Journal of the Egyptian Society of Parasitology, Vol.43, No.2, August 2013
J. Egypt. Soc. Parasitol., 43(2), 2013: 373 – 386

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

By
MAMDOUH M. EL-BAHNASAWY[1], EMAN EBRAHIM ABDEL FADIL[2] AND TOSSON A. MORSY[3]
Consultant of Endemic Diseases and Fevers, Military Medical Academy[1], Nursing School, Alexandria Armed Forces Hospital[2] and Department of Parasitology, Faculty of Medicine, Ain Shams University, Cairo 11566[3], Egypt

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 developed 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 Heartworm….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 parasitic 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 surveillance for designing and implementing effective feasible measures for the disease control and prevention (White, 2002).

Classification

Mosquitoes belong to the Class Insecta (= Hexapoda), Order Diptera and family Culicidae. Two important subfamilies are Anophelinae (which includes the genus *Anopheles*, the mosquito vector for malaria) and Culicinae (includes the genera *Aedes*, *Culex, Mansonia* and *Haemagogus,* the mosquito 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

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

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. Anopheline 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, Anopheles 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 Anopheline and Culicine mosquitoes. Anopheline female palps are about the same length as the proboscis, while Anopheline male palps are club-shaped at the ends. Culicine 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. Anopheline 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 larva 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:

The Egyptian mosquitoes were *Cx. pipiens, Cx. antennatus*, *Cx. thelerei*, *Cx. univittatus, Cx. perexiguus, Cx. poicilipes, Cx. pusillus*, *Aedes caspius*, *Ae. detritus*, *An. sergentii, An. pharoensis*, *An. multicolor*, *An. detali*, *An. algeriensis*, *An. tenebrosus*, *An. gambiae* (formerly), *An. superpictus*, *An. tarkhadi*, *An. hispaniola*, *An. rhodesiensis*, *An. stephensi, An. coustani* and *Culiseta longiareolata*.

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 Qualyoubia 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%).

In Egypt, Kenaway (1988) studied anopheline mosquitoes in malaria transmission in Egypt. Anopheline species were *An. algeriensis*, *An. tenebrosus*, *An. pharoensis*, *An. sergentii*, *An. gambiae, An. detali*, *An. multicolor*, *An. superpictus*, *An. tarkhadi*, *An. hispaniola*, *An. rhodesiensis* and *An. stephensi*. Kenaway (1990) reported that *An. pharoensis* and *An.. sergentii* are proven vectors. *An. multicolor* and *An. superpictus* are suspected vector. Others; *An. stephensi, An. detali* are vector abroad but their role in Egypt was not yet determined at that time.

Morsy *et al.* (1988; 1990) studied *Culex* species in the Suez Canal Governorates. Morsy *et al.* (1995) in Al Fayoum Governorate where malaria was endemic identified *An. pharoensis, An. sergenti, An. multicolor* and *An. tenebrosus.*

Mosquitoes in Egypt by selected publications

Genus	Species	Authors
Anopheles	*algeriensis*	Kirkpatrick, 1925, Gad, 1963, Kenawy, 1988,1990, Morsy *et al*, 1995a,b, El-Bahnasawy *et al*, 2010; 2011b
	detali	
	gambiae (formerly)	
	Hispanioal	
	multicolor	
	pharoensis	
	rhodesiensis	
	sergentii	
	stephensi	
	superpictus	
	tarkhadi	
	tenebrosus (=*antennatus coustani*)	
Culex	*perexiguus*	Kirkpatrick, 1925, Gad, 1963, Harbach *et al*,1988 Morsy *et al*, 1990, 2003, 2004 Mostafa, 2002 El-Bashier *et al*, 2006 Abdel Hamed *et al*, 2011a,b, 2013, El-Bahnasawy *et al*, 2013
	pipiens	
	poicilipes,	
	pusillus	
	quinquefasciatus	
	thelerei	
	univittatus	
Aedes	*aegypti*	Gad, 1963; Mostafa *et al*, 2002, Morsy *et al*, 2003, 2004, El-Bahnasawy *et al*, 2011a
	caspius	
	detritus	
Culiseta (=*Theobaldia*)	*longiareolata*	Mostafa *et al*, 2002, Morsy *et al*, 2003, 2004

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. sergentii* were found in El Fayium, Aswan and El Wady El Gadeed; but in Kena *An. sergentii* was found as larvae and *A. multicolor* as adults.

