POPULATION INTERACTION OF *TOXORHYNCHITES SPLENDEN*S AND *AEDES AEGYPTI* (DIPTERA: CULICIDAE) IN THE LABORATORY

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Abstract. Population interaction of *Toxorhynchites splendens* and *Aedes aegypti* in relation to the complexity of the breeding habitats and their initial number was studied in the laboratory. The predator and the prey were introduced in different ratios in the colony cages (1 m^3) with different oviposition structures. Predator-prey interaction lasted for 5-9 weeks without structural complexity of the oviposition containers. When there was a structural complexity, their interaction lasted for 18 weeks. During the interaction period, *Ae. aegypti* number was at a lower level. Therefore, both structural complexities of the breeding sites and initial predator and prey number play a crucial role in establishing stable interaction between them at a lower threshold level for a longer period.

INTRODUCTION

Predator-prey interaction in nature should be a sustained one for the effective control of vector populations below a threshold level. Laboratory observations showed that the genus *Toxorhynchites* and *Aedes aegypti* interacted at a low equilibrium level for 24 weeks in 1 m^3 colony cages (O'Flynn, 1975; O'Flynn and Craig, 1982). Trpis (1973) observed a classical predator-prey relationship of *T. brevipalpis* and *Ae. aegypti* in a tire dump in Dar es Salaam, Tanzania. He reported a marked seasonal fluctuation in population density with increase in *Ae. aegypti* population preceding increase of *Tx. brevipalpis*. The existence of complexity in nature is known to influence the distribution of eggs among sites and predation within the site that ensured the synchronicity in the horizontal and vertical overlapping of breeding habitats of both the interacting species (Edward, 1941; Huffaker, 1958; Corbet, 1964; Trpis, 1973; O'Flynn, 1975; O' Flynn and Craig, 1982). The present study examines (1) the influence of time-lag generated by seasonal fluctuations in population density and differences in the length of life cycle of predator and prey on the biocontrol potential of the predator, and (2) the predator release schedule determination.

MATERIALS AND METHODS

To demonstrate the population interactions, *Tx. splendens* was introduced into cyclic colony of *Ae. aegypti* in four rearing colony cages (1 m^3) in a controlled room temperature (22°C) and the predator-prey interaction was studied for a period of 20-30 weeks. There were three enamel trays per cage in the first two cages and one earthern-pot with plant twigs besides three enamel trays per cage in the remaining cages. Containers were filled with chlorine free tap water. Immatures of *Tx. splendens* and *Ae. aegypti* were counted once in a week. After counting, larvae, pupae and eggs were transferred to the containers with fresh chlorine free tap water. Twenty ml from a 20 g/l liver powder suspension were added to the containers as food for the *Ae. aegypti* larvae. Glucose and honey soaked cotton pads were provided for adult mosquitos. An immobilized chicken was provided twice a week for female *Ae. aegypti*.

Five hundred first and ten fourth instars of *Ae. aegypti* and *Tx. splendens* respectively were introduced in the four cages. No further introduction was made thereafter in the first and third cages. Fifty pairs of adults of *Tx. splendens* were released in the second cage. One hundred and fifty and twenty-five pairs of adults of *Ae. aegypti* and *Tx. splendens* were released respectively in the fourth cage. Though it was possible to count *Tx. splenden* adults in cages in the subsequent weeks after the initiation of the experiment, counting of adults of *Ae. aegypti* was difficult. Moreover, the immature density of both the species was assumed to reflect the respective adult densities. Therefore, only immature density of both the species was estimated during the study period.

RESULTS

The synchronicity of predator and prey (immatures of *Tx. splendens* and *Ae. aegypti* respectively) population interaction in relation to structural complexity of breeding habitats and their initial number is shown in Figs 1 and 2. They interacted for 9 weeks in the first cage. During the 9 weeks, *Ae. aegypti* population was fluctuating at lower level and due to predation pressure its population was observed under check but *Tx. splendens* number fluctuated and at the end of 9th week its population vanished. As a result, *Ae. aegypti* number increased and peak density of 1,250 in the 15th week was recorded (Fig 1a).

The predator and prey interacted only for 5 weeks in the second cage. Prey number declined to zero during the 2nd week that resulted in the gradual reduction of *Tx. splendens* and no predator was found after the 5th week. As a result, the *Ae. aegypti* number built up gradually and reached the peak density of 2,220 during the 15th week (Fig 1b).

Predator-prey interaction lasted for 18 weeks in the third cage and during this period the *Ae. aegypti* population was maintained at a lower level. Their interaction existed with a declining trend during the first 7 weeks. *Tx. splendens* immature number dropped to xero after 7th week, but adults in the cage laid more eggs in the pot. No predator was present between the 8th and 11th weeks. However, *Tx. splendens* appeared in the 12th week and thereafter the population fluctuated with a peak in the 18th week. *Ae. aegypti* number fluctuated at a low equilibrium level till the 18th week with a peak number of 750 in the 17th week and dropped to zero thereafter, but five to ten immatures of *Tx. splendens* were present in the containers till the end of the observation period (Fig 2a).

