CHAPTER 1

Introduction

1.1 Basic understanding

Mosquitoes are dipteran insects and blood sucking fly pests of man. Mosquitoes are surviving on earth since millions of years. They have always given tough time to men as important carriers of various diseases. People fight globally against mosquitoes and mosquito borne diseases. Malaria, dengue, filaria, Japanese encephalitis, west nile virus and chikungunia are the major diseases spread globally by different mosquito. These diseases challenge the developed and developing countries of the world for irradiication.

Mosquitoes are very well recognized as vectors of protozoan, viruses and other pathogenic organisms, after the discoveries made by Sir Patrick Manson, Sir Ronald Ross and Sir Walter Reed. It is well known also that under the influence of environmental conditions a vector species may show changes in the seasonal distribution in the same area of dominance. The increase in density of a vector species is very much dependent on climatological factors favorable for its breeding, and adult survival.

1.2 Mosquito Ecology

The ecology and distribution of various mosquito species are important in the determination of mosquito vector abundance and associated diseases prevalence. Some aspects of human ecology greatly influence mosquito distribution, species relative abundance and their survival. All mosquitoes breed in water more often quiescent. There are mosquito species groups; subgenus and genus have their own preferred habitat based on locations and conditions of the water body.

Mosquitoes are distributed throughout the world and have occupied many niches including higher altitudes. Thirty four mosquito species of five different genera were recorded within the altitudinal range of 300 to 2000 m from Garhwal region (Pemola and
Effect of natural factors like temperature, humidity and rain fall also have impact on the mosquitoes. Climate has been established as an important determinant in the distribution of vectors and pathogens (Pemola and Jauhari, 2006).

The effects of land use change by humans have long been recognized as a factor in the exacerbation of mosquitoes and mosquito-borne diseases. These alterations can be placed onto several broad and overlapping categories including water retention systems, deforestation, agricultural development, canal irrigation and urbanization. In addition to these alterations human behavior associated with each of these landscape modifications may contribute significantly to vector and disease transmission (Douglas, 2004).

The major tropical vector-borne diseases are usually viewed as an environmental consequence of underdevelopment, occurring in communities (Brightmer and Fantato, 1998). Local mosquito distribution and flight range is dependent upon breeding habitat preference, availability of the host and resting preference. Biological invasions challenge our ability to understand the biotic and abiotic process that governs distribution and abundance (Steven et al., 2004). Different mosquito species exhibit particular type of rhythmic pattern of behaviour during their life cycle. Majority of the mosquito species rests during day time and their activities start little before the dusk and end little after the dawn. Majority of the Anopheles and Culex species are night time biters, whereas species of genus Aedes and Armigeres have been reported biting during day time also. Feeding host preference of mosquitoes varies from human to other mammals and birds.

Water is essential for mosquito breeding. The larval stage is aquatic and mosquito larval habitats are varied, which starts from tree holes to ponds and lakes. Overall mosquito larvae prefer still water. Some mosquito species are fresh water breeders whereas some mosquito species breeds in organic water (i.e. sewage). Mosquitoes have shown their greater ability of adaptation and sustenance. Rapid urbanization and development
have given more chances to mosquitoes for breeding. Disease outbreaks are naturally associated with water sources and water use, as mosquitoes are unavoidably linked to aquatic breeding sites for the immature stages. Human alteration of the environment continues to expanding mosquito breeding habits. These land use alterations may be unavoidable; however, a better understanding and recognition of the effects of habitat modification may lead to better land use strategies (Douglas, 2004). Water management deficiencies have resulted in man-made mosquitogenic conditions facilitating proliferation of the vectors. With the improvement in irrigation facilities, there has also been increase in mosquitogenic conditions.

1.3 Major vector borne diseases in India

1.3.1 Malaria

Malaria remains to be the most vital cause of morbidity and mortality in India and in many other tropical countries with complete 2 to 3 million new cases arising every year. Malaria is a major health problem in the world. Malaria is well-known oldest chronic and most widespread fatal disease that has plagued mankind for centuries, which also causes economical loss.

At present, malaria is the Third World’s most dreaded killer (Singh and Rahman, 2001). The direct costs of malaria include a combination of personal and public expenditures on both prevention and treatment of the disease and the indirect cost of malaria are the human sufferings caused by the disease. Migration of population and precipitation of drug resistance in addition to the ecological conditions, remoteness and inaccessibility are contributing to the problem of malaria (Joshi et al., 2005).

Ninty one countries and 40% of the world’s population are at risk of malaria (Matta et al., 2004). The world-wide malaria incidence is estimated to be 300-500 million clinical cases every year (Matta et al., 2004). India is one of the affected countries.
Millions of people die every year due to malaria. Most of the arid and semi-arid in western India fall in an unstable malaria zone in the country (Srivastava and Yadav, 2000).

