Introduction
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Mosquitoes are an ancient group of insects, which have persisted for millions of years. Through the process of evolution, nature has superbly perfected them that they may survive under the most adverse conditions and in a diversity of environments. Nature has succeeded in combining in them certain advantageous characteristics, the combination of which is found in no other groups of insects. If diversity of species, habits, number of individuals and persistence in geological time are the measures, then mosquitoes are undoubtedly one of the "successful groups among insects" of biological evolution.

Mosquitoes belong to the order Diptera, suborder Nematocera and family Culicidae and they are an integral part of medical entomology because of their blood sucking forms and as vectors for various diseases. More than 3100 species of mosquitoes, which belong to 34 genera, have been recorded and arranged under three sub-families, namely, Anophelinae, Culicinae, and Toxorhynchitinae (Knight and Stone, 1977). They are small insects and are readily identified by the presence of scales on the body, and along the fringes and veins of the wings. They possess long antennae, most joints of which bear whorls of hairs. Like all True flies (Diptera), they have two wings, but unlike other flies, their wings have scales and their mouthparts (in female mosquitoes) form a long piercing-sucking proboscis. Males differ from female by having feathery antennae and mouth parts not suitable for piercing skin. Nectar is their principal food source.
The Spanish called the mosquitoes “mosketas”, and the native Hispanic American called them “Zancudos”. “Mosquito” is a Spanish or Portuguese word meaning “little fly” while “Zabcudos” a spanish word means “long-legged”. The use of the word “mosquito” is apparently of North American origin and dates back to 1583. In Europe, mosquitoes were called “gnats” by English. “Les moucherons” or “Les cousins” by French writers, and the Germans used the name “Stechmucken” or “Schnacke”. In Scandanavian countries mosquitoes were called by a variety of names including “myg” and “myyga” while the Greeks called them “konopus”. In 300 BC Aristotle referred to mosquitoes as “empis” in his “Historia Animalium” where he documented their life cycle and metamorphic abilities. Modern writers used the name Culex and it is retained today as the name of a mosquito genus. The correct plural form of the word mosquito is “mosquitos” in Spanish and “mosquitoes” in English.

Research studies on the taxonomy of mosquito begin with Linnaeus, father of systematic zoology, who named the first genus Culex in the year 1735. He described 6 species belonging to this genus in the tenth edition of his book, the Systema Naturae in 1758. Meigen (1818) described the genera Aedes and Anopheles.

Bonani (1691) studied and described the life history of the common European mosquito Culex pipiens. Raschke (1887) studied the larvae of a European Culex, while Hurst (1890) on the pupae of Culex. Jan
Swammer Dam in 1890 started the research on the biology and life history of mosquitoes.

The necessity of a low oxygen concentration for the hatching of *Aedes* mosquitoes eggs were reported by Gjullow *et al.*, (1941). They found that any method; chemical or physical, caused hatching when the oxygen content of the water was reduced. The great importance of a thorough knowledge on the biology and life history of mosquitoes may be illustrated best in actual mosquito control operations.

Robineau (1827) added the genera *Sabethes*, *Psorophora* and *Megarhinus*. Several attempts on the classification of mosquitoes were carried out in the late 19th and early 20th centuries, Theobald a leading research worker on classification of the mosquitoes published five volumes of monograph about the family Culicidae. In 1932, Edwards firmly established the mosquito classification in *Wytsman Genera Insectorum*. According to this classification, the family Culicidae includes Culicincae (true mosquitoes), Dixinae and Chaborinae include 4 tribes, namely Megarhinini, Anophelini, Culicini and Sabethini. Among these two tribes (i. Culicini and ii. Anophelini) of mosquitoes, which are medically important, the latter include vectors for malarial fevers, while the former is responsible for Yellow fever, Filariasis and Dengue fever. Apart from these, they also include some of the most seriously annoying biting forms (Busvine, 1978).
The mosquitoes go through four separate and distinct stages of life cycle: Egg, Larva, Pupa and Adult. Each of these stages can be easily recognised by its special appearance.

