SEASONAL ABUNDANCE AND DISTRIBUTION OF MOSQUITOES

INTRODUCTION:

Entomological information needs to be upgraded to monitor the impact of rapidly changing ecological conditions such as deforestation, population movement and developmental activities on mosquito distribution and vector bionomics (Rahman et al., 1977). Seasonal abundance of mosquitoes may vary spatially. Sampling of mosquito population is an important task, which estimate the number of species presents in a target area. Patterns of seasonal abundance of certain mosquito species are correlated to proliferation of its breeding habitats during rainy season and its scarcity during dry season (White, 1974). Various populations have specific characteristic features which facilitate the formation of epidemiological characteristics of vector borne diseases (Kondrashin and Kalra, 1987). Rapidly changing environment brings about frequent changes in vector behavior, which affects the vector bionomics (Prakash et al, 1998).

Global warming is reshaping the ecology of many medically important arthropod vectors. Warmer temperatures have been shown to directly increase mosquito biting and pathogen transmission.

REVIEW OF LITERATURE:

Review of literature indicates that several workers (Senior White, 1937; Senior White *et al*., 1943; Foot and Cook, 1959; Nagpal *et al*., 1983; Das *et al*., 1984; Rao, 1984; Nagpal and Sharma, 1987; Nagpal and Sharma, 1995; Reuben *et al*., 1992; Rajavel *et al*., 2000; Sathe and Girhe, 2001a, 2001b, 2001c; Murty *et al*., 2002; Kanojia *et al*., 2003; Sharma *et al*., 2005; Joshi *et al*., 2005; Tilak *et al*., 2006; Pemola and Jauhari, 2006; Malarial Research Centre, 2006; Baruah *et al*., 2007; Jagtap and Sathe, 2008a; Jagtap and Sathe, 2008b; Jagtap and Sathe, 2008c; Sathe and Jagtap, 2009; Jagtap and Sathe, 2009; Sathe and Jagtap, 2010) etc attempted abundance of mosquitoes from India. The present work is precise attempt on the seasonal

abundance of mosquitoes and will add great relevance in solving cases of mosquito borne diseases in the region.

MATERIALS AND METHODS:

The survey of mosquitoes was made from Western Maharashtra (districts Pune, Satara, Kolhapur and Sangli) (Fig. 2) from 2005 to 2010. A large number of specimen were collected by visiting various places of Western Maharashtra namely, districts Pune (Baramati, Pune, Bhor, Saswad, Haveli, Junner), Satara (Medha, Wai, Mahabaleshwar, Satara, Patan, Mhaswad, Koregaon), Kolhapur (Ajra, Malkapur, Kagal, Kolhapur and Jaysingpur) and Sangli (Miraj, Vita, Tasgaon, Shirala and Jath) at 15 days interval.

The mosquito surveillance was carried out indoor as well as outdoor. Mosquito surveillance started in early in the morning from 6.15 am or in evening after 6.30 pm. Mosquitoes were collected by suction tube were transported in to test tubes for further identification. Larvae were collected with the help of ladle and dropper by one-man one-hour density. Larvae and pupae of mosquitoes from natural habitats from selected spots have also been collected and reared in the laboratory for their adult formation. The specimen collected during study period were identified by consulting Christopher (1933), Barraud (1934), Horsfall (1955), Rao (1984), Nagpal and Sharma (1994), Sathe and Girhe (2002) and Sathe and Tingare (2010) Distribution records of the specimens have been made by visiting, collecting and identifying the species from study spots of Western Maharashtra.

RESULTS:

Results are recorded in table 1 to 3.

The observations on seasonal abundance of mosquito species belonging to genera *Anopheles, Culex* and *Aedes* indicates that out of 31 species 10 species were rare and 21 species were common in the Western Maharashtra.