In India 58 species of *Anopheles* have been reported (Das *et al*., 1990). Among these species only nine species viz. *An. stephensi*, *An. culicifacies*, *An. varuna*, *An. sundaicus*, *An. fluviatilis*, *An. annularis*, *An. philippinensis*, *An. minimus* and *An. dirus* have been known to transmit malaria. Of the nine established vectors of malaria, two species viz. *An. culicifacies* in rural and *An. stephensi* in urban area are well known vector of malaria in our country.

1.3.2 Filaria

In India filaria is one of the most important public health problems. It is a chronic disease and consequent social, physical and economical hazards are enormous. In India high microfilarial rates have been recorded in northern and coastal parts of Andhra Pradesh, Bihar, Tamil Nadu and Kerala and Coastal parts of Orissa and eastern parts of Uttar Pradesh. About 2.5 million people are exposed to the risk factors with about 2 million microfilariae carriers and 1.2 million disease cases occurs in India (Patel, 2002).

There are fifty nine species of mosquitoes vectors of the filaria. Among them most important vector is *Cx. quinquefasciatus*. This species belongs to *Cx. pipiens* complex, which includes *Cx. molestus*, *Cx. pipiens*, *Cx. quinquefasciatus*, *Cx. Australiens*, *Cx. pallens*, and *Cx. globocoxitus*. *Cx. quinquefasciatus* is widely distributed in tropical and subtropical latitude. It is recorded up to over 1800 m. above this altitude it is not found due to climatic conditions and lack of breeding places (Pemola and Jauhari, 2004). Increased mosquito nuisance in most urban areas is mainly because of *Cx. quinquefasciatus* (Batra *et al*., 1995).
This species is responsible for 90% of the total transmission of the disease. Other than *Cx. quinquefasciatus*, *Cx. molestus* and *Cx. pallens* are the filarial vectors. *An. gambiae*, *An. flavirostris* and *An. barbirostris* of genus *Anopheles* transmits filaria worm. *Mansonioides* like *M. annulifera*, *M. uniformis* and *M. Indiana* are important vectors of Burgian filariasis. These all species are distributed in different regions of the world and working as a disease causing agent.

**1.3.3 Dengue**

Dengue is one of the oldest mosquitos borne disease in India like Malaria. It is a virus borne disease. Dengue commonly occurs in urban, semi urban and rural areas. Occasionally it causes severe haemorrhagic manifestations, which may lead to the death of an individual. Also it causes economical loss and Affect the social functions (Viroj, 2006). About 50 million cases of dengue occur in India every year and 2.5 million people are under the risk of dengue viral infection. Continuing process of urbanization may cause dengue to become a more serious problem in the future, unless stricter environmental control measures are enforced. Environmental degradation has serious public health consequences, since vectors and pathogens rapidly adapt to exploit new ecological niches whenever they appear (Kwa, 2006).

The disease had only been identified and named in 1779. The most serious global pandemic began in Southeast Asia in the 1950s and by the mid-1970s; Dengue Fever was a leading cause of death in the region. Epidemic dengue has only become more frequent since the 1980s. By the late 1990s, dengue was second only to malaria among the most important mosquito-borne disease affecting humans. Significant outbreaks of dengue fever tend to occur every five or six years (www.dengue.in).
Ae. aegypti and Ae. albopictus are two well known vectors of dengue in India. Ae. aegypti is vector in the urban area and semi rural, which was originally introduced in India from Africa. The earliest reports of dengue fever epidemics date back to 1779-1780 in Asia, Africa and North America, indication a widespread tropical distribution of Ae. aegypti during past 200 years (Marianne and Jonathan, 2001). It is well adapted to urban environment because of domestic breeding habits and its total dependence on man for a blood meal. Ae. albopictus is a vector of dengue in semi urban and rural area.

1.3.4 Japanese encephalitis (JE)

Japanese encephalitis (JE), caused by a mosquito-borne virus was first recognised in India in 1955 and since then many major out-breaks from different parts of the country have been reported, predominantly in rural areas. Children are mainly affected, with morbidity rate estimated at 0.30 to 1.5 per 100,000 population. Case fatality rate has ranged from 10% to 60%, and up to 50% of those who recover may be left with neurological deficits. Reported incidence has generally been higher in males than in females, but subclinical infections have occurred equally in both sexes. A large number of subclinical infections occur each year during the transmission season. Diagnosis at the primary health centre (PHC) level is based on clinical symptoms only. Therefore, there is a need to develop simple tests for use at the peripheral level both for diagnosis and for epidemiological surveys (Chaudhuri et al., 1997).

