# A REVIEW OF URBAN MALARIA CONTROL SITUATION AND RELATED ENVIRONMENTAL ISSUES IN TAMIL NADU, INDIA

*B. HYMA, A. RAMESH, K.P. CHAKRAPANI*

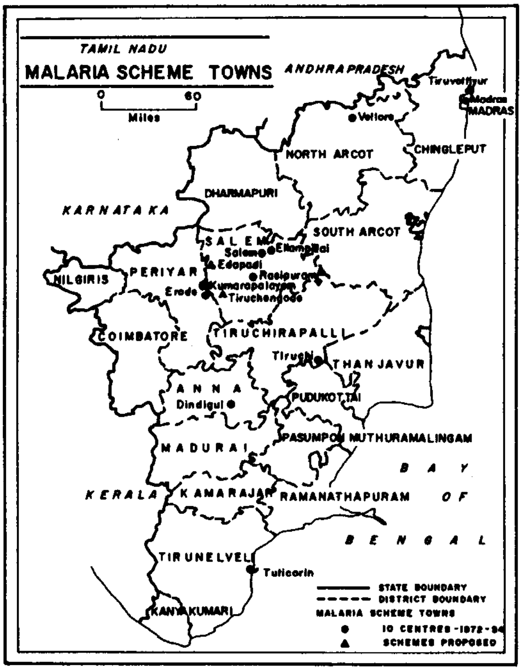
## INTRODUCTION

According to a recent World Health Organization (WHO) report, malaria has become endemic in many urban places in India. This is especially so «where vector control services (i.e., source reduction and larviciding, supported by legislative provisions) have been inadequate or unsatisfactorily executed» (1, p. 52). WHO also noted that in India, A. stephensi is a major urban malaria vector in many cities and presents a formidable problem and may spread to adjoining peri-urban areas through movements of the vector or migrant populations (1, p. 51). Yet many urban areas have remained relatively free from indigenous malaria transmission, because either parasites or vectors are absent.

In response to the problem of urban malaria transmitted by vector A. stephensi, the Government of India introduced urban malaria control schemes in 1971-72 in selected towns. In the state of Tamil Nadu, ten towns were selected. During 1972-73, five centrally sponsored schemes were begun: Madras (1972), Tuticorin (1972), Rasipuram (1972), Salem (1972) and Ellampillai (1975) (Fig. 1, p. 1). At present, ten urban malaria schemes are functioning in the state. The following towns were added to the initial five (2, p. 2) : Vellore (1977, Erode (1978), Dindigul (1979), Tiruchirapali (198O) and Kumarapalayam (1981). In addition to the ten urban areas where control schemes are functioning, the state has recently identified three other urban places where schemes are to be introduced in view of the increasing trend in malaria incidence and vast vector breeding potential in these three towns (2, p. 4) : Tiruchengodu, Edapadi and Tirurottiyur (Fig. 1). No comprehensive information or publications are available on the status of these schemes in operation, their successes and constraints.

This study examines urban malaria/vector control schemes in the ten seriously affected

**Figure 1**




urban areas in the state of Tamil Nadu for the period 1974 to 1984 and some of the factors contributing to malaria resurgence of the 197Os in the state. The main source of information is from Malaria Division of the Joint Director of Public Health and Preventive Medicine in Madras City. In all towns there is a separate malaria unit attached to either the corporation or municipalities which maintains records of malaria cases registered on a monthly basis. In addition to this, the annual reports of the malaria unit proved to be a useful source of information. Field observations and dialogues with chief epidemiologists and joint director of the Malaria Unit were valuable. Even though malaria is a notifiable disease private doctors and clinics rarely report any cases to the corporation or municipalities. The figures are based only on laboratory confirmed cases reported by the state/corporation and municipal malaria services. They may represent a considerable underestimate of the actual situation for the following reasons (3, p. 12) :

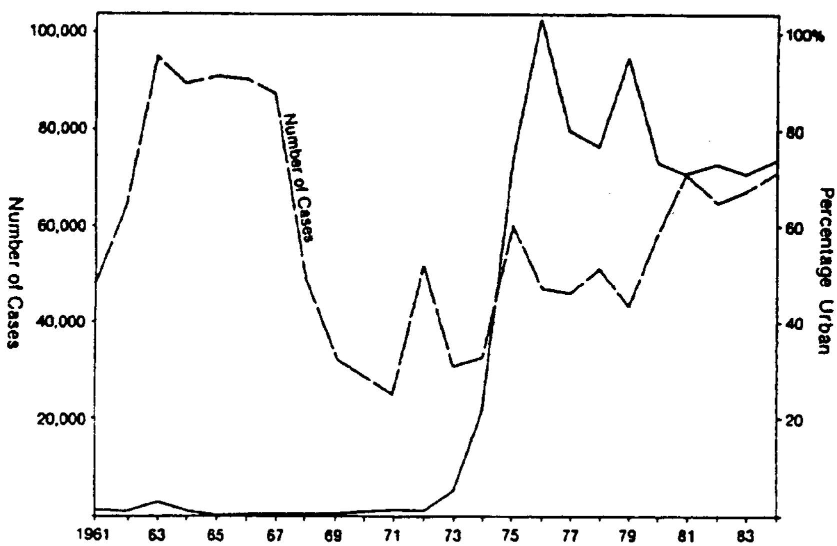
1) There is considerable variation in the accuracy of the reporting, coverage of the reporting system, and the efficiency of laboratory services.

