Discussion
DISCUSSION

In the past 50 years, the world has experienced unprecedented population growth that continues unabated in the waning years of the 20th century. It is projected that by the year 2025, the global population will be 8.3 billion people and by 2050, 10 billion people (Plant, 1996). Most of the recent population increase has occurred in urban areas of developing countries, which has resulted in uncontrolled and unplanned urbanisation, especially in the tropics (World Resources Institute, 1996). Moreover, it is estimated that by the year 2000, 39% of the global population will live in urban areas and will increase to 56% by the year 2025 (Knudsen and Sloof, 1992).

Coincident with these demographic changes there has been societal changes that have had a marked influence on the movement of commerce and people. While these changes reflect economic progress and have increased the standard of living in some respects, they have also had some disastrous effects on public health, especially in tropical developing countries of the world (Gubler, 1998).

Mosquito borne diseases have caused havoc both among the urban and rural populations of India. The last century has witnessed the adverse effects of these mosquito-borne diseases, particularly malaria. Outbreaks of Japanese encephalitis, dengue, filaria and dengue haemorrhagic fever have also been witnessed quite frequently in the last few decades. The resultant morbidity and mortality have impeded the development and active economic progress of the nation.
Vector control has been the thrust area for disease control. The effective management of vectors by using appropriate methods requires adequate information about the bionomics of mosquitoes. 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 favourable for its breeding and adult survival.

Knowledge of the breeding, resting and biting habits and longevity of a vector species is, therefore, essential for organising anti-vector measures and the evaluation of the impact of such measures. It is essential to carryout such observations before initiating anti-vector measures. As the above mentioned aspects differ with the variations in environmental conditions it is easily understood why entomological studies are necessary for all representative situations and that the results cannot be extrapolated from one area to another or from one season to another, unless the environmental conditions are exactly the same (WHO, 1975).

Mosquitoes are the most successful groups in the animal kingdom that have occupied an ecological niche near human dwellings. The selection of larval habitat is made by the female adult mosquito and the preference for one type or types of breeding habitat or another is more or less genetically fixed by natural selection.
In urban areas, among human dwellings, wells and intra-domestic sources act as habitats for breeding of mosquitoes. The breeding pattern may vary based on the type of containers selected and microclimate of that habitat. The present study helps us to understand the breeding pattern of the vectors with reference to *Anopheles stephensi*, *Culex quinquefasciatus* and *Aedes aegypti* in different habitats, which occur commonly among human dwellings.

**DOMESTIC WELLS**

Wells are perennial sources for mosquito breeding. If remained unused and undisturbed, these wells tend to be regularly exploited for the sake of oviposition by mosquitoes. Marked variations in the conditions are observed in wells. The breeding of mosquitoes vary accordingly. Rainfall plays an important role in influencing the oviposition of mosquitoes in wells.

Perennial breeding in wells has been reported by Sabesan *et al.* (1986). In the studies conducted on *An. culicifacies*, they have reported the breeding to be high during the rainy and post rainy seasons without much fluctuations in immature densities in wells. Higher well positivity during the monsoon and post monsoon season have also been reported by Rajnikant *et al.* (1993).

The breeding of *Cx. tritaeniorhynchus* in wells has been reported by Reuben (1971) in North Arcot district, Tamil Nadu. She has also reported
the breeding of *Cx. vishnui* and *Cx. pseudovishnui* in wells. The breeding of *Cx. pseudovishnui* and *Cx. tritaeniorhynchus* has also been reported in agricultural wells in the rural areas of the desert district, Bikaner, Rajasthan (Vinod Joshi and Bansal, 1991). An in-depth understanding on the species-specific habitat preference and interspecific associations are essential for optimising species sanitation (Bhatt *et al.*, 1990).

