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Seasonal Activity and Predatory Efficacy of the Water Bug *Sigara hoggarica* Poisson (Hemiptera: Corixidae) Against the Mosquito Larvae *Culex quinquefasciatus* (Diptera: Culicidae) in Riyadh City, Saudi Arabia

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Abstract: Bioefficacy of the water bug *Sigara hoggarica* Poisson (Hemiptera: Corixidae) was assessed in the laboratory and in the field (at El Haeir area, South of Riyadh City) in relation to larval and pupal densities of *Culex quinquefasciatus* Say (Diptera: Culicidae) during winter and summer seasons. The results revealed that the predatory efficacy was highest against the first larval instar and it decreased as the larvae grew older. The predatory efficacy of the bug during summer was significantly higher than winter. The population of *Sigara hoggarica* started to increase gradually in November and a peak was attained in next April, when the Mean Water Temperature (MWT), Mean Ambient Temperature (MAT) and Relative Humidity (RH) were 28, 25.5°C and 39.6%, respectively. The activity of the bug started to decline in June and it reached the lowest during August to October, when the water temperature varied between 28 to 30.5°C, the ambient temperature ranged between 26.6 to 34.9°C and the relative humidity varied between 15.5 to 23.1%. It is concluded that the water bug *Sigara hoggarica* has great potential for control of mosquito larvae in permanent and semi permanent water habitats in Riyadh City, but further studies on prey-predator relationship are required.

Key words: *Sigara hoggarica*, mosquito control, seasonal activity, Riyadh City

INTRODUCTION

The need for effective biological control organisms for mosquito larvae is great, since insecticide resistance increases in areas having received extensive insecticide treatment. Impact of pesticides in nature and the nature of mosquito resistance should be spelled out. Corixids represent one of the most important predators; they can feed on algal cells, filamentous blue-greens, small invertebrates, diatoms, fish eggs and microscopic protozoa (Bachmann, 1981; Schaefer and Panizzi, 2000). Earlier studies in Saudi Arabia have shown that *Culex quinquefasciatus* Say (Diptera: Culicidae) is the most widespread haematophagous insect and it is considered as an important source of nuisance in Riyadh Region (Biittiker, 1981; Alahmed and Kheir, 2005). The water bug *Sigara hoggarica* Poisson (Hemiptera: Corixidae) is known to be one of the efficient predators of mosquito larvae and has considerable mosquito control potential in permanent and semi permanent water habitats (Tawfik *et al*., 1990). The predatory efficacy and seasonal abundance of *Sigara hoggarica* in Saudi Arabia has not been investigated. In this study, an attempt was made to assess the predatory efficacy of *Sigara hoggarica* against *Culex quinquefasciatus* larvae in the laboratory and in the field during summer and winter seasons. The seasonal activity of the predator in Riyadh City was also investigated.

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MATERIALS AND METHODS

Collection, Identification and Rearing of the Predator

This study was conducted during the period Sept. 2003 to 2004 in Al Haeir area, 50 km South of Riyadh City (24°27' N, 46°47' E). *Sigara hoggarica* was collected from four sites at Wadi Hanifa (Riyadh City), using a D-shape hand-net and then taken to the laboratory. The predator was kept in glass aquarium (50×40×25 cm) and supplied with oxygen. The predator was fed *ad libitum* on the first or second mosquito larval instars. Representative sample of the predator was sent to The Natural History Museum in London for identification. The mean monthly temperature, humidity and rainfall in El Haeir area were obtained from the Meteorology Department, Riyadh City.

