General Conclusion
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Mosquitoes are one of the largest groups of insect vectors in terms of public health importance in the world as they are capable of transmitting many diseases. In India 40 million people suffer from mosquito borne diseases annually. Here, 2800 people were killed by malaria alone in 1996. Recently, virulent strains of the dengue virus emerged and killed more than 500 people in Delhi, the capital city. Filariasis struck more than 50,000 and Japanese encephalitis killed about 1,300 people in the past two years (Halarnkar and Menon, 1997). In this regard, unplanned urban areas, infrastructure development and agricultural progress have contributed much by creating mosquitogenic conditions.

Japanese encephalitis (JE) has been one of the important arboviral diseases in India. Cx. vishnui and Cx. fuscocephala are two important vectors of this disease. In Karnataka state JE epidemics have occurred in Kolar, Mandya, Bangalore, Tumkur and Bellary districts. The JE problem is mainly due to rice fields and irrigation systems where the main vectors breed. The greatest risk of creating mosquitogenic conditions are in the minor distribution canals and these areas are often neglected (Das and Rajagopalan, 1989). The basic reasoning behind the epidemiological studies of any disease is to give guidelines to the planner about the importance of the disease in an area and to monitor and evaluate changes in the endemicity due to control programmes. Environmental management measures depend on a thorough understanding of vector ecology and population dynamics. In order to undertake an integrated control campaign a thorough knowledge of the ecology, insecticide...
susceptibility, genetics and behaviour of the vector species is essential. So it has become necessary to make detailed studies on vectors of local importance at different places. As a part of investigations in this regard in Mysore and Mandya districts of Karnataka state, the author has taken up the present project on two JE vectors. Important aspects such as insecticide susceptibility/resistance, isozyme profiles, physico-chemical factors of breeding sources, immature density, oviposition rhythm, pupation rate and sex ratio were probed.

Periodic monitoring of susceptibility status of locally important vectors to insecticides has become an essential component of integrated vector control programmes. This is furthermore important in view of the recurrence of diseases transmitted by them and the increasing problem of resistance to insecticides. Widespread development of resistance to insecticides in mosquitoes is one of the factors which had hampered vector control programmes. There is large scale use of organochlorine and organophosphate insecticides in agriculture and public health sectors even today, especially in the developing countries. So the susceptibility status of Cx. vishnui and Cx. fuscocephala from two different ecological situations were assayed by the author. The results showed the impact of agricultural insecticides on the mosquitoes breeding in rice fields. So appropriate measures are needed to undertake judicial application of insecticides in the agricultural field as well.

Polyacrylamide gel electrophoresis has been a good biochemical tool to detect the genetic differences existing among populations or subspecies or species. It gives valuable information on the extent of allozyme
polymorphism in a given population so that it is easy to detect genetic variation existing within and between populations of a species or a complex or a group. Genetic studies on the medically important insect vectors are of great importance by virtue of their changing behaviour and increasing resistance to many insecticides. Various investigators have worked on mosquito systematics employing electrophoretic techniques (Bullini and Coluzzi, 1973; Wagner and Selander, 1974; Kitzmiller, 1976; Steiner and Joslyn, 1979). In the present investigation on isozymes the Mandya populations of *Cx.vishnui* and *Cx.fuscocephala* have shown significant difference with regard to esterase-A & B. This is in line with the results of bioassay and resistance studies. As these enzymes have the property of detoxification, it may be presumed that the rice field populations in the irrigated sector are divergent in terms of their genetic makeup. Thus mounting insecticide selection pressure is evident in both bioassay results and isozyme profiles. Further, emergence of *Cx. vishnui* as a tolerant species is of much concern, as it is a prolific breeder in the rice fields. Its elevated tolerance against synthetic pyrethroids compared to *Cx. fuscocephala* should be considered seriously as synthetic pyrethorids are now employed in both public health and agriculture in Karnataka state. Thus continuous application of these insecticides in the field may not be advisable in the interest of public health. By properly planning and managing water resource development projects it may be possible to control major vectors of JE.

The purpose of larval sampling is to monitor the population dynamics and to give a feedback to control operations. It also provides valuable data on species composition, seasonal abundance, replacement
and their relationship with various physical, chemical and biotic factors. Physico-chemical parameters do exert considerable impact on mosquito survival, emergence and control. Analysis of various factors such as phosphate, nitrate, total alkalinity, hardness and dissolved oxygen, carried out by the author, have been estimated earlier only in very few places in India to correlate mosquito breeding (Shegal and Pillai, 1970; Sinha, 1976; Rajagopalan et al., 1976; Sarkar et al., 1978; Mosha and Subra, 1983; Ningegowda, 1993; Vijayan and Revanna, 1997). Survey of larval density is very important to know the major vectors involved in the epidemic outbreak. In the present investigation prolific breeding could be correlated with monsoon rains and irrigation facilities. The author has observed two peaks of Cx. vishnui breeding in a year; one during March-April due to irrigation water and the other in September, in Mandya district. As of Cx. fuscocephala, breeding was more in August and September with the peak in September in both Mysore and Mandya. In Mandya district, the irrigational facility has caused an additional peak of JE incidence during summer. Physico-chemical factors existing in the breeding sites of Cx. vishnui and Cx. fuscocephala are more or less the same. Further studies may throw more light on the ecology of these potential JE vectors. The present investigation indicates the existence of correlation between larval density and a few physico-chemical factors analysed. The studies on the preferred habitats of Cx. vishnui and Cx. fuscocephala have thrown light on variable range of these factors in their habitats. Further, the survey has clearly shown that, the irrigation facility and agricultural development in Mandya district have created vast areas of Cx. vishnui breeding along with other species, which resulted in the JE out-breaks in addition to the
development of insecticide tolerance by the vectors. Such investigations would help to understand the local ecology of the species and thereby the epidemiology of the disease could be understood better. The sex-ratio difference noticed is not significant in both the species.

The overall results indicate the immediate need for monitoring the irrigated rice fields to prevent further problems. Farmers could be properly educated against the improper and indiscriminate application of insecticides. Rotation of insecticides may be practiced. Application of synthetic pyrethroids should be done cautiously, as these are the effective chemicals available now. Planning and designing for good water management structures may avoid problems of mosquito vectors, so that the development of insecticide resistance will no longer be a concern.