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Characterization of larval habitats for anopheline mosquitoes in a malarious area under elimination program in the southeast of Iran

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PEER REVIEW

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Comments

This is a valuable research work in which authors have investigated the correlation between some environmental characteristics of anopheline larval habitats including intensity of light, water current, vegetation situation, the presence of algae, substrate type, water conductivity, total alkalinity, turbidity, total dissolved solid, pH and ions such as chloride, sulphate, calcium, and magnesium and anopheline larvae abundance, which can be considered for effective planning and implementing malaria elimination program.
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ABSTRACT

Objective: To determine the effects of environmental characteristics of larval habitats on distribution and abundance of anopheline mosquitoes in Bashagard county, a malarious area in southeast of Iran.

Methods: Larvae were collected monthly using the standard dipping method and identified using a morphological-based key. Environmental characteristics of the larval habitats were recorded. Water samples were taken from habitats during larval collection for physico-chemical characterization. Statistical analyses were performed.

Results: In total 5 150 anopheline larvae from 36 larval habitats were collected and identified. They comprised of six species: *Anopheles culicifacies* (29.36%), *Anopheles moghulensis* (25.20%), *Anopheles dthali* (18.02%), *Anopheles superpictus* (17.24%), *Anopheles turkhudi* (5.17%) and *Anopheles stephensi* (5.01%).

The most common larval habitats were natural and clear water bodies such as riverbeds with sandy substrates and still water. Furthermore, the anopheline larvae were abundant in permanent and full sunlight habitats without vegetation and algae. Larval density was positively correlated with water temperature. Chemical characteristics including conductivity, total alkalinity, sulphate and chloride had significant effects on distribution and abundance of anopheline species.

Conclusions: The result of this study indicates a correlation between some environmental characteristics and anopheline larvae abundance which can be considered for effective planning and implementing malaria elimination program in Iran.

KEYWORDS

Anopheles, Larval habitats, Malaria, Bashagard, Iran

1. Introduction

Malaria is one of the most widespread diseases in the world, especially in the tropical and subtropical regions[1]. It is one of the most important vector borne diseases and public health problems in Iran. The disease is endemic in the southeast of country with two seasonal peaks mainly in spring and autumn. According to the report of Iranian

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Ministry of Health and Medical Education, the annual malaria cases have been reported from 66 075 to 3 000 during 1995-2010, indicating the sharp decline of disease which has led World Health Organization to categorize Iran in the elimination phase[1,2]. The national malaria strategic plan has recently set goals to reduce local malaria transmission by taking strategies targeting vector control through indoor residual spraying, distribution of long lasting insecticidal nets and application of larvicides. In this regard, Iran is aiming to eliminate *Plasmodium falciparum* by 2015 and to become malaria-free by 2025[2,3].

In many parts of the world, larval control through source reduction and routine application of larvicides is considered as a key intervention in eradicating malaria[4]. Larval control measures are intended to reduce malaria transmission by preventing propagation of mosquito vectors and subsequently reducing human vector pathogen contacts[5,6]. Control of larval mosquito populations is often advantageous because the larvae are usually concentrated, relatively immobile, and often readily accessible. Moreover, mosquito larvae unlike adults cannot change their habitat to avoid control activities[6].

Several environmental characteristics affect larval density which may influence the development and survival rate of the malaria vector larvae. These characteristics include climate, physical and chemical conditions of the aquatic habitats, vegetation type, and biological characteristics[7,8]. Finding of local change in environmental characteristics of anopheline larval habitats can help in conducting suitable vector control programs[9,10].

Bashagard is a malaria endemic focus in the southeast of Iran where local transmission occurs every year. Mosquito larval control measures, consisting of regular application of *Bacillus thuringiensis* and environmental management are important activities of malaria control programme in this county. Five anopheline species including: *Anopheles stephensi* (*An. stephensi*), *Anopheles dthali* (*An. dthali*), *Anopheles culicifacies* (*An. culicifacies*), *Anopheles fluviatilis* (*An. fluviatilis*) and *Anopheles superpictus* (*An. superpictus*) are widespread and constitute the malaria vectors in this area[11]. Understanding the larval ecology of these vectors is of particular importance for monitoring and control of malaria in this county. Knowledge of larval vector ecology is a key factor in risk assessment and establishment of effective control measures, because the most effective method for controlling vector populations is to control the larvae in their aquatic habitats before they emerge as adults[12].

The aim of this study was to determine the environmental characteristics of anopheline larval habitats and their potential influence on the distribution and abundance of malaria vectors in Bashagard county, southeast of Iran. The results of this study will provide information that would help in planning and implementing an effective program for larval control by the National Malaria Control Program in the country.

2. Materials and methods

2.1. Study area

The study was done in Bashagard county in the Hormozgan province, southeast of Iran. The county is located between latitudes 26°04′-26°58′ N and longitudes 57°23′-59°02′ E with an approximately 31 000 population in 2011. The average of annual rainfall is about 265 mm while annual mean relative humidity is 40%. It has a warm climate with mean annual temperature of 26.2 °C ranging from 9.4 °C to 44.2 °C. It is an underdeveloped area with majority of the population living in straw houses on hills and foot-hills, close to rivers. Socio-economic condition of villagers is poor and they solely depend on livestock herding. In the study area, natural earth dams block the water flow and create suitable places for mosquitoes breeding. Malaria is a major public health problem in Bashagard which occurs year-round with peaks after the two annual rainy seasons (April-June and October-December)[3].

In this study, 11 villages were selected based on similarity in ecology and human population densities as fixed places for anopheline larval collection. The study villages had exhibited documented consistent endemic malaria transmission[3].

2.2. Larval sampling and identification

Anopheline larvae were collected form selected villages monthly for a period of 12 months from September 2009 to August 2010. In each village, all larval habitats present in and within a 500-m radius of the village were sampled for anopheline larvae using a standard 350 mL capacity mosquito dipper or a white plastic pan with the same capacity according to WHO procedures[13]. When mosquito larvae were present, 10-30 dips were taken depending on the size of each larval habitat at intervals along the edge. In small breeding places where dippers were not effective, larval collection was performed using plastic pipettes. Samplings were always done by the same individual in the morning (08:00-12:00 h) or afternoon (14:00-17:00 h) for about 30 min at each larval habitat. All third and fourth instars of anopheline larvae were passed though a 100 mesh sieve and preserved in lacto-phenol. In the laboratory, each larva was individually mounted in Berlese's medium on a microscope slide and identified to species by morphological characters[14,15].

2.3. Characterization of larval habitats

Environmental characteristics of each larval habitat were measured and recorded during the larval collection. Environmental data which were determined in this study