Collection, Identification and Rearing of the Prey

Larvae of *Culex quinquefasciatus* were collected from Riyadh City and identified according to the available identification keys (Hopkins, 1936; Mattingly and Knight, 1956; Harbach, 1988). The larvae were reared in mosquito rearing cages (61×61×61 cm, Bioquip Company, C.A., USA) in the laboratory and the emerged adult were fed on concentrated sugar solutions. For egg laying, the adults were fed on a pigeon as a source of blood. When mosquito larvae are required, some egg masses were taken and put in metal trays (40×30×12 cm) with some water. Some animal food concentrates were added as food for larvae and the trays were covered with iron mesh. When the mosquito larvae reached the 4th larval instar, they were transferred to a special mosquito rearing cages and the emerged adults were taken by an aspirator to a big metal cage where they were fed on sugar solutions and blood until they are required.

Predatory Efficacy of *Sigara hoggarica* in the Laboratory

Six treatments of mosquito immature stages, each consisted of 4 replicates, were prepared in plastic containers partially full of water. The first 5 experimental treatments consisted of 400 either L1, L2, L3, L4 or pupae of *Culex quinquefasciatus*. The sixth treatment was left as control treatment. A starved predator for 24 h was added to each experimental replicate and each container was tightly closed and put at room temperature in the laboratory. After 24 h, the mean numbers of larvae and pupae consumed were determined and the mean predatory efficacy of the predator against each larval instar and pupa were calculated.

Assessment of Predatory Efficacy of *Sigara hoggarica* in the Field

A shade made of plastic materials and iron frame (6×4×2 m) was made in the Agricultural Research Station at College of Food and Agricultural Sciences, King Saud University, Riyadh. Inside the shade, a table (80×60×100 cm) was placed. Six treatments, each consisted of four replicates were made and a starved predator was added to each replicate (except the control group) as described earlier for determination of predatory efficacy of *Sigara hoggarica* in the laboratory. The six treatments were put on the table inside the shade (to simulate the field conditions where the temperature, humidity, light and wind are not under control) and covered with iron mesh, to protect them from other insects. After 24 h, the mean number of each larval instar and pupae consumed by the predator were determined and the mean predatory efficacy against each larval instar and pupae were calculated.

Study of the Seasonal Activity of *Sigara hoggarica*

Four sites (different ponds and water collections at Wadi Hanifa) were selected for collection of *Sigara hoggarica*. Each site was visited every two weeks and the predators were collected by an aquatic D-shaped hand net and the collected *Sigara hoggarica* were counted and recorded. The water temperature was recorded and the mean monthly temperature, humidity and rainfall of the study area were obtained from Meteorology Department, Riyadh City.

For statistical analysis, means were compared using Least Significant Difference (LSD), (SAS, 1990). Correlation coefficients (r) between the numbers of *Sigara hoggarica* and temperature and relative humidity were also calculated (SAS, 1990). All statistical analyses results were compared at 5% level for significance.

RESULTS

The Predatory Efficacy of *Sigara hoggarica* in the Laboratory

The highest predatory efficacy was shown against the first larval instars (Fig. 1) and it decreased as the size and age of the larval instars increased (means followed by similar letters are not significantly different).

The Predatory Efficacy of *Sigara hoggarica* in the Field

The results showed that the predatory efficacy of *Sigara hoggarica* was highest against the first larval instar and it decreased as the size and age of the prey increased (Fig. 2). The results also showed that the predatory efficacy of *Sigara hoggarica* during summer is significantly higher than that during winter against each respective larval instar (means followed by similar letters are not significantly different).

The Seasonal Activity of *Sigara hoggarica*

The water bug, *Sigara hoggarica* was collected throughout the year, but the numbers obtained started to increase gradually in November and a peak was reached in next April, where 218 insects were caught. During this peak, the mean ambient temperature was 25.5°C (Fig. 3), mean water temperature was 28°C (Fig. 4) and relative humidity was 39.6% (Fig. 5). The activity of the bug started to decline in June and it reached the lowest density during August to October, where less than 3 insects were collected. During this period, the ambient temperature ranged between 31 to 35.9°C (Fig. 3), the water temperature varied between 28 to 30°C (Fig. 4) and the relative humidity varied between 15.5% to 23.1% (Fig. 5).