Table - 1: Check list of Mosquitoes from Southern Maharashtra

Sr. No.	Mosquito species	Abundance	Citations
FAMILY - CULICIDAE **SUB FAMILY - ANOPHELINAE** **GENUS - *ANOPHELES***			
1.	*Anopheles culcifascies* Giles	Common	1901b. *Ent. Mon. Mag.* **37** : 196-198.
2.	*Anopheles stephensi* Liston	Common	1901. *Indian Med. Gat.* **36** : 361-366.
3.	***Anopheles annularis*** Vander Wulp.	Common	1884. *Notes Leyden Mus*. **6** : 248-256.
4.	*Anopheles subpictus* Grassi	Common	1899. *Indian Entomologist* **34** : 192-197.
5.	*Anopheles turkhudi* Liston	Rare	1901. *Indian Med. Gat.* **36** : 441-443.
6.	*Anopheles compestris* Reid.	Common	1962. *Notes Leyden Mus*. **6** : 248-256.
7.	*Anopheles culiciformis* Cogill	Common	1903. *J. Bombay nat. Hist. Soc.* **15** : 327-336, 1 pl.
8	*Anopheles jeyporeiensis* James,	Rare	1902**.** *Sci. Mem. Med. Sanit. Dept. India (N.S.)* No.2, 106 pp.
9.	*Anopheles karwari* James	Rare	*1902. Sci. Mem. Med. Sanit. Dept. India (N.S.)* No.2, 106 pp.
10	*Anopheles maculatus* Theobald,	Rare	1901.*A mon. of Culicidae or Mosq, 1:171-174.*
11	*Anopheles vagus* Doenitz.	Rare	*1902. Zeit. Fur Hyg. Und Infek., 41: 15-88.*
12	*Anopheles mahabaleshwari sp. nov*.	Common	
13	*Anopheles waii sp. nov.*	Common	
14	*Anopheles karveeri sp. nov.*	Common	

15	*Anopheles krishnai sp. nov.*	Common	
16	*Anopheles kolhapuri sp. nov.*	Common	

SUB FAMILY - CULICINAE **GENUS - *CULEX***			
17.	*Culex epidesmus* Theobald	Rare	1910a. *Royal Society* 12 pp. *British Museum (Nat. His.).*
18	*Culex tritaeniorhynchus* Giles	Common	1901a. *J. Bombay Soc.* **13** : 592-610, pls. A & B.
19	*Culex vishnui* Theobald	Common	1910. *Rec. Indian Mus.* **4** : 1-33, 3 pls.
20	*Culex quinquefaciatus* Say	Common	1823. *J. Acad. Nat. Sci.* Philad **3** : 9-54.
21	*Culex fuscocephala* Theobald	Rare	1907. M. C. iv. P. 420.
22	*Culex malhari sp. nov.*	Common	
23	*Culex malkapuri sp. nov.*	Common	
24	*Culex satarensis sp.nov*	Common	
25	*Culex mirjensis sp.nov*	Common	
SUB FAMILY - CULICINAE GENUS – A*RMIGERS*			
26	*Armiger (Armiger) subalbatus* Coquillett.	Common	1898. *Rec. Indian Mus.* **4** : 1-33, 3 pls.

SUB FAMILY - CULICINAE **GENUS - *AEDES***			
27	*Aedes aegypti* Linnaeus	Common	1762. Zweyter Theil, ent. Besc. varschiedener wichtiger *Naturalien* pp. 267-606.
28	*Aedes albopictus* Skuse	Common	1894. *Indian Mus. Notes.* **3**, No. 5, p. 20.
29	*Aedes vittatus* Bigot	Rare	1861. *Ann. Soc. ent. Fr.* (4) **1** : 227-229.
30	*Aedes (Mucidus) sathei sp. nov.*	Rare	
31	*Aedes (Finalaya) rajashri. sp.nov.*	Rare	

Among the total 3362 mosquito species collected the highest contribution was from *Anopheles* (45.33%) followed by *Culex* (35.01%), *Armiger* (10.71%), and *Aedes* (8.95%) The remaining 26 species were contributes 41.7%. Five vector species among the 16 *Anopheles* species (55%), three vector species (93.02 %) among the 5 *Aedes* species and four vector species (52.7 %) among the 9 *Culex* species were found in Western Maharashtra. The total 12 vector species were contributed 51.93% population. Results indicate that the vector species were prominent and this abundance was alarming sign for the mosquito borne diseases in Western Maharashtra (Table 3).

The seasonal prevalence of mosquitoes in Western Maharashtra reveals that the densities of *An. stephensi* were maximum during the pre monsoon period (Feb – May) (Table 2). The density of *An. subpictus, An. annularis, Culex vishnui, Culex triataniorhynicus, Culex biteaniorhynchus* were prominent during the post monsoon period (Oct-Jan). The density of *An. culicifacies, An. fluviatilis, Aedes albopictus, Aedes aegypti, Aedes vittatus, Culex quinquifasciatus* and singular *Armiger subalbatus* were found abundant in monsoon period (Jun – Sept).