Japanese encephalitis (JE) is prevalent in India since mid fifties. It was from Tamil Nadu that JE virus was isolated for the first time. It is essentially an animal virus and domestic pigs are its major reservoirs. Pigs in turn get the infection from birds, especially pond herons and egrets, through mosquitoes. Man is just an accidental link in the disease cycle and is not a source of infection for further transmission. Cases of JE
were recorded on large scale from Uttar Pradesh, Bihar and Assam. Extensive spread of
JE was reported in Karnataka and Andhra Pradesh.

Out of 27 proven and suspected vectors of JE, *Cx. tritaeniorhynchus* and *Cx. vishnui* are the most important vectors of JE in India. *Cx. epidesmus, An. Hyrcanus, An. subpictus, An. barbirostris* and *Mansonia annulifera* are also known as vectors of JE in India. JE virus also has been isolated from *Cx. Whitmorei, Cx. pseudovishnui, and Cx. Gelidus, Cx. bitaeniorhynchus, and Cx. fuscocephala*. Most of the region of Gujarat is free from JE but it is prevalent in north-eastern and southern part of India.

1.3.5 Chikungunya

Chikungunya is a relatively rare and benign form of viral fever caused by an alphavirus that is spread by mosquito bites from the infected *Aedes aegypti* mosquito. The name chikungunya, is given by Lumsden’s initial 1955 report, which is derived from the Makonde word ‘kungunyala’, meaning to dry-up or become contorted. Subsequently, Marion Robinson who first described the disease following an outbreak in 1952 on the Makonde plateau, between Tanganyika and Mozambique, glossed the Makonde termmorespecifically as“that which bends up”. Chikungunya is not considered to be fatal. However, in 2005 - 06, 200 deaths have been associated with chikungunya of Reunion Island and widespread outbreak in southern India. Clinically it is characterized by abruptonset of fever, chills, headache, joint pain, and swelling especially involving small joints. Various types of rashes develop usually after the subsidence of fever and in the convalescent phase (Ashok *et al*., 2007).

Prevalence of this mosquito is more in semi-urban and rural areas. Thus more number of cases was reported from rural areas. First case of Chikungunya was described in Tanzania, Africa in 1952. The first outbreak in India was in 1963 in Kolkata (Calcutta). Chikunguniya is generally not fatal. However, in 2005-06, 200 deaths were
associated with chikungunya with widespread outbreak in India, primarily in Tamil Nadu, Karnataka, Kerala, and Andhra Pradesh. After flood and heavy rains in Rajasthan, India in August 2006, thousands of cases were detected in Rajasthan, Bhilwara, Udaipur, and Chittorgarh districts and also in adjoining regions of Gujarat and Madhya Pradesh, and in the neighbouring country of Sri Lanka. In the southern Indian state of Kerala, 125 deaths were attributed to Chikungunya with the majority of the cases reported in the district of Alapuzha, primarily in Cherthala. A recent outbreak of the disease during June 2007 in Pathanamthitta, Kottayam and Alappuzha districts of South Kerala, India claimed more than 50 lives. Some reports suggest that more than one hundred thousand are suffering from symptoms of chikunguniya (www.wikipedia.org, www.medindia.net).

1.4 Enemies of mosquitoes

After development of Science and chemistry lots of insecticides and larvicides have been evolved with different chemical structures, compositions and applications. After development of applied chemistry so many simple and complex synthetic insecticides were developed. Insecticides and larvicides are formulated as dust, powder or liquid, which effects in different ways on different parts of insects. Insecticides and larvicides are important weapons developed by men to fight against adult and larval mosquitoes.

The stepping stone in the era of modern synthetic insecticides development was the discovery of DDT (Dichloro-diphenyl-trichlorethane). Paul miller in 1939 first discovered contact action of DDT against insects. Swiss Zeisler in 1872 synthesized DDT and formulated in to dust and utilized as insecticide. Initially DDT was effective but now mosquitoes are becoming resistant to it.

Presently insecticides belonging to different groups’ viz., organochlorine, organophosphate and synthetic pyrethroid are used for public health sprays in India.
Strategy for the change of insecticides has always been reactive. Successive changes in insecticide were made after the failure of the control by the ongoing insecticide intervention. A subsequent change in the insecticides has led to sequential selection pressure of insecticides resulting in multiple insecticide resistant mosquito vectors. Mosquitoes are becoming resistant to different insecticides which are used in the field to protect the crop. In spite of the sustained and prolonged use of chemical insecticides, vector borne diseases are not only still prevalent but also outbreaks into epidemics. Therefore, to minimize the dependency on chemical insecticides, efforts have been made for the search and development of alternative methods for the control of vector mosquitoes (Mittal, 2003). Insecticide resistance is expected to directly and profoundly affect the reemergence of vector borne diseases and where resistance has not contributed to disease emergence; it is expected to threaten disease control (William and Janet, 1998).