Vasanthi (1996) reported the breeding of *An. stephensi* in wells, in urban areas, periurban and also in semiurban areas. The breeding of *An. stephensi* in natural water collections like rivers, bed pools, rain water collections, pits near leaking water pipe lines, seepage water collections and other water collections near houses were reported by Sharma (1989) in the periurban areas of Delhi. Yadav *et al.* (1989) have also reported the breeding of *An. stephensi* in bed pools, puddles and hoof prints in the Kheda district of Gujarat. The breeding of *An. stephensi* var *mysorensis* in river bed pools, borrow pits, excavation in brick kilns and wells in the periurban areas near Chennai was reported by Vasanthi (1996).

The present study on immature density in domestic wells during the months of July - December 2000, reveals the breeding of vector species continuously without any incompleteness in breeding. The immature density of *Cx. quinquefasciatus* shows a sudden increase in population, while in *An. stephensi* and *Ae. aegypti* the density shows a slow increase. The peak immature density was recorded in the month of September and October, while Robert *et al.* (1998) reported the maximum anopheline abundance in the month of June and maximum Culicine abundance in September.
The present study reveals that, in domestic wells, *Cx. quinquefasciatus* is the predominant breeder followed by *An. stephensi* and *Ae. aegypti*. This was in accordance with the work of Chandrahhas and Sharma (1987), Sharma (1994) and Abdullah and Merdan (1995). Some other work shows *An. stephensi* as predominant breeder in wells (Tyagi *et al.*, 1996; Kaliwal, 1991; Mariappan *et al.*, 1992). The perennial breeding of *Cx. quinquefasciatus* and *Ae. aegypti* in wells was also reported (Bansal *et al.*, 1994; Mariappan *et al.*, 1996; Gionar *et al.*, 1999; Souza, 1999).

The regression analysis on the total immature density with abiotic factors revealed positive correlation with temperature. The t-values shows that there is a significant impact of temperature over the immature density. The t-values also show their significant dominance of one species over the other in this breeding habitat.

**INTRA DOMESTIC SOURCES**

Sources that contribute to mosquito population close to human dwellings are named as intra domestic sources. Gupta *et al.* (1992) reported the breeding of *An. stephensi*, *Cx. quinquefasciatus* and *Ae. aegypti* in intra domestic sources of Gujarat, India. *Ae. aegypti* was reported to breed in household water containers (Wu and Wang, 1985; Marten *et al.*, 1994; Igbinosa, 1989; Schweigmann *et al.*, 1997; Macoris *et al.*, 1997; Marquetti *et al.*, 1996). In the present study some common mosquito breeding sources were selected. They are cisterns, cement tanks both indoor and outdoor and construction sites (curing pits and barrels). Yadav *et al.* (1989) reported the breeding of *An. stephensi* in intradomestic sources in Gujarat.
CISTERNs

The cisterns are small cement tanks, which are commonly used in houses of urban and suburban areas to store water for a long period. This may be used to store both potable and non-potable water. The longitudinal study for a period of one year showed the breeding of An. stephensi, Cx. quinquefasciatus and Ae. aegypti. In the present observation, An. stephensi was found to be the dominant breeder in cisterns followed by Cx. quinquefasciatus and Ae. aegypti. The preference of mosquitoes to breed in outdoor water bodies was reported by Biswas et al. (1992). The preference of An. stephensi to breed in shaded condition has been reported by Rao (1984). This behaviour could have encouraged An. stephensi to breed in cisterns. Chandrahas (1990) reported the dominance of Cx. quinquefasciatus breeding in cisterns followed by An. stephensi and Ae. aegypti. Souza (1999) reported that cisterns are the preferred breeding habitats for Ae. aegypti.