Egg: Eggs are laid one at a time and they float on the surface of the water. In case of Culex and Culiseta species, the eggs are stuck together in rafts of 200 or more. Anopheles and Aedes species do not make egg rafts but lay their eggs separately. Culex, Culiseta and Anopheles lay their eggs on water while Aedes lay their eggs on damp soil that will be flooded by water. Most eggs hatch into larvae within 48 hours. Water is a necessary part of their habitat.

Culex mosquitoes lay their eggs on the surface of fresh or stagnant water. The water may be in tin cans, barrels, horse troughs, open tender coconut drupes, ornamental ponds, swimming pools, puddles, creeks, ditches or marshy areas. Mosquitoes prefer water sheltered from the wind by grass and weeds. Culex mosquitoes usually lay their eggs at night. A female mosquito may lay a raft of eggs every third night during its life span. Culex mosquitoes lay their eggs one at a time, sticking them together to form a raft of 200 to 300 eggs. A raft of eggs looks like a speck of soot floating on the water and is about 1/4 inch long and 1/8 inch wide. Tiny mosquito larvae emerge from the eggs within 24 hours. Anopheles mosquitoes lay their eggs singly on the water, not in rafts. Aedes mosquitoes lay their eggs singly on damp soil. Aedes eggs hatch only when flooded with water (salt water high tides, irrigated pastures, tree-holes, flooded stream bottoms).
Larva: The larva lives in the water and comes to the surface to breathe. Larvae shed their skins (molt) four times, growing larger after each molting. Most larvae have siphon tubes for breathing and hang from the water surface. Anopheles larvae do not have a siphon and lay parallel to the water surface to get a supply of oxygen through breathing openings. The larvae feed on microorganisms and organic matter in the water.

Mosquito larvae, commonly called “wrigglers”, live in water for 7 to 14 days, depending on water temperature. Larvae must come to the surface at frequent intervals to obtain oxygen through a breathing tube called siphon. The larva eats algae and small organisms, which live in the water. During growth, the larva molts four times. The stages between molts are called instars. When the 4th instar larva molts, it becomes a pupa.

Pupa: The pupal stage is a resting, non-feeding stage. This is the time the mosquito turns into an adult. It takes about two days before the adult is fully developed. When development is complete, the pupal skin splits and the mosquito emerges as an adult.

Mosquito pupae commonly called, “tumblers” live in water for 1 to 4 days, depending upon the species and temperature. The pupa is lighter than water and, therefore, floats at the surface. It takes oxygen through two breathing tubes called “trumpets”. When it is disturbed it dives in a jerking, tumbling motion and then floats back to the surface. The pupa
does not eat. The metamorphosis of the mosquito into an adult is completed within the pupal case. The adult mosquito splits the pupal case and emerges to the surface of the water where it rests until its body dries and hardens.

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.

Only female mosquitoes bite animals and require a blood meal. Male mosquitoes do not bite, but feed on the nectar of flowers. *Aedes* mosquitoes are painful and persistent biters. They are crepuscular and search for a blood meal early in the morning, and at dusk. Some are diurnal (daytime biters) especially on cloudy days and in shaded areas. They usually do not enter dwellings, and they prefer to bite mammals like human. *Aedes* mosquitoes are strong fliers and are known to fly many miles from their breeding sources.

*Culex* mosquitoes are painful and persistent biters. They prefer to attack at dusk and after dark, and readily enter dwellings for blood meals. Domestic and wild birds usually are preferred over man, cows, and horses. *Culex* mosquitoes are generally weak fliers and do not move far from home, although they have been known to fly up to two miles. *Culex* usually lives only for a few weeks during the warm summer months. Those females, which emerge in late summer, search for sheltered areas where they “hibernate” until spring. Warm weather brings them out again in search of water on which to lay their eggs.
Psorophora, Coquillettidia and Mansonia mosquitoes are becoming more pestiferous as an ever-expanding human population invades their natural habitats. Anopheles mosquitoes are the only mosquitoes which transmit malaria to man. The egg, larvae and pupal stages depend on temperature and species characteristics to determine how long they take for their development. Some species are naturally adapted to go through their entire life cycle in four days or one month.