Among newly described species *Anopheles kolhapuri, Anopheles compestris, Anopheles karveeri, Anopheles krishnai, Aedes rajashri, Culex malkapuri, Culex satatarensis* and *Culex mirjensis* were found abundant in monsoon period. *Anopheles mahabaleshwari, Anopheles waii, Aedes sathei* and *Culex malhari* were found abundant in post monsoon period.

DISCUSSION:

Mosquitoes respond to local temperature increase in various ways. Within limits higher temperature means more rapid development of larval populations and shorter time between the blood meals, quicker incubation time for pathogen infection and shorter life span of adults although the latter is dependent on the humidity (Roussel, 1998). The temperature of breeding places plays an important role in the persistence and growth of larvae. Rate of development of larvae accelerates in the warm water and slows down in the cold water (Ramchandra

Rao, 1984). Many species such as *An. culicifacies, An. subpictus, An. vagus* breed and survive both in open water such as burrow pits or river bed pools and also in some shady places while *An. fluviatilis* and *An minimus* prefer to breed in shady places such as under overhanging trees and bushesh or from thick growth of grass. Species breed in deep wells such as *An. stephensi* and *An. varuna* remains in shade most of the day. In fact, *An. stephensi* grows well in cistern or covered wells, which never get any direct sunlight (Ramchandra Rao, 1984).

Vector control requires through knowledge on the ecology of the local species with respect to breeding and resting habitats and behavior. Therefore, periodic survey of vector populations in a given area is most essential for better understanding of the changing ecology, bionomics of mosquitoes and thereby possible disease outbreak can be predicted, and an effective vector control could be initiated. Keeping in view all above facts the present work was carried out. The rate of mosquito born diseases again depends on the index of species of the region. The rapid separation and identification of mosquitoes of primary medical importance is an important task in the assessment of disease potential area.

Senior White (1937) reported twenty three anophelines species in 1935-36 on Jaypore Hills in which *Anopheles fluviatilis*, *An. varuna* had the highest peak in the month of Sept. and Feb. These species were most prevalent in the spring and in the rains. *An. jeyporiensis* and *An. culicifacies* were found resting mostly in cattle shade. Senior White *et al.* (1943) again reported eighteen anophelines species in Orissa during the year 1935- 1941. *Anopheles annularis* and *An. aconitus* were most prevalent species observed in November-March.

According Foot and Cook (1959) mosquitoes have thirty two regions in the world. In India and SriLanka *Anopheles culicifacies* is a most important and wide spread vector of malaria. This species was also most important vector in Srilanka. In the foot hill areas of peninsular India, *Anopheles fluviatilis* was dominant vector species for causing malaria. Foot and Cook (1959) also visualized *Anopheles varuna* from East-central India. *Anopheles stephensi* from Northern West-coast and Gangas plain and *Anopheles sundaicus* from Kolkata, while, from Orissa they documented

Anopheles annularis. *Culex annulifera was* the chief vector of filarial in the lower parts of the Gangas River basin, Bihar and Orissa on the North-east coast and Travancore state and *Aedes aegypti* was common throughout India (Foot and Cook, 1959). They stated that, *Aedes albopictus* was not so closer to man and less universally distributed in India.

Seasonal abundance of 11 species of *Anopheles* mosquitoes have been reported by Sen *et al*., (1960) from Dhanbad area from 1953 to 1958. *Anopheles culicifacies* was most abundant during monsoon from July to September and also in the month of February. *Anopheles subpictus* was the most predominant species and was found throughout the year with definite seasonal abundance during June to September. *A. annularis* was found during winter. *Anopheles pallidus* was found throughout the year but the peak densities were during winter (November).

Nagpal and Sharma (1983) reported seasonal abundance of twenty four species belonging to five genera of mosquitoes in the South, middle and North Andaman Island during a study tour in January-February 1982. In sixteen species of *Anopheles* the most prevalent species was *Anopheles vagus* followed by *Anopheles kochi* and *Anopheles sunduicus* and most dominated during monsoon. Among Culicines species the most dominant genera was *Culex* and most prevalent species was *Culex quinaquefasciatus* followed by *Culex tritaeniorhynchus* and *Culex vishnui* and dominant during the summer and fall in the winter. The genus *Aedes, Armigers* and *Mansonia* reported extremely low in the study area.