Intense An. stephensi breeding occurred from June to September. Peak density was recorded during the month of September. Sangita et al. (1998) studied An. stephensi breeding in cisterns and showed similar results with intense breeding from June to October. Russell and Rao (1941) reported the breeding of An. stephensi in the month of April and May. Chowdhury (1936) observed the prevalence of An. stephensi breeding in cisterns.
The results of statistical analysis showed a positive correlation with temperature and humidity, indicating the breeding of *An. stephensi* to be influenced by temperature and humidity. The study conducted by Ravindran (2000) showed similar result with regard to breeding of *An. stephensi*, *Cx. quinquefasciatus* and *Ae. aegypti*. He reported a decline in anopheline density in the months of November and December, similar to the present observations. The t-values also show their exhibit significant dominance of one species over the other in this breeding habitat.

The seasonal exploitation of each cistern was determined by analysing the frequency of oviposition days during different months. Maximum number of oviposition days was observed in *An. stephensi*, followed by *Cx. quinquefasciatus* and *Ae. aegypti*. The maximum number of oviposition days was observed during the months of June and September. Madder *et al.*, (1983) studied the daily fluctuations in oviposition behaviour by *Cx. pipens* and *Cx. restuans*. They observed the reduction in oviposition days during heavy rains.

**OUTDOOR AND INDOOR CEMENT TANKS**

These tanks are large in size, which are used to store more amount of water. Unfortunately, these tanks act as breeding sources for mosquitoes. Mosquitoes prefer to breed in these tanks because these tanks are normally seen in and around the houses. The water may be potable or non-potable.
Observations on the mosquito breeding in these tanks revealed the breeding of *An. stephensi*, *Cx. quinquefasciatus* and *Ae. aegypti*. In both the indoor and outdoor cement tanks, *An. stephensi* was reported to be dominant followed by *Cx. quinquefasciatus* and *Ae. aegypti*. Water in these tanks is clear but not clean. The breeding of *An. stephensi* in cement tanks was reported by Mariappan *et al.* (1992). Sharma (1994) reported *Cx. quinquefasciatus* to be dominant breeder in cement tanks. Vu *et al.* (1998) and Mahadev *et al.* (1993a) reported the breeding of *Ae. aegypti* in these tanks.

*Cx. quinquefasciatus* was observed to breed more in outdoor than in indoor cement tanks while *Ae. aegypti* was observed to breed more in indoor than in outdoor cement tanks. Hwang and Chao (1991) and Seng and Jute (1994) reported a similar result. However, larvae of *Ae. aegypti* were predominant in indoor containers with clear water (Lee, 1991). Brown *et al.* (1992) collected around 65% and 75% of *Ae. aegypti* and *Cx. quinquefasciatus* respectively from the surface of the water tanks.

*An. stephensi* and *Cx. quinquefasciatus* prefer to breed well in outdoor than in indoor cement tanks, while *Ae. aegypti* breeds well in indoor tanks. Shriram and Sehgal (1999) reported the preference ratio of mosquitoes to breed in mud/brick/cement tanks/containers than metal and plastic containers both in outdoor and indoor tanks.

The total immature density was highest during June-September and lowest during February-May in both indoor and outdoor cement tanks, which corroborates with the report by Ray and Tandon (1999).
The t-values reveal the dominance of one species over the other in this breeding habitat. The impact of temperature over the mosquito immature density showed a positive correlation.

CONSTRUCTION SITES

Due to rapid urbanisation and industrialisation, more and more new buildings are under construction. These construction sites act as a breeding source for mosquitoes. The contractors are forced to store water for a long period for their work due to scarcity of water. A site produces several habitats during construction process. Curing pits and plastic barrels of 200 litres capacity were selected for the study.

The immature density in curing pits shows high breeding during July-September. *Cx. quinquefasciatus* was the predominant breeder followed by *Ae. aegypti* and *An. stephensi*. This was similar to the reports given by Mahesh *et al.* (1995). Kaliwal (1991) reported that, *Ae. aegypti* prefers to breed in water inside building under construction. The breeding of *Ae. aegypti* was observed throughout the study period. *Cx. quinquefasciatus* larvae were significantly more common in high water volume sites compared to low water volume sites (Becker, 1995).