2) In view of the change from malaria eradication to malaria control strategy, the search for cases has been drastically curtailed, since large scale case detection is not usually carried out in malaria control programmes.

## URBAN MALARIA TRENDS IN TAMIL NADU

Tamil Nadu was known to be endemic for malaria for a long time. However, malaria incidence in the state is confined mostly to certain geographical areas in the administrative districts and a few urban places (2). Even though malaria has been considered predominantly a rural disease, nearly 70% (1981) in Tamil Nadu lives in 16.660 villages panchayats the trend of urban malaria has been on the increase since 1973 (Fig. 2).

**Figure 2 - Percentage of recorded malaria cases in urban areas of Tamil Nadu to total cases recorded in the state 1961-1964**




The National Malaria Control Programme (NMCP) was introduced in Tamil Nadu in 1953-54. Encouraged by its results where DDT was successfully used as a major vector control measure, the Government of India launched on a National Malaria Eradication Programme (NMEP) in 1958 on a nationwide scale. Under NMEP, special malaria units were established in Tamil Nadu (4, p. 157). By 1965 a significant malaria control was achieved in Tamil Nadu (5, p. 6).

Roy et al. reviewed the urban malaria situation in Tamil Nadu for the period 1961-72 (6, pp. 313 - 315). A subsequent review of trends from 1973 to 1984 is presented by present writers. Due to inadequate malarie control measures in urban areas during NMCP (1953) and NMEP (1958) the problem of urban malaria began to gradually increase in Tamil Nadu since 196O. Roy et al. (6) noted that :

In 196O nearly 5O.O percent of cases recorded were from the urban areas and by 1963 it had risen up to 95.O percent. Between 1964-67 the urban areas accounted for more than 8O.O percent of the malaria cases recorded in the State. From 1967 onwards, there was a decrease in the proportion of urban cases as there was an improvement in control measures in these areas, and it remained below or around 5O.O percent from 1968 onwards except in 197O (88.7 percent). During 1971, the urban cases amounted to only 25.O percent of the total cases. But in 1972, as additional areas became involved, there was a rise to 51.1 percent.

The number of malaria cases in urban areas has shown a significant upward trend again from a total of 1634 registered cases in 1973 to 48.842 in 1976. A slight decrease in cases occurred during 1977 and 1978 perhaps due to a Modified Plan of Control Operations introduced by the Government of India and improvement in control measures. A rising trend is noticed again from 41.316 in 1979 reaching 51.839 by 1984. Urban areas with the persistent malaria problem were found noticeable in only a few towns (1O seriously affected) with Madras City dominating the picture (Fig. 3). In 1974, Madras City accounted for less than 12% of the total cases in the state and from 1981 to 1984 it represented over three-fifths of the total cases (2, p. 2). In addition, an estimated 5OOO to 6OOO cases were exported annually from the city to other parts of the state. Roy et al. noted that (6, p. 313) :

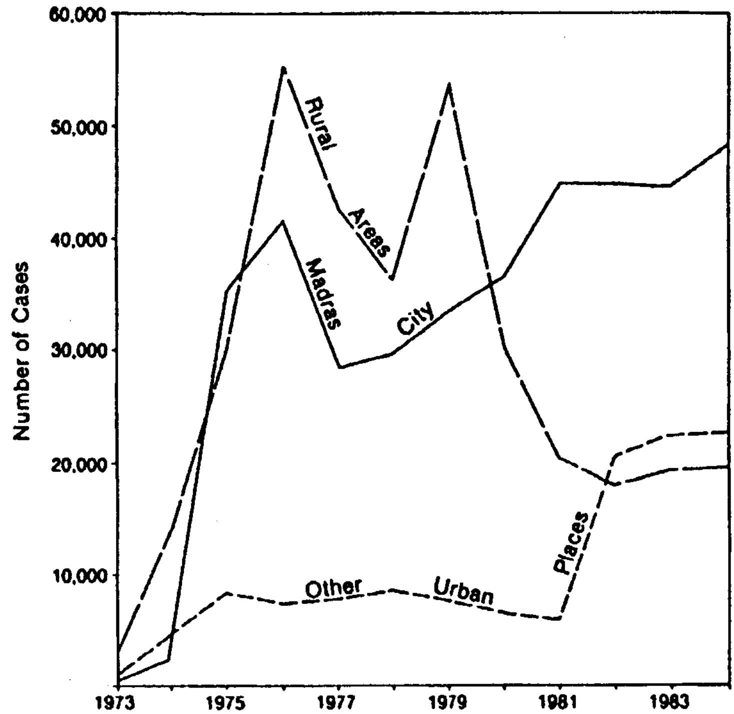
In the initial planning of the National Malaria Eradication Programme, malaria control in the urban areas with population of over 4O.OOO was expected to be implemented by the local bodies. The failure of this local implementation has resulted in persistance of the malaria problem. In recent years the problem of urban malaria has assumed greater importance due to movements of malaria cases from infected urban to healthy rural areas before adequate drug treatment. It is estimated that 25.O percent of the detected urban malaria cases are exported to rural areas before drug treatment can be completed.

