MOSQUITO-RELATED HEALTH RISKS OF WASTEWATER TREATMENT PONDS IN PERI-URBAN AREAS OF FAISALABAD, PAKISTAN

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Pakistan is located in a severe water-scarce zone, which increases the scope of the reuse of wastewater and resultantly it is now being used for irrigation virtually without treatment and restriction in almost all cities. Treatment ponds have been constructed in some cities of Pakistan, but due to financial constraints most of them are in a non-functional condition (Aftab, 1999). The irrigation-related ecological changes occurring in Pakistan stimulated us to conduct research on how these changes affect vector breeding and heath risks associated with them. This will then make it possible to plan appropriate management methods for disease vector control. The objective of this study was to investigate the health risks associated with mosquito breeding in a wastewater treatment and irrigation system at a site on the outskirts of Faisalabad, Pakistan.

Faisalabad is situated in Rechna Doab, located between the Chenab and Ravi rivers, 73.08'E, 31.25'N and at an altitude of 214m above mean sea level. The mean annual maximum and minimum temperature of the area are 48±2^{o}C and 10± 2^{o}C respectively and average annual precipitation is 550 mm. The total population of Faisalabad is 2 million. Ground water of Faisalabad is saline and drinking water is piped from Chenab well field 25 km away. Recently a wastewater treatment plant was completed consisting of 16 ponds in two rows covering an area of 16 ha. Of these, six are aerobic and 6 are facultative while 4 are sludge dewatering ponds. The plant has been designed for an average flow of 90,000 m^3/d. This study is investigating the role of these wastewater treatment ponds in the generation of medically important mosquitoes. Breeding preferences of mosquitoes in the 2-km area surrounding the treatment ponds are also investigated but results are not yet available.

The occurrence and abundance of mosquito immatures in different habitats reflect the egg-laying preference of females as well as the ability of the immature mosquitoes to survive under the prevailing conditions. Changes in physico-chemical and biotic characteristics of habitats may create the conditions either favorable or unfavorable for their breeding success, depending upon the ranges of tolerance of different species (Amerasinghe *et al*., 1995). From July 2001 to February 2002, 1,737 samples were collected from the treatment ponds. Five *Culex* species were found and six anopheline species. Each mosquito group showed its association with particular ponds. *Cx.*

tritaeniorhynchus (vector of West Nile fever, Japanese encephalitis), *Cx. quinquefasciatus* and *Cx. pipiens fatigans* (Bancroftian filariasis, West Nile fever) showed significant association with anaerobic treatment ponds. These ponds are characterized by turbid-foul water with low DO and EC. *Cx. bitaeniorhynchus* and *Cx. pseudovishnui* were found in facultative ponds, which are characterized by clear-foul water with high DO and EC. Generally, these species prefer foul and polluted water with low DO for breeding and other researchers have documented their existence in such habitats. For instance, Carlson and Knight (1987) recorded extremely high *Cx. quinquefasciatus* populations in wastewater treatment ponds in Florida. In Pakistan, Reisen *et al* (1981) and Aslamkhan and Salman (1969) have reported that *Cx. tritaeniorhynchus* was a dominant species in polluted habitats in the summer; a similar phenomenon occurred with *Cx. pipiens fatigans* in the winter. Of *Anopheles* species, only *An. subpictus* showed association with these ponds, particularly with anaerobic ones while the other five species were collected from facultative ponds. Such findings were well supported by Carlson *et al*., (1986) who recorded the very high *Cx. quinquefasciatus* population in untreated wastewater and at later stage of wastewater treatment *Anopheles* species were dominant. Herrel *et al.,* (2001), Reisen *et al.,* (1981) confirmed the presence in foul and polluted water like septic tanks, street pools and street drains. *An. stephensi* (secondary malaria vector) and *An. culicifacies* (major vector of malaria) also showed breeding preference for treatment ponds but only for facultative ones though their total number was low. Herrel *et al*., (2001) and Reisen *et al.,* (1981) reported their significant existence in fresh and clear water in irrigated areas of Punjab. However, the results of Mukhtar *et al*. (unpublished) also showed their existence in foul water. Krishnan (1961) also found a positive correlation between *An. stephensi* occurrence and polluted water in winter when there is low rain and less irrigation practice in Punjab. *An. stephensi* has been considered important malaria vector throughout Asia, including Indo-Pak subcontinent and Persian Gulf (Rao, 1984). Recent evidence from Sheikhupura, in northern Punjab suggests that *An. stephensi* may be a more important vector than previously believed (Rowland *et al.,* 2000).

Conclusions:

The occurrence of established vectors of human diseases such as *An. stephensi* and *An. culicifacies* (malaria), *Cx. tritaeniorhynchus* (West Nile fever, Japanese encephalitis), *Cx. pipiens fatigans* and *Cx. quinquefasciatus* (Bancroftian filariasis, West Nile fever) in the wastewater system indicated that such habitats could contribute to vector-borne disease risks for human communities that are dependent upon wastewater use for their livelihoods. Wastewater disposal and irrigation systems provide a perennial source of water for vector mosquitoes in semi-arid countries like Pakistan. Vector mosquitoes exploit these sites if alternative breeding sites with better biological, physical, and chemical conditions are not abundant. Therefore, proper understanding of breeding sites and preference of certain sites over other is vital to develop sound mosquito control strategies. This is particularly very important in areas where large-scale irrigation is being practiced. No doubt, wastewater has been widely investigated from helminths and protozoan infection point of view, but neglected in case of vectors' breeding investigation. Wastewater treatment systems can generate potential vectors of human diseases, and this emphasizes the need for more research on this issue. This would then

make it possible to develop appropriate environmental management methods for disease vector control. Health planners and policy makers should consider vector breeding in the design of wastewater reuse schemes. To the author's knowledge, there have been no previous published studies on mosquitoes breeding in wastewater-irrigated sites in Pakistan.

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