The dominance of one species over the other in this breeding habitat has been proved statistically. The impact of temperature over the mosquito immature density showed a positive correlation.
Plastic barrels or drums are also used to store water during construction. The observation on the immature densities revealed the dominance of *Cx. quinquefasciatus* followed by *An. stephensi* and *Ae. aegypti*. This was similar to the report by Sharma (1994) based on his study in Faridabad complex, Haryana, India. *Ae. aegypti* was reported to breed in drums made of metal (Bhattacharyya *et al*., 1996; Souza, 1999; Ogata *et al*., 1996; Fernandez *et al*., 1998) and plastic (Teng *et al*., 1996; Kay *et al*., 1995). Samarawickrema *et al*. (1993) reported the perennial breeding of *Ae. aegypti* in drums. The breeding of *Cx. quinquefasciatus* in artificial plastic water containers was reported by Forattini *et al*. (1998).

The dominance exhibited by one species over the other in this breeding habitat has been proved statistically. There was positive correlation between the temperature and mosquito immature density.

**VECTOR CONTROL**

Mosquitoes, the ancient scourge of mankind, continue to be a serious nuisance and public health problem. Public health care is a vital component essential for the development of disease-free healthy society. Inspite of the advances in science and the innovations in technology, eradication of these debilitating diseases has not been possible. Mosquitoborne diseases stand foremost among the major public health problems.
The common tropical viral infections like yellow fever, dengue fever and Japanese encephalitis, helminth infections like filariasis and protozoan diseases like malaria are carried and transmitted by mosquitoes, thereby causing severe health problems (WHO, 1982). In mosquito borne diseases, vector control is an essential component of disease eradication programme at threshold level so that the transmission of the disease is interrupted.

Many pesticides have been used for the management of mosquito populations. Most of them are undesirable as far as environment is concerned, because of the development of insect resistance and also threat to ecological balance due to their toxicity to non target organisms (Sharma and Srivastava, 1998).

Temephos and Fenthion are two Organophosphorus synthetic larvicides that are being used commonly in mosquito control programmes in Chennai City. The Chennai Corporation recorded many reports on development of resistance by mosquito larvae. Hence there is a need for an alternate ecofriendly larvicide to control these mosquitoes. Development of resistance to Organophosphorus compounds by mosquito larvae was also reported by many investigators (Shim et al., 1995; Rao et al., 1996; Wirth and Georghiou, 1999).

Populations of Cx. pipiens were sampled from 8 locations in Cyprus between 1987 and 1993. All population samples generally revealed Organo phosphate resistance to malathion, temephos, chlorpyrifos,
fenthion, dichlorvos and pirimiphos-methyl, in decreasing order of magnitude. (Wirth and Georghiou, 1996).

Using baseline data from two Townsville populations (1955 and 1989), *Ae. aegypti* larval bioassays detected significant increases in susceptibility to synthetic pyrethroids (cyfluthrin, beta-cyfluthrin, lambda-cyhalothrin and permethrin) and malathion and significant reduction in susceptibility to most organophosphates (chlorpyrifos, fenitrothion, fenthion and propoxur) were reported by Canyon and Hii, 1999.

The LC$_{90}$ values of all Organophosphorus, except for temephos (LC$_{90}$ = 0.0096 ppm), were high, ranging from 0.13 ppm (fenthion) to 2.882 ppm (chlorpyrifos-methyl). Pyrethroid LC$_{90}$ values were 0.021 ppm (bifenthrin), 0.00061 (cypermethrin) and 0.017 ppm (permethrin). In general, the toxicity ranking of chemicals and microbials tested was phenyl pyrazole > IGRs > pyrethroids > microbials > OPs (Ali et al., 1999).