Morsy *et al*. (2003, 2004) in Qalyoubia 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 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-Bahnasawy *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 longiareolat*. *Cx. pipiens* was was the commonest species. *W. bancrofti* cases were detected in three districts associated with the abundance of *Cx. pipiens* adults. El-Bahnasawy *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 monotherapy-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 (plan-ned) 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 filaria. 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 trans-mission rates for mosquitoes exposed to hamsters with a viremia >or=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. Erroneous 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 Kena 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, Qualyobia 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 applied 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 the completely prohibiting adult emergence Essam *et al*. (2006) investigated susceptibility of 4^{th} 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 lambdacyhalothrin (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 citronellic 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 zygophylloside, 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, Dakahlia, 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.

References

Abdel-Hamid, YM, Soliman, MI, Kenawy, MA, 2011a: Geographical distribution and relative abundance of culicine mosquitoes in relation to transmission of lymphatic filariasis in El Menoufia Governorate, Egypt. J. Egypt. Soc. Parasitol. 41, 1:109-18.

Abdel-Hamid, YM, Soliman, MI, Kenawy, MA, 2011b: Mosquitoes (Diptera: Culicidae) in relation to the risk of disease transmission in El Ismailia Governorate, Egypt. J. Egypt. Soc. Parasitol. 41, 2:347-56.

Abdel-Hamid, YM, Soliman, MI, Kenawy, MA, 2013: Population ecology of mosquitoes and the status of bancroftian filariasis in El Dakahlia Governorate, the Nile Delta, Egypt. J. Egypt. Soc. Parasitol. 43, 1:103-13

Amin, E, El-Hawary, S, Fathy, M, Mohammed, R, Ali, Z, *et al*, 2011: Triterpenoidal saponins: bioactive secondary metabolites from *Zygophyllum coccineum*. Planta Med. 77, 5:488-91.

Ammar, SE, Kenawy, MA, Abdel-Rahman, HA, Gad, AM, Hamed, AF, 2012: Ecology of the mosquito larvae in urban environments of Cairo Governorate, Egypt. J. Egypt. Soc. Parasitol. 42, 1:191-202.

CDC, 2010a: Fact Sheet/Yellow Fever. http://www.cdc.gov/ncidod/dvbid /yellow fever/yf_factsheet.html:

CDC, 2010b: Chikungunya Distribution and Global Map: For information on current outbreaks, consult CDC's Traveler's Health website (http:// www. cdc.Gov/ travel/def-fault.aspx).

CDC, 2012: Traveler's Health-Yellow Book 2012-DF and DHF; http:// www nc.cdc.gov/travel/page/home.htm

El-Bahnasawy, MM, Morsy, TA, 2008: Egyptian human babesiosis and general review. J. Egypt. Soc. Parsitol. 38, 1:265-72.

El-Bahnasawy, MM, Dabbous, HKh, Morsy, TA, 2010: Imported malaria as a threat to Egypt. J. Egypt. Soc. Parasitol. 40, 3:773-88.

El-Bahnasawy, MM, Khalil, HH, Morsy, AT, Morsy TA, 2011a: Threat of dengue fever and dengue hemorrhagic fever to Egypt from travelers. J. Egypt. Soc. Parasitol. 41, 2:289-306.

El-Bahnasawy, MM, Saleh, NMK, Khalil, MF, Morsy, TA, 2011b: The impact of three anopheline mosquito species in Toshka, on the introduction of chloroquine resistant *P. falciparum* to Egypt. J. Egypt. Soc. Parasitol. 41, 3:57-592.