Similarly *Anopheles vagus* and *Anopheles subpictus* exhibited a peak during the months of monsoon rains, while *An. culicifacies* a rural vector showed two peaks of abundance, one during the monsoon and other in February (Kaul et al, 1982). Nagpal (1983) also studied seasonal abundance of twenty nine mosquitoes from Nainital Terai (U.P.) belonging to 8 genera viz. *Anopheles* (18), *Aedeomyia* (1), *Aedes* (2), *Armigers* (1), *Coquillettidea* (1), *Culex* (4), *Mansonia* (1) and *Mimomyia* (1) during 1980-82. Survey revealed that *Anopheles subpictus* dominant species during Sept. 1980 and Sept-Oct. 1981, then followed by *Anopheles culicifacies* and *Anopheles fluviatilis.* However, during May-June 1981 survey *Anopheles culicifacies* was most

prevalent species followed by *Anopheles subpictus* and *An. annularis*. During the Jan. – Feb. 1982 survey, *Anopheles fluviatilis* was most prevalent species followed by *Anopheles splendidus* and *Anopheles culicifacies*. *Culex quinquefaciatus* was the most prevalent species among the Culicinae collections in all four surveys followed by *Culex titaeniorhynchus* and *Culex vishnui*. The seasonal abundance of *Anopheles culicifacies* and *Anopheles fluviatilis* were distributed throughout the Ferial belt, while *Anopheles culicifacies* exhibited two seasonal peaks i.e. in May-June and Sept. – Oct.

Das *et al*. (1984) studied seasonal abundance of forty two species belonging to a genera viz., *Anopheles, Culex, Aedes, Mansonia, Armigeres* and *Coquillettidia* of mosquitoes from various places of Meghalaya during April-May 1980. Out of which *Anopheles vagus, Anopheles annularis, Anopheles barbirostris, Anopheles philippinensis, Culex tritaeniorhynchus, Culex vishnui, Culex bitaeniorhynchus, Culex gelidus* were most prevalent species throughout year and *Mansonia indiana*, *Mansonia uniformis* and *Aedes albopictus* were extremely rare.

Fifty one species of *Anopheles* and their locality, taxonomy, seasonal abundance, distribution, adult bionomics, larval ecology and diseases have been attempted by Rao, (1984). Nagpal and Sharma (1987) documented seasonal abundance of sixty one species from Assam, Meghalaya, Arunachal Pradesh and Mizoram during Sept. 1986. These sixty one species belongs to eight genera viz. *Anopheles, Aedes, Armigeres, Coquiletidia, Culex, Malaya, Mansonia* and *Toxorhynchites*. The most dominant genus was *Anopheles* then by *Culex, Aedes* and *Mansonia*. The most prevalent species in the genus *Anopheles* was *Anopheles vagus* followed by *Anopheles nigerrimum* and *Anopheles nivipes*. In the genus *Culex* the most prevalent species was *Culex quinquefaciatus* followed by *Culex tritaeniorhynchus* and *Culex vishnui*. *Aedes albopictus* was the most dominant species in the genus *Aedes* and it was followed by *Aedes chryolineatus* and *Aedes aegypti*. In the genus *Mansonia* the most common species was *Mansonia annulifera* followed by *Mansonia uniformis* and *Mansonia indiana*. The other four genera viz. *Armigeres, Coquillettidia, Malaya* and *Toxorhynchites* were rare in the region.

Proliferation of mosquitoes is determined by the availability of suitable and sufficient habitat for the larval stages, resting and feeding sources nearby. In urban areas like Delhi the *Aedes aegypti* populations increased with the onset of monsoon rainfall in June – July (Reuben et al, 1973). Prolific breeding could be seen in manmade habitats including air coolers. Ruben *et al*. (1992) visualized ten species of *Culex* mosquitoes in Madurai, Southern India. *Culex tritaenirhynchus, Culex pseudovishnui* and *Culex vishnui* were feed dominantly on cattle, but less frequently on humans and on pigs and birds. These three species were occurring predominantly throughout year where the cattle were reared, but *Culex tritaeniorhynchus* and *Culex vishnui* showed a marked in the population during the hot season. *An. culicifacies* was recorded in high numbers from April to September while *An. fluviatilis* only during October to March in Uttaranchal (Shukla et al., 2007).

From Maharashtra recently, Sathe and Girhe (2001) reported four species of *Anopheles* namely, *Anopheles culcifacies, Anopheles stephensi, Anopheles theobaldi* and *Anopheles subpictus*. The most prevalent species of *Anopheles* in Kolhapur region was *Anopheles culcifacies* while, *Anopheles subpictus* was rare in the Kolhapur region.

Sathe and Girhe (2002) reported fifteen species of mosquitoes from Kolhapur district belonging to genera *Anopheles* (4) *Culex* (3) and *Aedes* (7). Out of which *A. culcifacies, C. pipiens* and *A. aegypti* were predominant throughout the year. While, *A. indica* S. & G. the largest mosquito species found was extremely rare. Other eleven species were moderately distributed in Kolhapur.