The Organophosphorous compounds were also reported to act on non-target organisms stressing the need for an ecofriendly larvicide in mosquito control operations. The Zoospore yield of mosquito-pathogenic fungus *Lagenidium* was significantly reduced by the presence of 0.25 ppm of fenthion or temephos. (Balaraman and Hoti, 1986)

Natural products are preferred because of their biodegradability. In view of this, the study of plant extracts with antiviral activity has
attracted considerable interest (Saxena et al., 1993). Botanical derivatives in mosquito control, especially for mosquito larvae, as an alternative to synthetic insecticides offers a more eco-friendly method of insect control (Irungu and Mwangi, 1995).

Plants exhibit different degrees of toxicity to the different stages and conditions of mosquitoes such as larvicidal, pupicidal, adulticidal, growth and reproduction inhibition, repellent and ovipositional deterrents. Various plant species have been exploited to control the mosquito populations throughout the world (Zebitz, 1984, 1986; Tare and Sharma, 1991; Sharma and Goel, 1994; Pushpalatha and Muthukrishnan, 1995; Muthukrishnan et al., 1997; Mwangi and Mukilame, 1998; Jantan et al., 1999).

The present study aiming at evaluating the effect of the synthetic larvicide Temephos, Fenthion and a neem formulation, NeemAzal against Anopheles stephenst, Culex quinquefasciatus and Aedes aegypti, the common vector mosquitoes of Chennai City, has brought to light that Neem formulation was found to be an effective larvicide against mosquito larvae, and these findings agree with the work of earlier investigators. Nimbidin obtained from the fruits of the neem tree (Azadirachta indica) has proved to be active constituent of many drugs and is a powerful antiseptic and germicide (Mitra, 1979). Attri and Prasad (1980) used neem oil for mosquito control.
Sensitivity towards NeemAzal 40% decreased with increasing age of the larvae. In female *Ae. aegypti* a tendency was observed to lay fewer eggs with increasing NeemAzal concentration to which they had been exposed during larval development (Boschitz and Grunewald, 1994).

In the present study, bioassay tests were conducted to evaluate the toxic effect of neem formulation (NeemAzal) and the Organophosphorus compounds (Temephos and Fenthion) on the larvae of *Anopheles stephensi*, *Culex quinquefasciatus* and *Aedes aegypti* under standard laboratory conditions.

The larval mortality under the stress of neem formulation in the present investigation might be due to direct toxicity, antifeedent property or insect growth regulator. The above results are favourably comparable to the studies of other investigators (Patterson *et al.*, 1971; Joshi *et al.*, 1978).

The median lethal concentration (LC$_{50}$) values for III instar larvae against both the larvicides were less when compared to LC$_{50}$ values of IV instar and pupae. This shows that the III instar larvae are more susceptible to the larvicides. Susceptibility of III instar than IV instar and pupae to the neem formulation might be due to the increased metabolic activity of the younger developmental stages. Purohit *et al.*, (1983) have reported that the earlier instars are highly susceptible.
In the present study Azadirachtin rich fraction from *Azadirachta indica* has been observed to possess antifeedent, repellant, growth inhibiting and ovicidal activities against insect pests. Its properties and potentialities have been highlighted and discussed by Schmutterer (1990).

The pupal mortality in this study may not be due to antifeedent and growth regulatory property of neem formulation as it blocks moulting of pupae to adult. Many pupal-adult intermediates were observed during the study when pupae were exposed to neem and this was absent in pupae exposed to Fenthion.

There might be multiple mechanism of action operating on larval mosquitoes when exposed to Azadirachtin-A rich NeemAzal. Statistically significant reports show that the toxicant is viable and effective larvicide against, larvae of *Culex quinquefasciatus*.

Relatively low levels of resistance or cross-resistance to other Organophosphate and Carbamate insecticides (fenthion, malathion, chlorpyrifos, parathion and propoxur), and a high level of resistance to the pyrethroid (permethrin) were also observed. Mendelian crosses indicated that temephos resistance was inherited as a monofactorial trait (Wirth and Georghiou, 1999).

From this study it is suggested that the use of plant extract like neem formulation (Azadirachtin-A) against mosquito in vector control management as an alternative or along with synthetic insecticide will
minimize the use of synthetic insecticides, to maintain a better environment for the posterity.

