1.0 INTRODUCTION
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Malaria is one of the vicious diseases of humans. It played a major role in shaping the history and to the decline of civilization (Cheng, 1986). The history of scientific discoveries in Malariology begins from 1640, when the physician Huan Del Vego first employed the tincture of the Cinchona tree bark for treating malaria. The disease has always been a major public health problem. It is reasonable to suppose that our primate ancestors were recognizably malarious before they were recognizably human, and that this fever known for its world wide notoriety has accompanied us throughout the Darbinian descent (Harrison, 1978). The Charaka and Sushruta of Ayurvedic period gave vivid descriptions of the disease and associated it with bites of mosquitoes (referred to as Masaka in vedic literature also) bears testimony to the fact that malaria was well known to the ancients. Hypocrates in the fifth century B.C. gave classical descriptions of malaria (Park and Park, 1977).

In 1898, Sir Ronald Ross, working as a military physician in India, made another extremely important discovery, proving experimentally that mosquitoes serve as vectors (Harrison, 1978). A major part of his work was carried out in Presidency General Hospital in Calcutta (Hati, 1991). By solving the riddle that continued to haunt man for long, he happened to be a claimant of the Nobel Prize in 1902 (Harrison, 1978). The work was endorsed in the same year by the Italian scientist Bignani, Bastianelli and Grassi who demonstrated the sporozoites of human malaria in the salivary glands of Anopheles mosquitoes (Bhattacharya and Gupta Biswas, 1999).

Vector biologist Covell in 1932 rightly opined that the city of Calcutta might be claimed to be the birthplace of Malariology. The paradox is that the city continues reel under malaria fever. The recent epidemiological status of malaria in Calcutta has been studied by Mukhopadhyay et.al. (1997). Their study revealed that both mortality and morbidity due to malaria in this area showed increasing trend. According to a Report of State National Malaria Eradication Programme, the areas under the Calcutta Municipal Corporation (CMC) alone contributed to about 40.4% of total malaria incidences in West Bengal state and 59.7% confirmed deaths of the state total in 1995. These figures were 47.54% and 54.2% respectively in 1997, indicating that malaria situation in Calcutta in serious (Hati et. al., 1998).

Human malaria is an acute infectious disease caused by malarial Plasmodia transmitted in nature by the bite of infective female Anopheline mosquitoes (Hati, 2001). The multistage protozoan parasites *Plasmodium falciparum, Plasmodium vivax, Plasmodium malariae* and *Plasmodium*
ovaie are the etiologic agents of malaria, a disease of unfathomable impact. *Plasmodium falciparum* stands out as the most important of these agents in its effect on human life. Every year, *Plasmodium falciparum* kills an estimated 1 to 3 million individuals and is responsible for hundreds of millions of clinical infections throughout the world. The vast majority of the disease and death caused by *Plasmodium falciparum* occurs in Sub-Saharan Africa. A century after Alphonse Laveran's Nobel Prize winning discovery that malaria is caused by a protozoan in the blood, and 40 years after the publication of prominent malariologist Paul Russell's book “Man’s Mastery of Malaria” it remains one of the most important infectious disease in the World (Upadhyay and Pal, 1999). *Plasmodium vivax* and *Plasmodium falciparum* are found in tropical zone like India, Bangladesh, and Pakistan. *Plasmodium malariae* are found in sub – tropical zones, though occasional cases are reported in India. *Plasmodium ovale* are found in East Africa, West Africa, Nigeria, Philippines (Bhattacharya, et. al., 1999).

*Anopheles stephensi* is the urban malaria vector in India found in cities like Calcutta, Mumbai, Delhi, and Chennai (Siddons, 1946; Mukhopadhyay, 1980; Hati et. al., 1987 and Hati, 2001). *Anopheles annularis* was regarded as the secondary vector in certain areas of India (Timber, 1935; Vishwanathan, et. al., 1941; Panigrahi 1942; Senior White et. al., 1943). In Nepal, *Anopheles annularis* is considered to be the vector of malaria (Shrestha and Parajuli, 1980). *Anopheles annularis* was incriminated as malaria vector by Ghosh et. al., (1985) in Gurap village of Hooghly district, about 60 Km away from Calcutta. Bhattacharya et. al. (1999) reported the presence of *Anopheles annularis* and *Anopheles subpictus* in Calcutta and adjoining areas. The vectorial status of these Anopheline species in Calcutta is not known. *Anopheles subpictus* is the most abundant of the Anopheline species found in India including Calcutta. The incrimination of *Anopheles subpictus* in a village of Tamilnadu (Panicker et. al., 1981) suggests that the species is a potential vector.