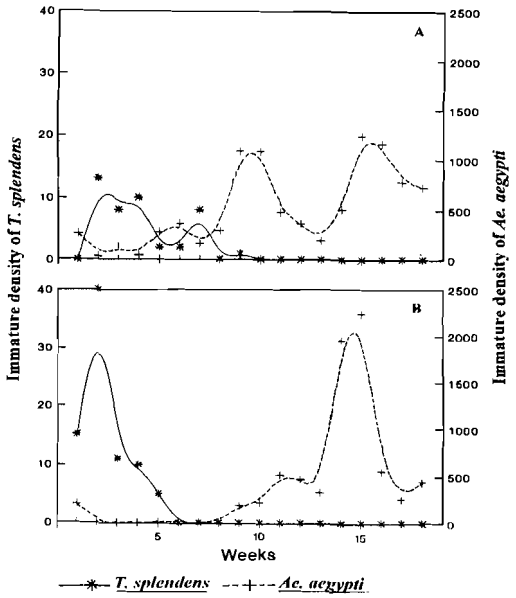

Fig 1–Population interaction of immatures of *Tx. splendens* and *Ae. aegypti* in simulated container habitats. (A) No adults were introduced and no structure provided; (B) Adults were introduced but no structure provided. Points and line represent values and trend respectively.

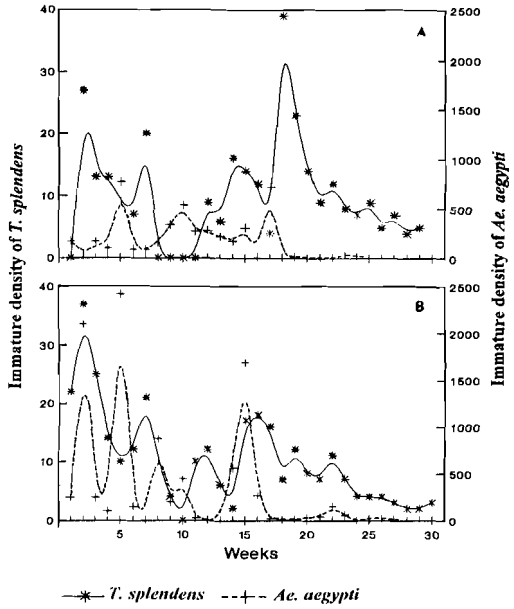

Fig 2–Population interaction of immatures of *Tx. splendens* and *Ae. aegypti* in simulated container habitats. (A) No adults were introduced but structure provided; (B) Adults were introduced and structure provided. Points and line represent values and trend respectively.

Prey and predator interacted for 17 weeks in the fourth cage. The *Ae. aegypti* larval density peaked at 2,400 during the 5th week. Thereafter, the numbers fluctuated widely. At the end of the 17th week, prey number dropped to zero and remained so throughout the observation period but *Tx. splendens*, inspite of a declining trend after the peak density in the 2nd week, was not totally eliminated during the observation period (Fig 2b). This may be attributed to the inherent

ability of the fourth instars of *Tx. splendens* to starve for longer periods. Thus, the presence of twigs in pots did not prevent *Tx. splendens* from reducing the *Ae. aegypti* population, even when large initial numbers of *Ae. aegypti* adults were present.

DISCUSSION

The *Tx. splendens-Ae. aegypti* model was selected for studying the predator-prey population interactions in the laboratory in relation to complexity of breeding habitat and initial ratios of the interacting populations. This was possible on two counts: (1) Both the genus *Toxorhynchites* and *Ae. aegypti* are container breeders (Corbet, 1964; Trpis, 1973), so the use of small laboratory containers did not exert much influence on the behavior of these interacting species and (2) there was a possibility of extending this observation for many generations. First and second cages differed in the initial number of prey and predator and no structural complexity of the breeding habitat was present in both the cages. In these cages, the prey population peaked at the same time but the difference was only in its number. In the first cage, the peak density was 1,250 whereas, it was 2,200 in the second cage in 15th week. The sudden drop in the prey density from 2,200 to as low as 300 in the predator free habitat in the second cage was attributed to overcrowding and the resultant high mortality. Because of the presence of a greater number of predator at the beginning of the experiment in the second cage, the chance of *Ae. aegypti* to establish its population was negligible. The present study indicates that only in those cages (third and fourth) with structural complexity in the oviposition containers, a strong interaction was observed between the reacting populations.

The predator and prey densities at the beginning of the breeding season are crucial on two accounts: (1) reproductive time lag and (2) reaction time lag. The reproductive time lag is generated because the time taken to complete one life cycle of *Ae. aegypti* is shorter than that of *Tx. splendens*. So the population turnover is faster in the former than in the latter. The reaction time lag is generated because the density of *Tx. splendens* at the beginning of the breeding season is much lower to have control over the *Ae. aegypti*. So they differ in reacting to seasonal changes. Both reproductive and reaction time lags can be overcome in nature by augmenting the density of the predator through releases of adults in large numbers. The objective of any vector borne disease control program is to reduce the density of target species below the critical level. To sustain the target population below that level, neither the target species nor the predator should be eliminated. Both should co-exist at a very low equilibrium level. This is possible only through the sustenance of the interaction between the predator and preys population for at least a desirable time. The present study amply demonstrated that initial predator number as well as the structural complexity in the breeding habitats is important for sustained interaction of the prey and predator populations. Releasing one predator for every fifty prey is considered sufficient for the control of target species depending on the extent of structural complexity of the breeding habitat.

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