Millions of people in developing countries suffer from devastating diseases transmitted by mosquitoes. The loss in terms of human lives is irrevocable. Unabated population growth, ever-growing destruction of ecosystems, rapid development in transport facilities and improper management of vector control operations have led to the re-emergence and perpetuation of the diseases. New and appropriate vector control strategies are essential for effective disease control. It is our duty to devise sound, ecologically safe and environmentally friendly methods for controlling vector mosquitoes.

HEALTH EDUCATION

Strengthening of research should be a continuous process with proper motivation and direction. Delay in adoption of new and successful strategies should be avoided to ensure diseasefree, healthy society. We should educate our masses and also actively involve the community in vector control programmes.

In general, the strategy of spraying of insecticides to interrupt vectorborne disease transmission has become less effective as it resulted in vector resistance, environmental pollution, harmful effects on the beneficial fauna, recurring high cost of insecticides and operational problems (Sharma, 1987).
Bioenvironmental control of mosquito-borne diseases is a community based approach and, therefore, effective involvement of community is the key to the success of vector control programme. Community participation received impetus through health education. The health education has high effect to provoke the community in participating in vector control programmes (Lee and Hishamudin, 1990; Chandrahas et al., 1993). Community participation through health education and use of appropriate vector control programme will help us to control mosquito and mosquito borne diseases. Several workers reported that, the health education through informal means have contributed to control these vectors in many areas (Sharma and Sharma, 1986; Tiwari et al., 1993; Singh et al., 1993; Chandrahas et al., 1993). The breeding sources of these vectors vary from place to place based on the climate and behaviour/cultural practices of human beings in that area.

The mosquito borne diseases affect common man, not only the poor but also the rich. The community creates breeding sources for mosquitoes without their knowledge. In order to bring out awareness and to motivate the community, health education must be imparted through health camps and group meetings in the experimental villages (Tiwari et al., 1993).

In fact, community participation without some perceived benefits may not be sustainable for a long-term basis. Moreover, in order to attain
sustained community participation emphasis should be laid on health education and socio-economic betterment.

To implement a long-term strategy, sustained effort is required. The strategy should be directed towards changing behavioural and cultural practices. The strategy to motivate people to participate in vector control could be successful only through constant supervision, persuasion and stimulation (Singh et al., 1993).

Health education forms the basis of community participation and both are essential for creating awareness and generating scientific understanding (Sharma and Sharma, 1986). Health education and Community participation also substantially contribute to the control of mosquito breeding in intra-domestic sources (Sharma et al., 1993). Community participation and intersectoral cooperation is an important and essential component of the environmental control strategy.

The awareness study among college students in Chennai City revealed a poor level among the student community about mosquito and mosquitoborne diseases. The lack of awareness among college students shows that there is need for health education in the college curriculum, as health is important for every individual. Present analysis revealed that most of the students were not aware that filariasis, dengue and dengue haemorrhagic fever are caused by mosquito bites. If the awareness among students is so poor, then the awareness among the common man would be worse.
By organising awareness programmes to public and making their conscience better, we can control vector and vectorborne diseases (Selvapary, 2000). Mass media coverage about these diseases will help us to make them familiar. But a sustainable knowledge can be achieved only through regular and continuous education about health. This will help the people to keep themselves away from mosquito and mosquitoborne diseases and to change their behavioural practices, which lead to mosquito breeding.

The Government agencies spend a huge amount of money to control mosquito and mosquitoborne diseases. The control of mosquitoes involves the reduction of sources and application of insecticides. A lack in any one of this will contribute to increase in mosquito density.

Reduction of mosquito breeding sources is impossible without the involvement of common public, as they are the producers of these sources. Only by educating them about the reduction of these sources will help us to control mosquito and mosquitoborne diseases. Making concerted efforts to disseminate information about mosquito and mosquitoborne diseases and to create awareness continuously among public are the only ways to control mosquitoes.