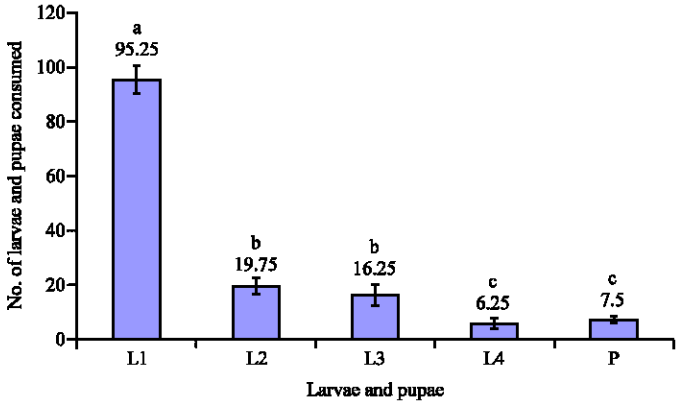

Fig. 1: Mean predatory efficacy of *Sigara hoggarica* against *Culex quinquefasciatus* immature stages in the laboratory. L1: First larval instars, L2: 2nd larval instars, L3: 3rd larval instars, L4: 4th larval instars, P: Pupal stage of *Culex quinquefasciatus*. Means followed by similar letters are not significantly different ($p>0.05$)

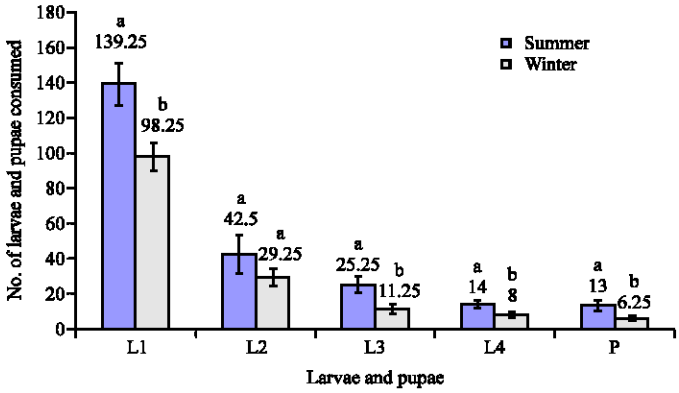

Fig. 2: Predatory efficacy of *Sigara hoggarica* against *Culex quinquefasciatus* immature stages during summer and winter in the field. L1: First larval instars, L2: 2nd larval instars, L3: 3rd larval instars, L4: 4th larval instars, P: Pupal stage of *Culex quinquefasciatus*. Means followed by similar letters are not significantly different (p>0.05)

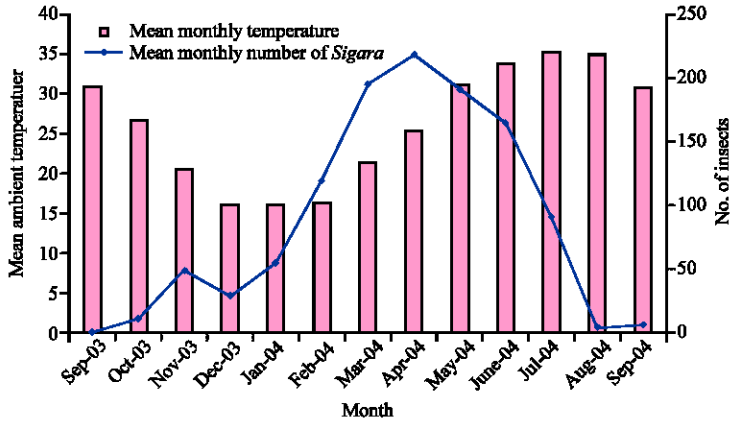

Fig. 3: The effect of ambient temperature on the seasonal activity of *Sigara hoggarica* at El Haier area, Riyadh City