El-Bahnasawy, MM, Khater, MMK, Morsy, TA, 2013: The mosquito borne west Nile virus infection: Is it threating to Egypt or a neglected endemic disease? J. Egypt. Soc. Parasitol. 43, 1:87-102

El-Bashier, ZM, Hassan, MI, Mangoud, AM, Etewa, S, Morsy, TA, Moh ammed, KhA, 2006: A preliminary pilot survey (*Culex pipiens*) Sharkia Governorate, Egypt. J. Egypt. Soc. Parasitol. 36, 1:81-92

El-Gebaly, RM, 1978: Epidemiological study of outbreak of rift valley fever in military personnel. J. Egypt. Pub. Hlth. Assoc. 53:141-50.

Essam, Abdel SS, Deon, Vahid C, Bruce, B, Mohamed, Wagdy FY, Abdel Wahab, HA, Abdel Hamid, M, 2006: Efficacy of botanical extracts from *Callitris glaucophylla*, against *Aedes aegypti* and *Culex annulirostris* mosquitoes. Trop. Biomed. 23, 2:180-5.

Farid, HA, Morsy, ZS, Gad, AM, Ramzy, RM, Faris, R, Weil, GJ, 1997: Filariasis transmission potential of mosque-toes to humans of different age groups. J. Egypt. Soc. Parasitol. 27, 2:355-64.

Fuller, DO, Parenti, MS, Hassan, A N, Beier, JC, 2012: Linking land cover and species distribution models to project potential ranges of malaria vectors: an example using *Anopheles arabiensis* in Sudan and Upper Egypt. Malar. J. 6, 11:264. doi:10.1186/1475-2875-11-.

Gad, AM, 1963: Insects of Medical Importance. Res. Inst. Med. Entomol., MOH, Dokki, Giza, Egypt.

Gad, AM, El Said, S, Hamed, MS, Soliman, BA, Abdel Mohsen, A, 1987: Distribution and bionomics of Egyptian *Culex antennatus* (Becker). J. Egypt. Soc. Parasitol. 17, 2:591-607.

Gad, AM, Feinsod, FM, Soliman, B A, Nelson, CO, Gibbs, P, Shoukry, A, 1994: Exposure variables in bancroftian filariasis in the Nile Delta. J. Egypt. Soc. Parasitol. 24, 2:439-55.

Harb, M, Faris, R, Gad, AM, Hafez, ON, Ramsy, R, Buck, A, 1993: Research on lymphatic filariasis in the Nile Delta. Bull. WHO, 71:49-54.

Harbach, RE, 1985: Pictorial keys to the genera of mosquitoes, subgenera of *Culex* and the species *Culex* occurring in southwestern Asia and Egypt, with a note on the subgeneric placement of *Culex deserticola* (Diptera: Culicidae). Mosq. System. 17, 2:83-107.

Harbach, RE, 1988: The mosquitoes of the subgenus in Southwestern Asia and Egypt (Diptera: Culicidae). Contrib. Amer. Entomol. Inst. 24, 1:1-18.

Harbach, RE, Harrison, BA, Gad, A M, Kenawy, MA, El-Said, S, 1988: Records and notes on mosquitoes (Diptera: Culicidae) collected in Egypt. Mosq. System. 20, 3:317-31.

Hassan, MI, Hammad, KM, Amin, I, Mangoud, AM, Etewa, SE, *et al*, 2002: Hepatitis C virus and *Culex pipiens* complex. J. Egypt. Soc. Parasitol. 32, 3:1003-4.

Hassan, MI, Mangoud, AM, Etewa, S, Amin, I, Morsy, TA, *et al*, 2003: Experimental demonstration of HCV in an Egyptian strain of *Culex pipiens* complex. J. Egypt. Soc. Parasitol. 33, 2: 373-84.

Heikal, OM, El-Bahnasawy, MM, Morsy, ATA, Khalil, HHM, 2011: *Aedes aegypti* re-emerging in Egypt: A review and what should be done? J. Egypt .Soc. Parasitol. 41, 3:785-814.