Prevention and control of mosquitoborne diseases currently depends on the control of the vectors in and around the home, where most transmission occurs. Space sprays with insecticides to kill adult
mosquitoes are not usually effective (Newton and Reiter, 1992; Reiter and Gubler, 1997). The most effective way to control the vector mosquitoes is larval source reduction (Gubler, 1989).

For successful control, emphasis has been placed on community-based, integrated approaches to larval source reduction to provide programme sustainability (Gubler, 1989). The rationale is that the people who live in the house where transmission occurs, and who help create the mosquito larval habitats can only accomplish sustainable vector control by their life-styles. Community participation and community ownership of prevention programmes require health education and community outreach. Unfortunately, this approach is a very slow process, and it will take years for effective disease control to be achieved through community participation alone.

Suffice it to say that Public health departments and community should work in partnership to achieve effective disease prevention. Only with these changes we will be able to reverse the trend of emergent epidemics of mosquito-borne diseases in the 21st century.
Summary

Study on vector biology and ecology is necessary for effective management of vectors. The vectors of Chennai City include An. stephensi, Cx. quinquefasciatus and Ae. aegypti which cause malaria, filaria and dengue respectively. The study on breeding biology of mosquitoes in wells and intra-domestic sources reveals the following.

Domestic Wells

- Among the vectors, Cx. quinquefasciatus was the predominant breeder, followed with An. stephensi and Ae. aegypti.
- The peak immature density was recorded in the month of September and December.
- The correlation values were positive for total immature with temperature showing significant impact over immature density of mosquitoes.

Intradomestic Sources

- In cisterns, An. stephensi was the predominant breeder followed by Cx. quinquefasciatus and Ae. aegypti.
- Intense breeding was recorded from June to September. Maximum number of oviposition days of An. stephensi was observed during the months of July to August.
The t-values between the immature density were significant and the correlation values show that the temperature has an impact over mosquito immature density.

In outdoor and indoor cement tanks, breeding of *An. stephensi* was dominant followed by *Cx. quinquefasciatus* and *Ae. aegypti*.

*Cx. quinquefasciatus* was observed to breed in large numbers in outdoors than in indoor cement tanks. *Ae. aegypti* prefers to breed in clean water indoor than in outdoor cement tanks.

The total immature density was high during June-September, while it was low during February – May in both indoor and outdoor cement tanks.

The t-values between the immature density were significant and the correlation values shows that the temperature has a role over mosquito immature density.

In curing pits, *Cx. quinquefasciatus* breeds in abundance followed by *Ae. aegypti* and *An. stephensi*. The immature density was high during July – September.

In plastic barrels (drums), *Cx. quinquefasciatus* breeds in abundance followed by *An. stephensi* and *Ae. aegypti*.

The t-values between the immature density were significant and the correlation values show that the temperature has an impact over mosquito immature density.
VECTOR CONTROL

- Susceptibility of *An. stephensi*, *Cx. quinquefasciatus* and *Ae. aegypti* to larvicides like Temephos, Fenthion and NeemAzal was noted using bioassay or static acute toxicity test.
- III instar larvae are more susceptible to larvicides than IV instar larvae and pupae, when exposed to various concentrations of larvicides. Delay in moulting period was also observed.
- The Chi$^2$ value of the fitted regression was found to be in good fit. This shows that the Temephos, Fenthion and NeemAzal were effective in controlling mosquitoes at laboratory conditions. Need for an eco-friendly larvicide alternate to chemical synthetic larvicides was stressed.

HEALTH EDUCATION

- The need for health education in colleges was stressed, as there was poor level of awareness among students about mosquito and mosquito borne diseases. The need for health education to enhance community participation to control vector mosquitoes is stressed.
- Health education is necessary to create awareness among the community. Creating awareness among the people with regard to mosquito borne diseases and their control should be a sustained process and hence, the need for formal health education in schools and colleges is stressed.