For example, in Madras, it is common for drivers and cleaners of trucks to sleep in open places or on trucks without proper protection in certain high risk areas. They get bitten by infectious mosquitoes and carry the infection with them to other parts of the state (7, p. 328).

## ENVIRONMENTAL CONCERNS AND BREEDING OF VECTOR SPECIES (ANOPHELINE MOSQUITOES)

The persistence of urban malaria problem in seriously affected towns is often explained from the point of view of environmental features offering favorable breeding grounds for Anopheline and Culicine mosquitoes. A. stephensi is found to be the major vector,

**Figure 3 - Incidence of malaria cases in Tamil Nadu : Madras City, other urban places, rural areas 1973-1984**




breeding all the year around giving rise to typical urban localized malaria. The typical breeding grounds and sources giving rise to high risk and high incidence areas identified in the towns are : overhead (water storage) tanks, cisterns, domestic and public wells (in use and in disuse), public storm water drains, water collections found along railway tracks and construction sites, low-lying marshy and poorly drained areas, slums and low income tenement buildings, areas around lakes, unsewered areas, neglected house drains in garden areas, storage utensils and receptacles near the houses and numerous cattle yeards. Overall it can be said that inadequate water management or faulty drainage and unsatisfactory disposal of water had given rise to increasing mosquito nuisance in the towns (7, p. 325).

Wells and overhead tanks are the major source of water supply in towns. Many of them are not properly covered. A. stephensi is found in the crevices of the walls where lower temperatures and high humidity conditions prevail. Selected entomological survey data show the intensity of A. stephensi breeding in different parts of urban places (2).

Common mosquito breeding sources are applicable to all towns investigated. In addition to this, some of these towns face specific environmental concerns related to mosquito breeding. A few examples are given below :

## Madras City

Many neglected uncovered domestic wells, hard to reach overhead tanks in densely populated low-income old residential neighbourhoods, cess pools, kutcha drains, storm water drains, cisterns, many scattered low lying waterlogged areas, slum areas, water stagnation along the beds and edges of a canal and twosmall rivers and the river mouths blocked by sand bars, weeds and moss found along the edges of the river favor the breeding of the anopheles, especially after the rains (7). Other typical larval breeding grounds in Madras City are : where hypergonia (water plants) grows, growth of green algae in stagnant river waters, number of pits with stagnant water near certain slum areas. Other mosquito breeding sources are located in many inaccessible and unsecured structures such as private storages, warehouses, commercial firms and multi-storey residences with closely spaced residential houses and along the se coast in northern Madras where a number of boat repairing yards contain many unused and condemned boats which act as artificial water containers during rainy season. Salem, Erode and Rasipuram.

These towns are famous for handloom industries and it is the main occupation for the people in these towns. For washing and dyeing of the finished and unfinished handloom (textiles), the weavers use large water containers and all these are uncovered and become breeding sources for mosquitoes. Lakes nearby form another breeding source. Considerable movement of populations between these towns result in persistence of malaria cases. Tiruvannamalai.

Kutcha drains pose problems in this town. Madurai.

A large number of pit holes dug by building contractors, adjacent to the Vaigai river are filled with water and thus creating innumerable breeding sources. Karur.

Located along the riverbank of Amaravathi, Karur exhibits another peculiar problem. The river gradient near the town is very low and there is a large growth of long vegetal cover along both the sides of the river course. The combination of these factors reduce the velocity of the river. Stagnation of waste occurs. Breeding of mosquitoes occur in the stagnant wastes. Rameswaram.

The ground water table is very high. To supply water for the growing coconut saplings, people dig multitude of small pits 3O to 6O cms deep. Theses uncovered pits, provide favorable breeding sources for mosquitoes.

The above observations point out a need for continuous and imaginative investigation of different localities or neighbourhoods in different local situations within each town as they seem to present different environmental/epidemiological and humain (social) factors in malaria resurgence situations.