Mosquitoes, though known for their nuisance since ages, did not receive much attention until certain species were recognised as potential vectors of diseases affecting mankind and animals. WHO has declared the mosquito as "Public Enemy Number One", because mosquitoes are responsible for the transmission of various dreadful diseases (WHO, 1996). A major portion of the National Health budget is spent on the control of these diseases. The task is yet to be addressed expeditiously. Sustainable reduction in vector mosquito population and mosquito borne diseases can be achieved by judicious use of various available control strategies.

The World bank based on TDR budget of diseases in 1998-1999 is estimated to be 51% for Malaria, 10% for Filariasis and 1% for Dengue for the year 1999-2000. The most important man biting, disease transmitting and nuisance causing mosquitoes belong to the genera Anopheles, Culex, Aedes, Mansonia, Haemogogus, Sabethes and Psorophora. In India, the various species of Anopheles, Culex, Aedes and
Mansonía are important carriers of diseases. Malaria, Filaria, Japanese Encephalitis (JE), Dengue and Dengue Haemorrhagic Fever (DHF) are the four major mosquito-borne diseases in India.

Of these, malaria stands as the most important disease on account of intense morbidity and mortality caused. Malaria, a protozoan (*Plasmodium vivax*, *P. falciparum*, *P. malariae* and *P. ovale*) parasitic disease transmitted by mosquitoes belonging to the genus *Anopheles* remains the most important of these diseases, with 300-500 million cases and 2.7 million deaths being reported worldwide in the year 1997. Although fifty-eight species of *Anopheles* have been recorded in India, very few species are involved in the transmission of the disease. *An. culicifacies*, *An. stephensi*, *An. fluviatilis*, *An. minimus*, *An. annularis*, *An. philippinensis*, *An. sundaicus*, *An. balabacensis* are the major malarial vectors in India. Malarial vectors of minor importance are *An. varuna*, *An. aconitus*, *An. jeyportensis var. candidiensis*, *An. maculatus* and *An. tessellatus* (Rao, 1981). The primary vectors of rural and urban malaria in India are *An. culicifacies* and *An. stephensi*, respectively. *An. culicifacies* alone is responsible for 60-70% malaria cases reported annually (John William, 2000). *Anopheles stephensi* has wide distribution in India, Pakistan, Afghanistan, Iraq, Iran, Bahrain, Oman, Saudi Arabia, Bangladesh, China, Burma, Thailand and some parts of Africa (Rao, 1984).
Filariasis, a nematode (*Wuchereria bancrofti, Brugia malayi* and *Brugia timori*) parasitic disease transmitted by mosquitoes causes elephantiasis and male genital damage. This disease is a major social and economic scourge in the tropics and subtropics of Asia, Africa, parts of America and Western Pacific affecting over 120 million people. It is estimated that 1.1 billion people live in areas with transmission of this disease (WHO, 1998). It is much prevalent in India and over 19 million people suffer from this disease.

*Culex quinquefasciatus* is the major vector of bancroftian filariasis, which is also a common pestiferous mosquito. Bancroftian filariasis caused by *Wuchereria bancrofti* is wide spread, and is endemic in all states and union territories of India except in Jammu and Kashmir, Himachal Pradesh, Punjab, Haryana, Chandigarh, Delhi, Rajasthan, Nagaland, Manipur, Meghalaya, Tripura, Andhra Pradesh, Mizoram and Sikkim. Phenomenal increase in human population, migration of people from endemic to non-endemic areas, creation of mosquitogenic conditions and improper environmental sanitation have been contributing to the spread of this disease. The disease, that was once associated with urban area only, is rapidly emerging as a major problem in rural areas. It is an ubiquitous mosquito which prefers to breed in polluted water habitats like drains, cesspits, cesspools, etc. They are more common in urban areas due to the availability of numerous breeding sources. Brugian filariasis, unlike bancroftian filariasis, is restricted to a few regions in India, the major one being in the state of Kerala. Filaria due to *B. timori* has not been reported in India.
Mansonioides vectors are responsible for the transmission of brugian filariasis. *Mansonia annulifera* and *Ma. uniformis* are the major vectors and *Ma. indiana*, the secondary vector. Mansonioides species usually breed in habitats with aquatic vegetation, preferring ponds with vegetation like *Pistia stratiotes*, *Eichhornia crassipes* and *Salvinia molestes*.