Girhe and Sathe (2001) studied incidence of malaria during the year 1992-1996, was increasing in order. Maximum, 700 infection cases were reported during the year, 1996 due to prevalence of *Anopheles* mosquitoes. Later, incidence of malaria declined from the years 1997-2000 from Kolhapur region.

Recent work of Sathe and Girhe (2001, 2002) refers to the following species of genus *Aedes* namely, *Aedes aegypti, Aedes kolhapurensis, Aedes indica, Aedes indicus, Aedes sangiti, Aedes panchgangi* and *Aedes uniformis* from Maharashtra. The

work of Sathe and Girhe (2002) reported the first record of largest species *Aedes indica* from the world. *Aedes aegypti, Aedes indicus, Aedes uniformis* are well known to science from Southern Maharashtra. Four species of *Culex* namely *Culex epidesmus, Culex pipiens, Culex modestus, Culex malayi* previously have been reported from Maharashtra (Sathe and Girhe, 2002).

Murty *et al*. (2002a) studied the seasonal prevalence of *Culex quinquefasciatus* in the rural and urban areas of the East and West Godavari districts of Andhra Pradesh, India during 1999. These species occur dominantly throughout year in rural and urban areas. Murty *et al*. (2002b) reported a seasonal abundance of *Culex vishnui* sub group and *Anopheles* species in an endemic district of Andhra Pradesh during 1999. *Culex vishnui* subgroup was dominant throughout the year. Their density was high in January-December 1999. Kanojia *et al*. (2003) reported seasonal abundance of mosquito in Gorakhpur district, Uttar Pradesh during 1990 to 1996. The seasonal fluctuations in the mosquito population recorded. High prevalence of *Culex quinquefasciatus* was observed in March, *Culex tritaeniorhynchus* predominant species was noticed in September. The other species such as *Culex pseudovishnui, Culex whitmorei, Culex gelidus* and *Mansonia uniformis* had also shown peak occurrence in September. Seasonal prevalence of *Anopheles* species *Anopheles subpictus* and *Anopheles peditaeniatus* showed high prevalence during July and September.

Sharma *et al*. (2005) studied seasonal prevalence of *Aedes aegypti* in Delhi during 2003. *Aedes aegypti* was abundant in month of August and September. The rise in breeding indices during the post monsoon season may be attributed to increases in artificially collected breeding containers due to rains. Joshi *et al*. (2005) give seasonal prevalence of Anopheline mosquito in irrigated and non-irrigated area of Thar, Rajasthan during August 2001 to July 2002. They reported Anopheline species, *Anopheles subpictus, Anopheles culicifacies* and *Anopheles stephensi*. During monsoon *Anopheles subpictus* and *Anopheles stephensi* were dominant species but was peak in August to October. While *Anopheles subpictus, Anopheles stephensi, Anopheles culicifacies* and *Anopheles annularis* reported in winter

season in irrigated area and *Anopheles culcifacies* and *Anopheles annularis* were predominant in summer during April to July.

Tilak *et al*. (2006) studied the seasonal prevalence of mosquito in Pune during 2001 to 2003. They reported seventeen species of five genera *Anopheles, Culex, Aedes, Armigeres* and *Mansonia*. The dominated genera were *Culex* followed by *Anopheles, Aedes Armiger* and *Mansonia*. The seasonal abundance of mosquito in Pune reveals that the densities of *Anopheles stephensi, Anopheles varuna* and *Anopheles vagus* were maximum during summer (March – May). The density of *Anopheles annularis* and *Anopheles stephensi* were high in rainy season (June-Sept.) and winter season (Nov. – Feb.). The Culicines *Culex quinquefaciatus* was found in higher densities in all the three season with abundance in rainy season. Whereas the abundance of the other Culicines i.e. *Culex cornutus, Culex gelidus, Culex sitiens* and *Culex univittatus* were higher in summer season. *Aedes aegypti* was found in all the three season with high prevalence in rainy season. *Armigeres* and *Mansonia* species were extremely rare and reported in winter season.