## URBAN MALARIA CONTROL MEASURES : SOME ISSUES FOR CONSIDERATION

The persistence of urban malaria problems has been attributed to many causes : the slackening of malaria eradication measures, rapid urban growth and deteriorating environmental conditions with sewage, drainage and sanitation programmes lagging far behind the relevant plans. A recent Auditor-General's report of the Government of India (198O-81), cites the operational rather than technical failures in Tamil Nadu in the malaria control programmes : the use on a large scale of substandard drugs, the non-collection of smears in many clinical cases and gaps in coverage of spraying programmes. Anti-mosquito measures operate on a very limited scale due to administrative and financial difficulties. The problems are found to be political, administrative, economic, social and environmental in nature. Selected issues of significance are examined below (7, p. 329).

### Antimalaria Measures

In general, malaria eradication techniques involve attacking the malaria parasites both in humans and in mosquitoes. «The attack on the vector mosquitoes attempts to interrupt transmission through decreasing the density and longevity of the vector population, while the attack on the parasite reduces the sources of infection in man by attempting to eliminate all infective cases» (8). The major issues seen in malaria control in the study centers around reducing the man-vector contact by breaking the life cycle of parasites through

1) measures directed against vector carrier mosquitoes by the use of insecticides against adult mosquitoes, and
2) practising anti-larval methods through biological control (using larvivorous fish; chemical control (larviciding)
3) source reduction through environmental management techniques involving draining and filling of mosquito breeding sites and
4) active and passive case detection methods and treating infected population with drugs.

### Antimalaria Sprays

The list of antimalaria measures available for use in malaria control programmes in lengthy and only certain major measures in practise are noted here (3, p. 23). The use of chemicals (larvicides, insecticides and drugs) has dominated the Indian programmes since the NMEP period. Most of the antimalaria activites to combat the resurgence of the mid-197Os were again based heavily on chemicals. The residual house-spraying of insecticides (DDT, dieldrin) is an anti-adult mosquito measure requiring repetitive application. This method was highly successful during the NMEP campaings. Public cooperation in the late 195Os was good. Under NMEP, the rural areas received two rounds of DDT in indoor residual spray annually, while the urban areas were given one round of DDT spray supported by antilarval measures. Spraying operations have to be carried out in sections with API-2, and above. Some sections with less than two API would also qualify for such regular spray operations in view of their special epidemiological status and geographic location. Having selected the area for regular spray operations, it would then be decided which areas should go under spray with different insecticides - DDT, BHC, Malathion depending on resistance/susceptibility status (9, p. 146). However, the increased cost of pesticides, emerging vector resistance to DDT, HCH and dieldrin, and public refusal to cooperate for various reasons such as toxicity reports, limited their use except in the cas of epidemic outbreaks. Fogging by Malathion is currently in use in some places. Susceptibility status of A. stephensi in urban areas of Tamil Nadu has been studied (6).

Roy et al. reported that : «DDT either as an emulsion or in the form of suspension has been extensively used in Tamil Nadu during 1949-53 for the treatment of wells. Well walls were also being sprayed with DDT during 1954-57. Under the NMEP, DDT has been used as an adulticide during focal sprays. The first evidence of DDT resistance in larvae of A. stephensi was recorded from Erode town in 1955. Adult A. stephensi were also found to be resistant. Subsequently adult A. stephensi were found resistant also at Salem, Bhavani and Kumarapalayam». Tests carried out between 1964-71 indicated that resistance is prevalent in many localities where many malaria cases have been recorded (6, p. 315). The urban areas under the influence of A. stephensi are highly resistant to DDT and HCH (6, p. 315). Recent tests have also shown that vectors have developed resistance to insecticides like DDT, BHC and Malathion. More than 2O species of anopheline vectors have now been found to be resistant to insecticides. Hence the spraying of DDT has been suspended. However, in certain high risk areas like Sathanur Dam (near Thiruvannamali) and other large water stagnant bodies, DDT is still in use. The necessity of constant monitoring is stressed and timely decision may be of great help in planning the control operations on a scientific line. In chemical application, priority has been given to thermal fogging. It has its own limitations. Thermal fogging will be very effective where the wind velocity is less than 1O km/hour. Normally in coastal towns like Madras, the average wind speed of 3O km/hour limits its use. The cost of thermal fogging is high. Yet it is widely used because of Government decision. However focal spray is not well accepted by the public.