Dengue and Dengue Haemorrhagic Fever (DHF) are caused by a group of arbovirus (flavovirus). Four distinct sero types are present which are designated as DEN-1, DEN-2, DEN-3 and DEN-4. These viruses contain single-strand RNA. Once the mosquito gets infected it not only remains so for its life time but also passes the virus to its next generation through its eggs, which is called "Transovarian transmission". Severe pain in the joints and muscles, biphasic fever and skin eruptions are the common symptoms of dengue fever and are rarely fatal. Dengue Haemorrhagic Fever (DHF) is often fatal. Symptoms of DHF include bleeding from nose and mouth. Mosquito vectors of Dengue and DHF belong to the genera *Aedes*. *Aedes aegypti* is the major vector in urban areas. The species is mainly a receptacle breeder and is often found to breed profusely in rainwater collections in discarded tyres, tins, bottles, etc., in water storage containers like cisterns, barrels, pots, etc., and have been found to breed occasionally in wells. Dengue outbreaks are often associated in urban areas with irregular potable water supply. Growing urban population, availability of numerous breeding sites, rapid transportation involving the movement of both infected people and infected vector are responsible for frequent dengue outbreaks.
Dengue epidemics are known to have occurred during the last three centuries in tropical, subtropical and temperate areas of the world. A disease compatible with dengue is recorded in China as early as 992 A.D. An epidemic of this disease that occurred in Philadelphia in 1780 was described as "Break - bone fever". Although most of these epidemics were clinically dengue fever, some were associated with severe haemorrhagic form. The first record of DHF occurred in Australia in 1897, in 1928 in Greece and in 1931 in Taiwan. Confirmed epidemics of DHF with significant mortality have occurred in most countries of South East Asia region including India since 1953. Over the past 20 years there has been a dramatic increase in the incidence and geographical distribution of DHF. In India the first major out break of dengue accompanied by DHF was reported in Calcutta in 1963. (Radhakrishnan and Dhanraj, 2000).

Mosquitoes have a worldwide distribution. They are prevalent throughout the tropical and temperate regions and extend their range northwards into the Arctic Circle (Rajendran, 2000). Only in Antarctica and in a few islands they are absent. Mosquitoes occurring in the far northern regions do not carry any pathogenic agents, but the tropical and subtropical mosquitoes are carriers of pathogens, which transmit malaria, filaria, etc.
Temperature operates as a restricting factor in unusual or unseasonable periods of hot and cold weather. Some species of mosquitoes breed on snow and on high mountains, for e.g. *An. communis* of the Holarctic hibernates in winter and breeds in snow puddles in summer. Generally unusual temperatures modify or control the range of a species along some frontier. The southern house mosquito, *Culex quinquefasciatus*, may migrate northward and extend its range during years with mild winters, but is cut back southward during severe winter.

A remarkable selectivity in breeding habitats is exhibited by mosquitoes. The occurrence of immature stages of mosquitoes in a habitat is mainly determined by the ovipositional behaviour of the female adult mosquito as selection by the larvae is not possible (Bates, 1949).

The feeding and breeding behaviour in a given habitat predominantly control the proliferation of mosquitoes. The breeding behaviour consists of swarming, mating and oviposition activities. The habitat selection for oviposition by the mosquitoes is dependent upon several physico-chemical factors. The breeding habitats of the mosquitoes are grouped either as “on ground breeders” or “above ground breeders”. The on ground breeders lay their eggs in small pools, ponds, rivers, streams, stagnant water bodies on the surface of the soil etc. The above ground breeders lay their eggs in the carnet tanks, plastic and other man-made containers. The above ground breeders are also termed as “container breeders”.
Mosquito breeding habitats range from a thin film of water in leaf axils of jungle plants to huge water collections like lake-margins and swamps. Boyd (1930) classified larval habitats based on the source of water such as habitats with rainwater or surface drainage, habitat receiving both surface and ground water and seepage or ground water whereas Shannon (1931) based his classification on the location or condition of the breeding habitats. But, Bates (1949) went further ahead in classifying the larval habitats with both location and condition.