Pemola and Jauhari (2006) reported ten *Anopheles* and *Culicine* mosquitoes in the Doon valley Dehradun, Uttaranchal during 1999-2002. The seasonal prevalence of Anopheline species i.e. *Anopheles culicifacies, Anopheles fluviatillis* and *Anopheles stephensi* were dominant in monsoon (June-Sept.) and post-monsoon (Nov.-Dec.). The seasonal prevalence of Culicine species *Culex mimeticus, Culex vishnui, Culex quinquefasciatus* and *Aedes albopictus* were dominant in between May to November and December to February. Malarial Research Centre (MRC) (2006) reported seasonal prevalence and Bionomics of *Anopheles culicifacies, Anopheles fluviatilis, Anopheles minimus, Anopheles sundaicus* and *Anopheles stephensi* in Delhi, Kheda (Gujarat), Bhaber (Uttar Pradesh) and Rourela (Orissa) during 1989-1991. In Delhi seasonal prevalence were studied in a riverine zone of the river Yamuna and in a non riverine belt. *Anopheles culicifacies* was most dominant species in the riverine zone observed in April and in October. The non riverine area, the peak abundance was observed in May and August. *Anopheles culicifacies* was dominant in the Northern part of the reservoir zone where water pollution was at minimum

level. In Khed district (Gujarat) *Anopheles culicifacies* was found throughout the year in varying proportions. In the canal-irrigated area, its density starts to build up from February and reach high in March. In the non canal-irrigated areas, the abundance of *Anopheles culicifacies* remains low throughout the year. In Bhabar area of Uttaranchal in north India, *Anopheles culicifacies* abundance remains low during January to June and October to December. It increases during monsoon reaching a high in August.

Baruah *et al*., (2007) reported seasonality of malaria in Lama Camp, Hoograjuli, Behali and Pabhoi area in Sonitpur district, Assam during 2002 to 2003. The study period was grouped into four seasons such as pre monsoon (March to May), Monsoon (June to August), post Monsoon (September to November) and winter season (December to February). They reported seven species of genus *Anopheles* i.e. *Anopheles annularis, Anopheles culicifacies, Anopheles dirus, Anopheles fluviatilis, Anopheles minimus, Anopheles philippinensis* and *Anopheles varuna*. The *Anopheles philippinesis* dominated in all the four study area followed by *Anopheles annularis, Anopheles minimum, Anopheles culicifacies, Anopheles fluviatilis, Anopheles dirus* and *Anopheles varuna*. Density of *Anopheles philippinensis, Anopheles annularis, Anopheles minimus, Anopheles culicifacies* and *Anopheles dirus* increasing during the pre-monsoon period, peak in monsoon and declined during the post-monsoon

From Southern Maharashtra, Tingare and Sathe (2007) reported *Aedes khanapuri* sp.nov., *Aedes rhadhanagari* sp.nov., *Aedes tasgaonensis* sp.nov. and *Aedes mangalvedhi* sp.nov. are newly described for the first time from India. From the genus *Anopheles,* six new species have been described first time i.e. *Anopheles atpadi* sp.nov, *Anopheles akuluji* sp.nov, *Anopheles sagareshware* sp.nov, *Anopheles karmalae* sp.nov, *Anopheles ajrae* sp.nov. and *Anopheles mirajensis* sp.nov. Seven species from genus *Culex* are newly described and reported from for the first time from Southern Maharashtra, which includes *Culex solapurensis* sp.nov., *Culex krishnai* sp.nov., *Culex chandrabhagi* sp. nov., *Culex rankali* sp.nov., *Culex mahalaxmi* sp.nov., *Culex kalambae* sp.nov. and *Culex sangolensis* sp.nov.

Recently, Jagtap and Sathe (2008a) studied three decades trend of malaria situation of Sangli district during the period 1971-2005. the maximum amplification of the disease was observed in drought prone area i.e. Jath, Kavathemahankal and Atpadi.This is correlated with rainfall. In early epidemic phase *Plasmodium vivax* was dominant but recently the increasing more than 30% trends of Plasmodium falciparum were observed. Jagtap and Sathe (2008b) documented the role of intensified mass surveillance campaign in malaria problematic section in Sangli district. Jagtap and Sathe (2008c) study the Chloroquine resistance to Plasmodium *falciparum* species in Etapalli block district Gadchiroli.

Very recently, Sathe and Jagtap (2009) studied the tree hole breeding and resting of mosquitoes in Western Ghats. Total 106 tree holes were examined 32 tree holes were found positives for adults and six were found for larvae. Jagtap and Sathe (2009) studied the incidence of dengue and shifting trend to rural in Kolhapur district. More recently, Sathe and Jagtap (2010) studied the abundance of Anopheles mosquitoes from Western Ghats and found responsible for malarial incidence in the region.