## Antilarval measures

While alternative insecticides are being tried, antilarval measures offer the best potential for immediate application. Antilarval control measures are best suited for densely populated urban areas where house spraying may be impractical or uneconomic as well as «where for technical or operational reasons house spraying either alone or combinet with drug administration fails to interrupt transmission or to effect adequate reduction of malaria cases or endemicity» (8, p. 2). Antilarval methods are used in the towns. Three methods as classified by WHO are tried depending on the particular environmental situation (8) :

(1) naturalistic control, including biological control
(2) chemical control (larviciding)
(3) source reduction

## Biological control through larval suppression

«Biological control implies the specific destruction of one living organism by another, but naturalistic control includes the influencing of environmental factors which inhibit the production of target vectors» (8). WHO observed that «from a practical standpoint, the use of mosquito larvivorous fish constitutes a most important element of the broad concept of "naturalistic control", and, within the limitations of the present knowledge, fish can be utilized effectively as a tool to aid in malaria eradication or control» (8). This aspect of biological control is therefore emphasized (11). There are many species of fish in India which prey unpon mosquito larvae. The most commonly used species in GGambusia affinis. Many experiments have been conducted in Madras in the control of urban malaria through the use of G. affinis, a larvivorous fish species which thrives in wells and tanks (8, p. 145). This method is recommended because there are objections to the application of larvicides to certain breeding places such as domestic wells, ponds and tanks. The advantage of using this fish includes its small size, prolific breeding in artificial hatcheries and ponds and wide tolerance of temperature and variations of chemical and organic content of the water (12).

Compared with the other antimalarial measures biological control using larvivorous fish has been the most successful one in Madras City (7, p. 33O). Implementing the other two methods (chemical control and environmental management) is difficult in densely populated areas of Madras City (7, p. 33O). Since this naturalistic method is considered to be harmless, most people have no objections to using it in their wells and tanks. It has reduced the problem created by the large number of wells.

Madras Corporation officials state that there is at present no regular hatchery programme nor a regular supply from government or private fishery centres. The fish are usually obtained seasonally from «temple tanks» from August to February. Since the use of larvivorous fishes has afforted better results than the other antimalarial measures, the Corporation Health Department has proposed to set up 14 permanent fishery farms for this purpose in different parts of Madras (7, p. 33O) However, the chief entomologist of Madras noted that there is a noticeable lack of maintenance of wells where fish are reared and unless this is undertaken weekly by replacing or adding more fish, this control measure will be difficulte to use. Operational methods for the use of Gambusia fish pose difficulties. «For best and most economical line of mosquito fish, a mosquito control programme must have adequate facilities for their rearing, holding and distribution» (8). The failure to re-stock promptly those wells where fish failed to establish themselves and the lack of proper attention to hatcheries and transport handicaps the programme (11). Maintaining fish hatcheries in different localities of urban areas poses difficulties.

It was reported that one of the problems of urban malaria control by the use of Gambusia fish is its poor survival in wells with saline water. Indigenous fish like Oryzios melastigna and Aplochelian blochi were found to have higher tolerance for temperature, salinity and pollution (12). Releasing a large number of small fish in all breeding places of mosquitoes from small breeding farms or ponds is a possibility. It is observed that such methods need research and the training of manpower. These methods can, however, be implemented as a fraction of the cost of imported insecticides (11). Nevertheless, it is necessary before such control measures are widely applied to conduct safety tests to ensure that the various biological control agents have no adverse effects on human beings or on the ecosystem. If proved successful, biological control is less expensive and potentially more efficient than chemical methods. Above all, it is not subject to vector resistance. Corporation authorities note that public cooperation is needed in antilarval control programmes (7). The use of larvivorous fish can be a successful control measure. To improve antilarval measures the chief entomologist has suggested the following actions : showing domestic wells to malaria field workers for the introduction of fishes; house owners reporting or writing to the health officers if workers do not arrive to stock the fish (stocking of fish should be periodical); reintroduction of fish if necessary (7, p. 33O).

**Chemical control of mosquito larvae**

In malaria control, larviciding offers excellent possibilities of reducing malaria with limited time. Some of the advantages of chemical larviciding are : destruction of mosquitoes in their aquatic habitat itself; operations can be programmed and executed within a very short notice and time; operations can be carried out effectively by hand labour, machine or aircraft; there is a large choice of pesticides, some of which are locally available (8).

Mosquito larvicides currently used in the study area are Paris green and oil. Other inorganic and synthetic organic compounds (hydrocarbons such as DDT, dieldrin, fenthion, malathion, etc.) are also being tried. Paris green (copper aceto-arsenite) is an old and well known anopheline larvicide. It is effficient and was widely used in India until largely supplemented by DDT. There are many wells in the city in disrepair and they contain a lot of floating material which could be sprayed with oil to check breeding. Oiling water collections to stop breeding is also attempted. Such measures lack perfection and regularity, and so far no systematic coverage or inspection by the health authorities has been possible (7).