The development of botanical insecticides is also important in the terms of controlling chemical pollution and as new alternative. The active materials in pyrethrum flowers extracts have found potential in controlling insect population and it is widely used in controlling of mosquitoes. Other known organic compound of botanical origin, which have recorded potentiality are Pyrethrin, Allethrin, Nicotine, Anabasine, cyclethrin, Barthin, Dimethrin, Alkoloids, obtained from different parts of plants after different chemical processes.

1.5 Socioeconomic conditions

Ignorance and impoverished conditions of people contribute in creation of source and spread of malaria and other mosquito borne diseases and also hinder disease control strategies. The environment in and around homes is more critical to people’s health. Knowledge regarding mosquitoes and malaria and health consciousness may help in control of the diseases.
Socioeconomic conditions of a community have direct bearing on the problem of diseases. Public suffers from malaria as is not taken very seriously. General public is unaware of malaria related symptoms and so promptness in treatment is not realized. People are still confused over symptoms of malaria and its preventive measures. Major part of Saurashtra population is poor in disease assessment, attitudes towards healthy lifestyle and knowledge of malaria control strategy. Appropriate health education messages to public are important. In Saurashtra every year hundreds of the people suffer from mosquito borne diseases. Efforts are being put by government to control mosquito population and disease spreading. In addition to that government is also running awareness programmes through media, despite diseases are not under controlled.

It is apparent from the foregoing account that the geographical and ecological profile combined with socio-economic status of a region permits proliferation of a vector population and consequent health hazard issues. During the last seven decades, unplanned growth in the form of urbanization, excessive deforestation, insecticide and pesticide hazards, construction of dams, development of new agro-ecosystems, etc. have resulted in the insurgence and resurgence of various vectors and vector borne diseases. The development of resistance in various mosquito species warrants that this group of insects needs an extraordinary and immediate attention (Jagdish and Jagbir, 2003).

Quantitative and qualitative entomological information is required to assess the feasibility of any mosquito control programme. In chemical control measure, behaviour and physiology of malaria vectors is affected directly and its long term application may lead to changes in ecology of vectors. Environmental factors also influence the adaptations by change (adjustments) which are accompanied by biological and behavioural changes (Bhatt et al., 1991) Saurashtra is facing mosquito problem since last decade. Every year hundreds of people suffer from mosquito borne diseases. Malaria,
Dengue and most recent Chikun guniya are the disease found in Saurashtra, in which Malaria is more prevalent than any other disease. Disease spreading and vector population control have come up as biggest challenge to the local government body. Lots of efforts in terms of disease and vector control are being taken by local government body and private non government organizations.

1.6 AIMS

Despite of all above mentioned efforts mosquitoes are still sustaining and spreading diseases successfully. In villages, unhygienic living conditions, Open drainage system, lack of disposal system of sewage, solid wastes, water stagnation, waste water overflows in the open gutter which collects in streets, canal irrigation, chekdam, cattle sheds, farms nearby, increased buildings construction activities; all are serving as excellent breeding grounds for mosquitoes. During the rainy season more breeding grounds for mosquitoes are created. Almost every household, especially from the low-income and slum areas are found to be suffering from frequent bouts of mosquito borne diseases. These diseases have become an important public health problem. Hence, the fight against mosquito borne diseases has become one of the biggest tasks in the health care sector of the country and local region. There is a need for detailed local studies.

The basic aim of present study is to generate perfect baseline data about mosquitoes in Saurashtra. In past, no work has been done on the mosquitoes in Saurashtra rural area. Thus it is important to know the status of the rural mosquitoes. The present study was designed to fulfil following aims: Ultimate idea of the study is to suggest the management of mosquitoes in rural area.
1.7 OBJECTIVES

The main objectives of the study were to find out larval and adult population structure of different mosquito species and its bionomic found in Rajkot rural area. In order to fulfill the aim enumerated above, the following objectives are set for the:

1) Identification of mosquito species in the study area.
2) Generate baseline data about mosquito bionomic in the rural area.
3) Understand population dynamics, breeding biology, and distribution status of mosquito species.
4) Influence of natural and man made factors on mosquitoes population.
5) Awareness about mosquitoes, mosquito borne diseases and health consciousness.
6) Understand role of socio-economical, psychological, and awareness related aspects influencing mosquito ecology and related health hazards.

This type of study helps a lot in constructing new work strategy and target specific action plans to control mosquito borne diseases.