Each year 1-2.5 million deaths occur due to malaria. Most of those who die are children, aged less than five years. Again, the majority of death occurs in tropical Africa, where transmission is intense and where children are at most risk (Hati, 2001).

Malaria was nearly eradicated from India in 1960's (through meticulous planning, extensive use of insecticides spray operation and anti-malarial drugs) when the number of cases dropped from 75 million to 2 million in 1958 to 0.1 million in 1964 (Chandler and Read, 1981). National Malaria Eradication Programme of India was the largest in the World, involving the entire population. The objective was to eradicate malaria from India in 7-9 years or by 1965-1967. In
1964, the schedule was revised to termination year 1970. In 1967, it was again revised to 1976. Though initially NMEP produced good results, the situation deteriorated after 1969. The peak incidence occurred in 1976 (Hati, 2001).

Resurgence of malaria has posed a serious health hazard in rural West Bengal since the seventies (Ghosh et. al., 1985). Since then, distribution of different species of Plasmodium has been changed in West Bengal. *Plasmodium malariae* has virtually been extinct. *Plasmodium falciparum* in the form of a scourge was very much present in Bengal. *Plasmodium falciparum* constituting 11.1% of all malaria victims during 1981-1990 with only 109 deaths of which 68, 18 and 17 occurred in the district of Jalpaiguri, Purulia and Coochbihar respectively. The highest number of *Plasmodium falciparum* cases was found in 1986 (14096) comprising 26.3% amongst all malaria cases in that year. After 1981, yearly cases of *Plasmodium falciparum* in West Bengal had rather increased (Bhattacharya et. al., 1993). Malaria becomes hyperendemic in different areas of northern parts of West Bengal and particularly the Himalayan foothill regions are worst affected with the problem in recent years (Pradhan et. al, 1993, Malakar et. al., 1995).

Sharma (1986) reported that, although, the urban malaria scheme had been introduced into National Malaria Eradication Programme in 1971, its function was revised in depth during the introduction of Modified Plan of operation in 1972 (Anon, 1995).

The expert committee in 1995 identified 15 major cities including the area under Calcutta Municipal Corporation (CMC), where malaria situation was serious. As per State National Malaria Eradication Programme report, the areas under CMC alone contributed 40.4% of the total malaria case. Malaria is exclusively a local and focal phenomenon. The intensity of transmission, prevalence and distribution of parasites is determined by local maliariogenic conditions (Mukhopadhyay et. al., 1997). Malaria has been on the rise due to increased urbanization and migration of people from place to place (Choudhury & Sen, 1987 & Bhattacharya et. al., 2002).

According to Mukhopadhyay et. al., (1997) in Calcutta, *Plasmodium falciparum* cases and death due to malaria show remarkably increasing trend since 1990. The incidence of *Plasmodium falciparum* malaria has increased more than eleven folds in 1996 in comparison to 1990, with 0,0,0,4,7,52 and 17 deaths in 1990,1991, 1992, 1993, 1994, 1995 and 1996 respectively. The average *Plasmodium falciparum* infection had been noted around 28.27% in the study period with highest peak as 71.5% in November, 1996. Malaria cases along with the *Plasmodium*
were found to occur throughout the study period of 1995-1996. Malaria has been occurring in Calcutta every year since 1981 (Hati, 2001).

Sporadic mosquito faunastic surveys had been undertaken in between 1965 to 1987 in Calcutta and its adjoining areas (Ghosh and Hati, 1966; Das et. al., 1971; Mukhopadhyay and Hati, 1978; Hati et. al., 1987). Pramanik et al., (1992) made a faunistic study in 1989-1991 on mosquitoes in Greater Calcutta and adjoining areas of the districts of 24 Parganas (North and South), Hooghly and Howrah. Rapid urbanization and industrialization in Calcutta and its adjoining areas for the last few decades have contributed to creation of new mosquitogenic environment (Bhattacharya et. al., 1999).