Jamjoom, MB, Azhar, EA, Tonkol, AM, Al-Harthi, SA, Ashankyty, IM, 2006: Detection of malaria in Saudi Arabia by real-time PCR. J. Egypt. Soc. Parasitol. 36, 3:737-48.

Kenawy, MA, 1988: Anopheline mosquitoes (Diptera: Culicidae) as malaria carrier in A.R. Egypt: History and present status. J. Egypt. Publ. Hlth. Assoc. 63, 1/2:67-85.

Kenawy, MA, 1990: Fauna of Anopheline mosquitoes (Diptera: Culicidae) in A.R. Egypt: Historical background and present situation. J. Egypt. Publ. Hlth. Assoc. 65, 3/4: 263-81.

Kirkpatrick, TW, 1925: Mosquitoes of Egypt. Egyptian Government Press, Cairo.

Lane, RP, Crosskey, RW, 1993: Mosquitoes (Culicidae). In: Medical Insects and Arachnids. 1st edition; Chapman and Hall, London.

Mahdi, AH, Guirguis, SS, Kolta, S, Salit, A, 1963: A preliminary notes on the control of filariasis in Marsafa in U.A.R. J. Egypt. Pub. Hlth. Assoc. 38: 153-65.

Malcolm, CA, El Sayed, B, Babiker, A, Girod, R, Fontenille, *et al*, 2009: Field site selection: getting it right first time around. Malar. J. 8, 2:S9.

Micheal, WM, Al-Bursheed, KM, Allam, KA, 2007: Susceptibility of *Culex pipiens* complex to some insecticides in Qatar. J. Egypt. Soc. Parasitol. 37, 3: 893-902.

Mikhail, MW, Al-Bursheed, KhM, AbdEl-Halim, AS, Morsy, TA, 2009: Studies on mosquito borne diseases in Egypt and Qatar. J. Egypt. Soc. Parasitol. 39, 3:745-56.

Mohamed, NH, Rifaat, MA, Abdel Baki, MH, Fawzi, AF, 1981: Types of mosquitoes in Giza G. in reference to filaria. J. Egypt. Soc. Parasitol. 11, 2: 441-51.

Monath, TP, 1991: Viral febrile illness. In: Strickland, G.T. (ed.), Hunter's Tropical Medicine. W.B. Saunders, Philadelphia.

Morsy, TA, El Kadry, AA, Salama, MMI, Sabry, AA, El Sharkawy, IM A, 1995a: Studies on bionomics and vector competence of adult Anopheline mosquitoes in El Faiyum G., Egypt. J. Egypt. Soc. Parasitol. 25, 1:213-44.

Morsy, TA, El Kadry, AA, Salama, MMI, Sabry, AA, El Sharkawy, IM A, 1995b: Studies on Anopheline larvae in El Faiyum Governorate, Egypt. J. Egypt. Soc. Parasitol. 25, 2:329-54.

Morsy, TA, El Okbi, LM, Fawzy, AF A, Arafa, MAS, Shouma, MIM, 1988: Studies on blood sucking insects in Suez City, Egypt. J. Egypt. Soc. Parasitol. 18, 1:81-6.

Morsy, TA, El Okbi, LM, Kamal, A, Ahmed, MM. Boshira, EF, 1990: Mosquitoes of the genus *Culex* in the Suez Canal Governorate, Egypt. J. Egypt. Soc. Parasitol. 20, 1:256-63.

Morsy, TA, Khalil, NM, Habib, FS M, El-Laboudy, NM, 2003: Culicini mosquito larvae in Greater Cairo. J. Egypt. Soc. Parasitol. 33, 3:717-32.

Morsy, TA, Khalil, NM, Habib, FS M, El-Laboudy, NM, 2004: Seasonal distribution of culicini larvae in greater Cairo. J. Egypt. Soc. Parasitol. 34, 1: 143-52.

Mostafa, AA, Allam, KA, Osman, M Z, 2002: Mosquito species and their densities in some Egyptian governortes. J. Egypt. Soc. Parasitol. 32, 1:9-20.