With regard to larvicides, the following general observations were made in Madras. «Even though considerable money was spent by the Corporation and municipalities for frequent spraying of larvicides and insecticides results have been very poor. This is mainly because of the development of some larvicide resistance by the mosquitoes and the lack of cooperation on the part of people to spraying of chemicals inside their homes» (7, p. 337). Many people in the old residential areas of Madras do not permit Corporation staff to spray larvicides due to certain personal reasons and fear of chemical spraying. If one out of every two houses in a division does not get the larvicides, then that one house can affect the mosquito breeding of the entire area. Consequently this method has had a very low success rate. It is difficult to state when and where it has been a success or failure. To date, larvicides are used in limited situations only. Larviciding requires regular supervision, evaluation, and frequent operation and can create environmental pollution. Larviciding requires regular supervision, evaluation, and frequent operation and can create environmental pollution. Larviciding programmes have often suffered and been incomplete and ineffective for want of proper organization and supervision. The shortage of trained personnel and inadequate financial resources have been additional constraints. The 198O-81 report of the Comptroller and Auditor-General of India notes that although guidelines state that all breeding sources should be sprayed periodically with larvicide, this was not the case with the Madras City Corporation effort in 198O. Only 1O% of houses and wells in the city were sprayed and overhead water tanks were completely ignored. As mentioned above, these are major sources of A. stephensi breeding in the city (7, p. 332). Antilarval operations are now receiving more attention in malaria control programmes especially for urban areas. But there are some limitations : Larvae control operations and the methods and materials employed are very varied and complex as compared to residual house spraying which is applied to every situation in a relatively uniform fashion. The method applied has to be carefully matched to the specific situation related toknowledge of larval conditions, the vectors and their biology, the type of water, and the extent and accessibility of larval sources (8, p. 3).

Source Reduction : Environmental management techniques which either eliminate or alter the breeding habitats of mosquitoes

«Source reduction is a broad term. It covers any planned modification of the environment which physically removes from the surface of the ground or reduces the water in which mosquito develop, or through physical changes in the environment renders the water unsuitable for mosquito production» (8, p. 17).

In control programmes in urban areas, improvement of the environment has been given low priority. In theory, public drains and cesspools should be drained at regular intervals to prevent larval breeding in all covered and open drains, cesspools, ditch drains, and gully traps and weeds and moss removed from the rivers. All tanks and cisterns should be cleaned by the owners. In practice, this is rarely the case. De-weeding of waterways and removing floating mass for the free movement of fish await systematic operations. During the eradication period in Madras a special gang of workers was engaged to clean the waterways of weeds, floating moss and algae and the Special Works Department flushed the Kelly's storm water drain with sea water twice a week (11, p. 332).

The implementing of environmental management and engineering techniques in terms of covering wells, filling in low-lying areas, protecting disused wells, preventing stagnant water, proper cleaning and draining of streets and storm drains, covering the cisterns, constructing proper slopes for rain water gutters, controlling water used in building construction in densely populated old residential areas all present many obstacles and difficulties. On the other hand it has been comparatively easy to experiment with such techniques in the new residential areas of the city (7, p.332).

WHO states that «the application of source reduction measures generally produces results that are permanent, that is, they require little or no maintenance -1O% of the annual budget spent on source reduction would result in fewer areas to be treated with temporary measures each year, thus providing important economy in the programme's overall expenditure» (14). With minor engineering skills and simple techniques, many of the breeding sources cas be eliminated in urban neighbourhoods.

## CONTROL OF MALARIA IN MAN

In recent years, there has been an enormous increase in mosquito population following increasing urbanization, shortages of piped water supplies, environmental degradation and neglect. Consequently the risk of widespread transmission remains high. Malaria cases are generally detected and treated under surveillance methods and treated free of charge in Corporation and municipal dispensaries and government hospitals. For example, of the 4O Corporation clinics in Madras City, 23 are found in the highly malaria area of northern Madras.

Nevertheless many cases go undetected for a variety of reasons. The public is genrally aware of a blood film examination test which is available at various locations in the city if there is any suspicion that an individual is suffering from fever or chill. Full treatment will help prevent transmission of the disease (7, p. 333). The majority of cases were found to be p. vivax and indigenous in origin (2, p. 11; 6, p. 313). A few imported cases were from other towns in Tamil Nadu with urban malaria problems. Control of malaria involves medical officers (9, p. 145). Case detection methods center around the following guidelines factors :

1) active case detection;
2) passive case detection;
3) prompt institution of remedial measures around positive cases
4) supervision of laboratory services;
5) in areas where API is two or more, i.e. the incidence is not less than 2 cases per 1OOO), insecticidal spray is to be carried out regularly;
6) in areas having less than 2-API-2, focal spray is to be arranged whenever a case is detected;
7) in areas where there are large numbers of positive cases (detected by blood smear collection and examination, priority is given for radical treatment with drugs for confirmed P. falciparum and P. vivax cases.

## CORPORATION AND MUNICIPALITIES MALARIA CONTROL PROGRAMMES, SOME CONSTRAINTS AND LIMITATIONS

Various reasons are advanced for upward trend in urban malaria incidence, especially since 1974, in Tamil Nadu. Malaria control programmes in recent years have been operational rather than technological failures. The following is a summary of some of the constraints experienced by urban malaria control schemes in the state :

1) Increasing urban agglomeration of human populations and inadequate protected piped water supplies, necessitates increase in domestic wells, cisterns and overhead tanks to store water, which have consequently increased the breeding potential of vector species A. stephensi. Large numbers of wells and overhead tanks are often neglected and

are not inspected or regulated. The inaccessibility of many of the overhead tanks presents a persistent problem, especially in Madras.