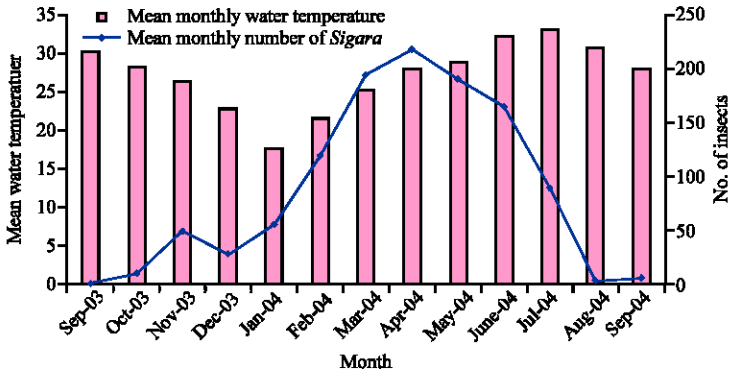

Fig. 4: The effect of water temperature on the seasonal activity of *Sigara hoggarica* at El Haier area, Riyadh City

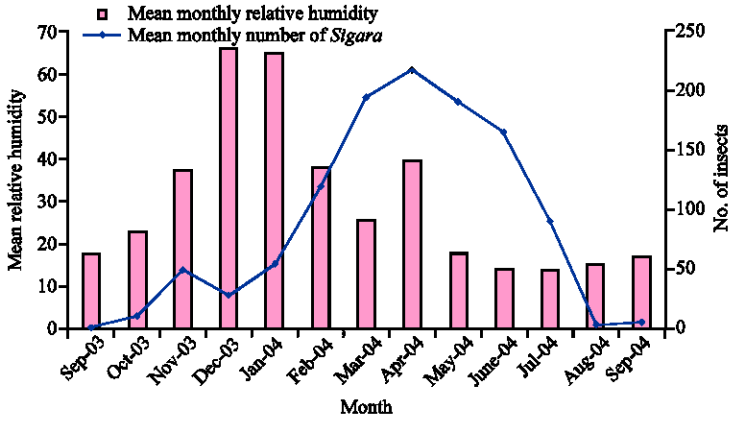

Fig. 5: The effect of relative humidity on the seasonal activity of *Sigara hoggarica* at El Haier area, Riyadh City

Statistical analysis have shown that there is a non significant negative correlation between ambient and water temperature and the numbers of *Sigara hoggarica* (r = -0.175 and r = -0.145, respectively). The results also have shown that there is a positive significant correlation between the relative humidity and the numbers of *Sigara hoggarica* (r = +0.481).

DISCUSSION

The predatory efficacy of *Sigara hoggarica,* both in the laboratory and in the field, was highest against the first larval instar and it decreased as the age and size of the prey increased. It seems that the size of the prey in relation to the size of the predator is very crucial in determining the predatory potential of the predator. Similar results were reported by Streams (1992), who found that the age of the prey has great effect on the predatory potential of the predator. Another factor which may influence the predatory potential of a predator, is the prey density. Predators may eat more prey at higher prey densities than at lower prey densities. When they eat more, predators may grow faster and the predation rate is thus a function of growth of predator size (Murdoch, 1973).

The mean predatory efficacy of the water bug in summer was significantly higher than that during winter and this might be due to the relatively high temperature during summer which makes the bug more active and predacious. Similar results were reported by Morton *et al*. (1988), who found that the predatory efficacy of mosquito fish *Gambusia affinis* during summer was significantly higher than that in winter.

These results have shown that *Sigara hoggarica* was available in its breeding sites throughout the year, but a peak of seasonal activity was attained during the period April to June. During this period, the ambient temperature varied between 25 to 30°C, the mean water temperature was 30°C and the mean relative humidity was 60% suggesting that these are the optimum environmental conditions for the bug activity.

The results of this study have shown that the water bug, *Sigara hoggarica*, is an efficient predator of *Culex quinquefasciatus* larvae and it has great potential to reduce immature stages of mosquitoes in permanent and semi permanent water collections, but further studies on prey-predator relationship are required.

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