Due to high reproductive potential and ubiquitous breeding habits, eradication of vector mosquitoes becomes virtually difficult. They are successfully established and proliferated in urban and rural areas due to unplanned construction of overhead tanks, drainage and disposal system, ultimately leading to the creation of potential breeding sites for them. In the past, when mosquito control programmes were initiated, emphasis was laid upon environmental manipulation and biological control measures to reduce the vector breeding. There are records of several successful disease control activities by environmental management methods in India (Covell, 1928; Clyde, 1931).

Lloyd (1910) and Chaudhari (1911) were the pioneers in postulating mosquito larval control by different fish species. With the arrival of DDT and other chemical insecticides with their spectacular effects, chemical control gained importance and the other approaches were overshadowed. However, the development of physiological
resistance to DDT, Malathion and other inexpensive insecticides were reported during and after the resurgence period (Sharma and Mehrotra, 1986). Further, the toxic effect of these chemical insecticides was always a source of danger to non-target organisms and to the environment.

The major obstacle in mosquito control programmes is the development of resistance in them to conventional insecticides. The WHO expert Committee (1982) felt the resistance in vectors was probably the “biggest single obstacle in the struggle against vector borne diseases”.

On account of these, the last few decades have witnessed intensive research for new, effective and appropriate tools for vector control. Old and forgotten traditional methods have been revived and modernized for effective vector control operations. Various vector control methods, viz., biological control, environmental management, etc., have been successfully demonstrated.

Plants are a rich source of bioactive organic chemicals and synthesize a number of secondary metabolites to serve as defense chemicals against insect attack. These chemicals may serve as insecticides, antifeedants, oviposition deterrents, repellents, growth inhibitors, juvenile hormone mimics, moulting hormones, antimoulting hormones as well as attractants. They offer an advantage over synthetic insecticides, as they are less toxic, less prone to the development of resistance, and easily biodegradable. Although only 10,000 secondary
metabolites have been chemically identified, their total number may exceed 4,00,000. Screening and identification of effective compounds may be successfully used to control mosquitoes in future. (Ignacimuthu, 2000).

The rise of vector borne diseases is explained by the factors such as rapid population growth, expanding urbanisation, inadequate water supplies and difficulties in refuse disposal (Lam, 1998). Rapid urban expansion has resulted in a considerable stress on already meager drinking water supplies. The supplies were observed to reach the top storeys with difficulty (Macdonald, 1956). This might lead to a gradient in water storage practices.

*Anopheles stephensi*, *Culex quinquefasciatus* and *Aedes aegypti* are the vector mosquitoes of urban malaria, filaria and dengue, respectively in Chennai city. *Anopheles stephensi* is the vector of malaria in Madras (Chennai). Overhead tanks, wells and cisterns are the preferred breeding sites. Apart from Malaria, Chennai city is endemic for dengue and dengue Haemorrhagic fever (DHF) transmitted by *Aedes aegypti*. This mosquito breeds in habitats similar to the ones where *An. stephensi* breeds. There was an outbreak of DHF in Madras during 1989 with 66 case and 21 deaths (Chandrahas *et al.*, 1993). *Culex quinquefasciatus* is the principal vector of *Wuchereria bancrofti* that causes bancroftian filariasis, which is a prevalent endemic disease in certain pockets of Chennai (Gunasekaran *et al.*, 2000).
The present study is concentrated only on the three common vectors of Chennai which causes heavy loss of life. The prevalence of these mosquito borne diseases in the areas of Chennai city is of much concern especially from Public health point of view. Therefore, the present work “Studies on vector mosquitoes of Chennai City” has been initiated. The need for such studies has been strongly recommended by WHO (1967 and 1975) for successful disease control.