2) Large scale building and construction activities have resulted in the multiplication of A. stephensi breeding sources. Malaria is seen as a man-made problem in urban areas by disturbance and pollution of the environment. For example, one of the common practices of building contractors is to dig large pit holes to obtain sands which leads to numerous breeding places.

3) Factors of human ecology and ethnology interfere with the application of anti-mosquito and anti-larval measures. There is a lack of public cooperation in accepting insecticidal spray and treatment for parasitologically positive cases, refusal to have chemicals or fish applied to wells or cisterns, to undergo full treatment, to give blood for examination. There is a lack of cooperation or resistance from the public in permanently sealing old wells and closure of old overtanks. Many Muslim women are reluctant to allow health workers inside their houses. The upper Hindu caste may not allow larviciding spraying crews who are usually lower caste in their houses. Most of the very poor and illiterate people never follow full treatment course or prescriptions. Many people have a habit of sleeping out of doors. People replaster house walls thereby neutralizing the effect of spraying. Other malaria measures to prevent contact between man and the vector as applied by urban individuals are the use of repellents, bed nets, house screening and coils and aerosols. Only the higher social classes of the city population can afford these repetitive measures. Repellents, coils and aerosol usage are promoted through television and newspaper advertisements.

4) The cattle population in urban areas though diminishing remains high.

5) There is a lack of plans for full and systematic coverage for spray. There is also an absence of provision for residual spray in urban areas having wards or localities or sections with API-2 or above. There is also a failure to identify the priorities for vector control operations.

6) Regulatory measures for containing mosquito breeding are inefficient. Many breeding places cannot be reached with larvicides due to inaccessibility and resistance from the public.

7) Persistent local foci of malaria were not identified early enough.

8) Inadequate knowledge and research on various control measures under different local conditions persist.

9) Resistance of many vectors to insecticides that could be safely used in human dwelling continue to pose problems.

1O)Development of resistance in malaria parasite, particularly Plasmodium falciparum, to certain antimalaria drugs is noticed;

11)Inadequate research support is reported;

12)Shortage of trained manpower and difficulties in attracting and keeping experienced personnel are felt;

13)Proper and systematic entomological studies were not done to identify behavioral changes of the vector population, especially their tolerance to insecticides then available for use;

14)There are defaults in collection of mass and contact smears for want of surveillance staff resulting in non-detection and treatment of cases.

15)Personnel problems continue to delay the programme. There are insufficient workers or trained technical staff available to cover vast areas for antimalarial work. Many of the sanctioned posts (since 1976) remain unfulfilled up to the present. Inadequacy or non-existence of active surveillance component under the urban malaria schemes as at present active surveillance component is provided only for the peripheral areas of the city and towns. Inadequate coverage of radical treatment of known positive cases in the heart of the towns where there are no provisions for active surveillance. Overall, poor organization and administrative management, lack of supervision and cross-checks coupled with the financial constraints of local bodies persist.

16)The development of water management techniques, such as draining pools, filing post holes, prevention and collection of wastes around the house, and the regular cleaning of overhead tanks and cisterns to reduce mosquito breeding sites continue to receive insufficient attention nor are they legally enforced. Media and film songs promote and try to motivate people to acept chloroquin tablets, mosquito coils and chemical sprays, but do not provide information on habitat management techniques which may be practised at the community level inorder to prevent the disease. Water stagnation of all types in residential areas continue to pose a grave threat and give rise to increasing mosquito nuisance. An editorial in the Hindu, a Madras newspaper, noted that «a major obstacle to effective control has been the failure to involve the people in a meaningful way that would make them feel they share the responsibility with the government. Official atempts at making people aware of the need to observe minimum norms of sanitation on their own behalf and in the interest of the society have been quite feeble. This lapse is not unconnected with the latest incidence of malaria as welle as filaria» (11). The question is : can residents take the responsibility and initiative to clean the environment themselves through community cooperation ? If environmental aspects of source reduction techniques (e.g. tanks and ponds to be cleaned by owners themselves) are to succeed, education and community involvement in the implementation of programmes as well as continuity in maintaining whatever control measures are an absolute necessity (1). So far Corporation plans have not developed any alternative methods or models of control such as those related to rational environmental practices at urban neighbourhood levels (7, p. 334). The floating population of large cities also leads to dissanitation and haphazards/environmental mismanagement. Even though the recent WHO report on integrated vector control presents broad criteria and guidelines for integrated vector control and community participation in vector control, very few workable models are available to antimalaria programmes. WHO reported on an experimental research project by the Vector Control Research Centre in Pondicherry, India, using integrated pest control technology including environmental manipulation, and community education through mass media (1, p. 19).