Amongst the seven Anopheline species reported by Bhattacharya et. al., (1999) during their mosquito survey between 1993-1995 in Calcutta and the adjoining areas, *Anopheles subpictus* (36.10%), *Anopheles annularis* (22.10%) and *Anopheles stephensi* (19.65%) occupied the first, second and the third position respectively.

Panicker et.al. (1981); Kulkarni (1983) and Rao (1984) reported that *Anopheles annularis*, *Anopheles stephensi* and *Anopheles subpictus* are the prime malaria vectors in India. In 1985-86 the percentage of *Anopheles subpictus* and *Anopheles stephensi* in Calcutta was 0.2% and 2.1% respectively (Hati et. al., 1987). Siddons (1946), Das et. al(1971), Mukhopadhyay (1980), Hati et. al. (1987) reported that in Calcutta the prime vector is *Anopheles stephensi*. For the last few decades, investigators, however few, have been referring *Anopheles stephensi* is the only vector in Calcutta, despite the presence of few other suspected Anopheline species (*Anopheles subpictus*, *Anopheles annularis*), which are the vectors of the disease in other parts of India (Bhattacharya et. al., 1999).

Chakroborty and Tandon (1995) observed that *Anopheles stephensi* is zoophilic and prefers to feed on bovine blood irrespective of the biotope and availability of host. Hati et. al. (1987) did not find any adult *Anopheles stephensi* by spending 192 man hours in the month of January and March 1986, although malaria cases were reported in those months (Hati, 1991). Several human bait experiments with mosquitoes conducted in Calcutta indicate no *Anopheles stephensi/man contact was evident in certain months of the year (Chatterjee & Hati, 1995 & Mukhopadhyay, 1980).

In countries with tropical climate, malaria is transmitted all the year round; in the subtropical and temperate zones, transmission is limited to summer and autumn (Loban and Polozok, 1985).
Temperature and humidity play an important role during the development of malarial parasites in the mosquito (Hati, 1979; Chandler and Read, 1981). Tandon, and Chakroborty, (1998) reported that during their study on the behavioural factors of *Anopheles stephensi* in 1995, they noticed a notable increase in the larval density of *Anopheles stephensi* during monsoon. Investigators, however few, have been referring *Anopheles stephensi* as the only vector in Calcutta, albeit, no systematic and thorough attempt has so far been made to find out the role of other Anopheline species, such as *Anopheles subpictus*, *Anopheles annularis*. Keeping the above perspectives, apprehension has been raised in certain quarters, that besides *Anopheles stephensi*, the above-mentioned species may have some role in the transmission dynamics of malaria in Calcutta. *Anopheles annularis* and *Anopheles subpictus* have been incriminated as vector of malaria in other parts of India. According to Bhattacharya et. al. (1993), alteration of host-parasite relationship, addition and alteration of vectors and vectorial capacity may have some role in the present malaria situation in West Bengal. Therefore, study on vector/suspected vectors in relation to transmission of malaria is of immense importance.

Economic activities of man have proved to be a major contributor of some epidemics of vector borne diseases. Urbanization, with population migration, creates a real possibility of the formation of new malaria foci (Youdeowei and Service, 1986). Since early 1980’s owing to huge construction and developmental works, followed by population migration in Calcutta metropolis have changed the ecological situation significantly. Since then, no systematic study encompassing the various ecoepidemiological aspects of malaria in relation to vectors have been studied.

Pattern of incidence of vivax and falciparum malaria in Calcutta has not been studied, especially; in any malaria prone ward with reference to age, sex and seasons. In the present investigation, an attempt has been made to study the pattern of incidence of malaria in a malaria prone ward of Calcutta.

In view of the growing concern over insecticidal contamination of the environment and its subsequent detrimental effect to biotic community along with the continuing appearance of multiple resistance of insect pests, to most chemical insecticides with their rising costs, the search for alternative vector control strategies, has thus assumed a priority demand. In the present study, an attempt has been made to study the potentiality of Guppy fish (*Poecilia reticulata*) and *Aplocheilus panchax* as the biocontrol agents against mosquitoes.