Pates, H, Curtis, C, 2005: Mosquito behavior and vector control. Ann. Rev. Entomol. 50:53-9.

Rifaat, MA, Mahdi, AM, Wassif, SF, Morsy, TA, 1971: Laboratory efficiency ratio of *C. pipiens* and *C. antennatus* as filarial vectors in U.A.R. J. Egypt. Pub Hlth. Assoc., 46:266-70.

Robert, L, 2001: Mosquitoes (F.: Culicidae). In: Guide to Entomological Surveillance during Contingency Operations; Walter-Reed Army Institute of Research, Washington D.C.

Roberts, DM, 1996: Mosquitoes (Diptera: Culicidae) breeding in brackish water: Female oviposition preferences or larval survival. J. Med. Entomol. 33, 4:525-30.

Rodhain, F, Rodhain-Rebourg, F, 1976: Geographical distribution of lymphatic filariasis. 5- Near and Middle East, Indian sub-continent, and South East Asia. Med. Malad. Infect. 6, 3: 108-14.

Saleh, NM, 2012: *Aedes* mosquito in Aswan Governorate, Egypt. J. Egypt. Soc. Parasitol. 42, 1:233-8.

Sebai, ZA, Morsy, TA, Zawahry, M, 1974: A preliminary study on filariasis in Western part of Saudi Arabia. Castell Tropenmed. Dermato., 2, 12:263-6.

Shaalan, EA, Canyon, DV, Younes, MW, Abdel-Wahab, H, Mansour, A H, 2005b: Effects of sub-lethal concentrations of synthetic insecticides and *Callitris glaucophylla* extracts on the development of *Aedes aegypti*. J. Vector Ecol. 30, 2:295-8.

Shaalan, EA, Canyon, DV, Younes, MW, Abdel-Wahab, H, Mansour, A H, 2005a: Synergistic efficacy of botanical blends with and without synthetic insecticides against *Aedes aegypti* and *Culex annulirostris* mosquitoes. J. Vector Ecol. 30, 2:284-8.

Shoukry, NM, Elwan, MA, Morsy, T A, 2012: *Aedes aegypti* (Linnaeus) reemerging in southern Egypt. J. Egypt. Soc. Parasitol. 42, 1:41-50.

Shoukry, NM, Morsy, TA, 2011: Arthropod borne diseases at Toshka, Upper Egypt. Wld. J. Zool, 6, 2:126-33.

Soper, FL. 1966: Paris green in the eradication of *Anopheles gambiae*: Brazil, 1940; Egypt, 1945. J. Am. Mosquito Cont. Assoc. 26:470-6.

Stone, A, 1977: A Catalog of the Mosquitoes of the World (Diptera: Culicidae). Thomas Say Foundation, USA.

Stresman, GH, 2010: Beyond temperature and precipitation: Ecological risk factors that modify malaria transmission. Acta Trop. 116:167-72.

Turell, MJ, Presley, SM, Gad, AM, Cope, SE, Dohm, DJ, *et al*, 1996: Vector competence of Egyptian mosquitoes for Rift Valley fever virus. Am. J. Trop. Med. Hyg., 54, 2:136-9.

Wasimi, SA, 2010: Climate change in the Middle East and North Africa (MENA) region and implications for water resources project planning and management. Int. J. Clim. Change Strat. Manag. 2:297-320.

White, GB, 2002: Mosquitoes. In: Manson's Tropical Diseases, 21st Edition, Cook, GC, and Zumla, A, (Eds.), WB Saunders, London.

WHO, 1991: Malaria: World Health Organization Statistics. 44, 4:219-21.

WHO, 1998: Division of Control Tropical Diseases: Malaria Prevention and Control; WHO/CTD, Geneva.

Wills, WM, Jacob, Wl, Fray, DB, 1985: Sindbis virus isolated from Saudi Arabian mosquitoes. Trans. Roy. Soc. Trop. Med. Hyg. 79, 1:63-6.

Wilson, ME, 1991: A World Guide to Infection: Diseases, Distribution, Diagnosis. Oxford, Oxford University Press.