17)Political factors pose difficulties. For example, the State Government spent 5O% of the annual malaria budget and posted 6O% of the State malaria department employees for nearly three months in the city of Madurai where a World Tamil Conference was held in 198O. To seal all the city wells (to provide covers), the DPHS suggested a new legal act. A draft was prepared and sent to the State assembly, but failed to pass. Political factors such as a lack of comprehensive legislation and/or its enforcement also play a role. Allocation of budget is not enough to meet all the problems. Only limited areas can be covered. There is a lack of coordination or cooperation on the part of other government departments such as Tamil Housing Board, Tamil Nadu Water Supply, Sewage and Drainage Board, Slum Clearance Board, and other local bodies in closing the public wells or the overhead thanks where necessary. Proper design and construction of overhead tanks for cleaning purposes are not provided. In many of the flats constructed prior to 198O, it was impossible to reach the terrace to clean the overhead tanks.

**Public Concerns, Support and Community Participation**

Except for occasional letters appearing in newspapers regarding malaria/mosquito nuisance, public concerns regarding the disease are not clearly demonstrated. The general attitude of the public is that all mosquitogenic conditions should be the exclusive responsibilities of the city corporation and town municipalities. Community cooperation, participation and assiistance to Corporation / municipalities programmes are hard to measure. It may be said, however, that at present, urban neighbourhoods of the city lack strong community organizations through which they may persuade their members to participate in public health education and implementation of simple environmental measures such as ensuring waste water should not be allowed to flow on the streets or stagnate in the surroundings of houses. Without wholesale community cooperation, individual householders or health officials who take prèventive action can never succeed in their tasks. Not only are community incentives lacking but awareness and enforcement of existing sanitation laws are not being realized (7, p. 335). WHO cites a number of constraints on community participation that have to be overcome :

«(1) Community participation in vector control work is likely to be limited by
a) lack of experience in communal actions
b) lack of effective local self-government
c) lack of knowledge and
d) inadequate motivation

(2) Community participation in vector control requires effective supervision of health workers at the peripheral and intermediate levels of the general health service system.

For the immediate future, the inadequate skills of health workers at these levels and lack of interest in vector control may be barriers to community participation.

(3) It takes time to reorient or develop vector control programmes and their personnel to the new approach and the initial costs may be high.

(4) Community participation in vector control should aim ultimately at continued vector control activities, yet it is not easy to find ways and means to sustain community involvement» (1, pp. 42-43).

Among the measures directed against the vector, biological control and antilarval operations have been found effective and will have the greatest values in areas of high populations density, but, whenever practicable, measures for improvement of the environment by the permanent reduction of sources should be instituted, particularly in towns and in areas of new development projects (3, p. 24).

## CONCLUDING DISCUSSION

There is a continued need for : complete data and information on malaria distribution by census wards and divisions of city/towns; notification of disease by all those who contract it; continued research support and activities related to insecticides, antimalarial drugs; complet treatment; and developing alternate methods of control under different and specific conditions. With continued use of insecticides and drugs for the long-term control programmes, problems will persist or arise. For example, A. stephensi has become resistant to both DDT and HCH. Training of staff and medical officers through orientation and surveillance techniques lags behind plans (13, p. 222). Administrative and general services to support antimalaria activities need to be strengthened (16, p. 1O-11). As Roy et al. stated (6, p. 315).

«Perhaps the urban malaria problem would disappear when adequate protected water would be available through piped water supply, eliminating the necessity for wells and cisterns. A good underground draingage system is also necessary in view of the adaptability of A. stephensi to breed in polluted waters».

Though the importance of urban malaria problem has already been given some recognition through centrally sponsored and guided schemes, operational factors continue to pose many constraints. Preliminary case studies recently undertaken by the writers in four locations in Madras as well as in two other towns, Salem and Dindigul, indicate that there is a need for a continuous and imaginative investigation of different localities within the towns, which seem to present different environmental/epidemiological and human (social) challenges in the malaria resurgence situation.

Public health programmes like urban malaria eradication will not succeed without community participation. Various participatory approaches need to be evolved.

Thus it may be said that public knowledge, attitude and practice of antimalaria control measures and environmental awareness are not being achieve. Even though the health authorities recognize the importance of environmental improvements for permanent vector control or reducing its density, lack of organization, coordination and understanding among different agencies and the corporation and municipalities continue to prevent implementation of an integrated scheme for environmental improvement. To date, biological and chemical methods of malaria control on a small scale seem to provide only temporary control of the vector. Environmental improvement and management techniques, and health education, including raising both the public awareness and cooperation and willingness to develop methods to facilitate participation at neighbourhood/community levels have a long way to go in achieving permanent vector control and eliminating the reservoir of infection (7, p. 335).