Qalyobia and Giza. Abdel-Hamid et al. (2011) in El Menoufia reported *Ae. (O.) caspius* and *Ae. (O.) detritus*. Shoukry and Morsy (2011) reported the presence of *Ae. aegypti* in the new reclaimed Toshka project. Heikal et al. (2011) declared that the re-emergence of *Ae. aegypti* in Aswan, the vector of viral hemorrhagic fevers, encountered in Africa, needs to alert for this public health threat.

Shoukry et al. (2012) stated that *Ae. aegypti* is one of the demonstrated vector-borne diseases worldwide particularly in the Sub-Sahara of Africa. Its re-emergence in the Egyptian southern border (Aswan) and now in Toshka is an integration mark. Saleh (2012) in Aswan Governorate reported immature and mature stages of *Ae. aegypti*.

No doubt, *Aedes* is the vector of many potential bioterrorism viral fevers (CDC, 2012). *Ae. aegypti* (the Egyptian tiger mosquito, or yellow fever mosquito or dengue fever mosquito) is vector of many arboviruses of medical and/or economic importance. It transmits the yellow fever (CDC, 2010a), dengue (El-Bahnasawy et al., 2011a) and Chikungunya viruses (CDC, 2010b). *Ae. aegypti* is a domesticated mosquito, as much as the pet dog or cat, most mosquitoes can live in forested areas a long way from humans and live on animal blood. It relies on man and only bites animals in his total absence and any mall water collections constitute its potential breeding sites.

**As to control:**

Shaalan et al. (2005a) stated that the increasing insecticide resistance requires strategies to prolong the use of highly effective vector control compounds. The use of combinations of insecticides with other insecticides and phytochemicals is one such strategy that is suitable for mosquito control. In *Ae. aegypti* and *Cx. annulirostris*, binary mixtures of phytochemicals with or without synthetic insecticides produced promising results when each was applied at a LC25 dose. All mixtures resulted in 100% mortality against *Cx. annulirostris* larvae within 24 h rather than the expected mortality of 50%. All mixtures acted synergistically against *Ae. aegypti* larvae within the first 24 h except for one mixture that showed an additive effect. They found that mixtures were more effective than insecticides or phytochemicals alone and that they enable a reduced dose to be ap-
plied for vector control potentially leading to improved resistance management and reduced costs. Shaalan et al., (2005b) evaluated the effect of synthetic and botanical insecticides on the developmental period, growth, adult emergence, fecundity, fertility, and egg hatch. They used fenitrothion, lambda-cyhalothrin, and Callitris glaucophylla (Cupressaceae) extract, LC25, LC50, and LC75 (4 replicates) were used for each synthetic insecticide and LC25 and LC75 (4 replicates) were used for C. glaucophylla. Observations of larval mortality, duration of larval stage, pupal mortality, duration of pupal stage, adult emergence, sex ratio, and malformations were recorded over 14 days. Although C. glaucophylla extract doses were higher than synthetic insecticide ones, LC75 treatment outperformed synthetics by completely prohibiting adult emergence Essam et al. (2006) investigated susceptibility of 4th instar Ae. aegypti and Cx. annulirostris larvae to extracts from Callitris glaucophylla; steam distillation extract, liquefied refrigerant gas extract, and 3: methanol reflux extract), lambda-cyhalothrin (synthetic pyrethroid) and fenitrothion (an organophosphorous). Cx. annulirostris was significantly more susceptible than Ae. aegypti to all chemicals except lambda-cyhalothrin. Response to C. glaucophylla extracts was exceptional for a botanical compound: Cx. annulirostris (LC50=0.23, 9.53 & 38.95mg/l) and Ae. aegypti (LC50=0.69, 5.21 & 306.43mg/l). Cx. annulirostris and Ae. aegypti larvae were significantly more susceptible to lambda-cyhalothrin (LC50=0.00013 and 0.00016mg/l) than fenitrothion (LC50 =0.0009 & 0.004mg/l). Pyrethroid and organophosphorous were more potent than crude C. glaucophylla extracts. The steam distilled extract was fractionated and major components guaiol and citronelic acid were identified and were lower than the distillate.

Amin et al. (2011) found phytochemical investigation of the aerial parts of Zygophyllum coccineum led to the isolation of nine ursane-type triterpene saponins (1-9), including the new zygophyllloside, together with a known flavonoid glycoside (10) and a sterol glycoside (11). Among isolated compounds 1, 3, 5, 6, & 9 showed 32-77% fungal growth inhibition at 30µM against Phomopsis viticola. Compound 9 showed 90% and 80% mosquitocidal activity at 3.1µg/0.5µl against Ae. aegypti and Cx. quinquefasciatus, respectively.

**Conclusion**

Undoubtedly, mosquitoes play the most serious role in the transmission of many zoonotic diseases worldwide, particularly in the Tropic and Subtropic countries. Culicine situation necessitates a wide vector control program to minimize Egyptian lymphatic filariasis transmission particularly in Ismailia, Dakahila, Menoufia Governorates. Also, Yellow fever and Dengue fever and Dengue hemorrhagic fever transmitted by Aedes must be into consideration particularly in Southern Egypt.

A generated map delineating mosquito risky areas could be used by the Health Authorities to predict epidemics
or endemic outbreak by knowing their breeding sites and thus suggest feasible mosquito control measures.

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