

Effect of three constant temperatures on the predatory efficiency of four aquatic predators on culicine mosquito larvae

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ABSTRACT

The predatory efficiency of four aquatic predators [*Bufo regularis* L., *Orthetrum* spp., *Anisops sardea* Herrich Schaeffer and *Sigara selecta* (Fiebre)] at three constant temperatures (15, 25 and 35°C) was evaluated on culicine larvae. Results showed significant variation in predation rate between the four predators at the three constant temperatures tested. Regardless of temperature, the predator *Orthetrum* spp. exhibited the highest active predators (18.1 larvae/day), followed by *A. sardea* (12.2 larvae/day). *B. regularis* and *S. selecta* showed significant low predation rate (5.7 and 1.0 larvae/day). The predatory efficacy of the four predators was higher at 25 and 35°C than that at 15°C.

INTRODUCTION

Mosquitoes are closely associated with human habitation and readily enter buildings for both feeding and resting. Besides annoyance, mosquitoes play an important role in transmitting many dangerous diseases such as malaria, yellow fever, filaria and dengue (Chandler, 1955).

The current mosquito control strategies depend on synthetic insecticides. The wide use of chemicals for pest control caused many problem such as environmental pollution, toxic effect on non target organisms and appearance of resistance among target organisms to many groups of pesticides. This concept has led to other alternatives for pest control particularly among vector control, species, biological control is now a subject of interest in the present era (Ahmed, 2011).

Many pathogens and predators affect the larvae and adults of mosquitoes (Jenkins, 1964). Many attempts were conducted to evaluate the predatory efficacy of mosquito predators under laboratory conditions (Farghal, 1979; Abou Bakr, 1984; Azzam, 1987; Agamy, 1989 and Abo El-Maged, 2009).

The present work is a trial to study the effect of temperature on the predatory efficacy of four predators, *Bufo regularis*, *Orthetrum* spp., *Anisops sardea* and *Sigara selecta*.

MATERIALS AND METHODS

Mosquito maintenance:

1- Mother culture:

Larvae of *Culex pipiens* were collected from their natural breeding sites; mainly from a drainage canal near Al-Azhar Univ. at Assiut region. Metallic strainer (20 cm in diameter) with an aluminium handle (150 cm long)

was used to sweep the larvae. Collected larvae were, then, evacuated in metallic-enamiled pans (32 cm. in diameter) half-full of water from the same breeding sites. After removing plant parts or any other undesirable bodies, the contents of each pan were gently poured in a 5-liter screw capped plastic jar with a wide-mouth opening of 11 cm. Jars of mosquito samples, which have been half-full of water, were transported immediately to the laboratory.

2- Collecting and maintenance of mosquito predators:

In general, tools and methods used to collect mosquito predators were similar to those previously reported for collecting mosquito aquatic stages. However, these methods slightly differed according to the group of insects collected.

The predatory efficiency of four predators was evaluated under three constant temperatures (15, 25 and 35°C).

The predators are:

- *Bufo regularis*.
- *Orthetrum* spp. (Corduliidae, Odonata).
- *Anisops sardea* (Notonectidae, Hemiptera)
- *Sigara selecta* (Corixidae, Hemiptera).

Four instar larvae of *Culex* complex (*pipiens*, *antennatus*, *univittatus* and *fatigans*) were used in evaluation the predatory efficiency.

At each temperature degree, 3 replicates were used for each predator, evaluation was conducted in plastic cups provided with 300 ml water + 20 to 50 4th instar *Culex* larvae and one predator.

The number of mosquito larvae consumed by each predator was recorded after 24 hr for ten successive days.

RESULTS AND DISCUSSION

As shown in table (1), the predation rate of the predator *B. regularis* varied significantly at three different temperature degrees. The predator was active significantly against *Culex* larvae at 25°C, than at 35°C. The average numbers of mosquito larvae consumed by one nymph of the predator at the two temperatures ranged between 0.66 to 16.00 with an average of 9.33 larvae/day, and 0.66 to 18.00 with an average of 5.40 larvae/day, respectively. At 15°C the predator showed low predatory efficiency against mosquito larvae. The range and average consumption were 0.00 to 1.66 and 0.36 larvae/day for the predator.

According to data presented in table (2), the predation rate of the predator *Orthetrum* spp. varied significantly at the three constant temperature degrees. The predator showed the highest efficiency against mosquito larvae at 35°C followed by 25°C. The numbers of mosquito larvae consumed by one nymph of the predator ranged between 15.66 to 42.66 with an average of 25.80 larvae/day, and 12.66 to 35.66 with an average of 23.10 larvae/day, respectively. The predator show low efficiency at 15°C, the range and average consumption were 3.00 to 11.00 and 6.16 larvae/day.

Table (1): Average consumption for the predator *B. regularis* from the 4th instar larvae of Culicine mosquitoes under three constant temperature degrees.

| Days | Average number of mosquito larvae consumed/day | | |
|--------------|--|------------------------|------------------------|
| | 15°C | 25°C | 35°C |
| 1 | 0.33h±0.18 | 6.33fgh±0.48 | 5.66fgh±2.10 |
| 2 | 0.00h±0.00 | 4.33fgh±0.79 | 6.66fgh±3.12 |
| 3 | 0.33h±0.18 | 10.00efg±1.37 | 11.00def±3.11 |
| 4 | 0.00h±0.00 | 11.00def±2.21 | 12.66abc±2.93 |
| 5 | 0.00h±0.00 | 13.33ab±2.05 | 12.00cde±1.13 |
| 6 | 1.00h±0.31 | 13.33ab±1.27 | 2.33gh±1.27 |
| 7 | 0.00h±0.00 | 15.33a±0.18 | 3.66fgh±2.00 |
| 8 | 0.00h±0.00 | 4.00fgh±2.18 | 0.00h±0.00 |
| 9 | 0.66h±0.36 | 3.33fgh±1.82 | 0.00h±0.00 |
| 10 | 1.33h±0.18 | 12.33bcd±0.72 | 0.00h±0.00 |
| Range & Mean | 0.36C± (0.00-1.66) | 9.33A± (0.66-16.00) | 5.40B± (0.66-18.00) |

In each column, means followed by the same letter are not significant at 0.05% level.

Table (2): Average consumption for the predator *Orthetrum* spp. from the 4th instar larvae of Culicine mosquitoes under three constant temperature degrees.

| Days | Average number of mosquito larvae consumed/day | | |
|--------------|--|--------------------------|--------------------------|
| | 15°C | 25°C | 35°C |
| 1 | 10.33hi±1.62 | 14.66g±0.96 | 17.00g±0.54 |
| 2 | 4.66j±0.79 | 14.33gh±0.79 | 17.33g±0.48 |
| 3 | 4.00j±0.83 | 16.66g±0.65 | 18.66g±0.72 |
| 4 | 4.33j±0.18 | 18.33g±0.18 | 17.33g±0.96 |
| 5 | 6.66ij±0.65 | 23.00f±2.18 | 23.00f±1.09 |
| 6 | 4.33j±0.18 | 27.66de±0.36 | 30.66cd±0.36 |
| 7 | 5.00j±0.31 | 27.33def±0.36 | 28.33de±0.65 |
| 8 | 5.00j±1.09 | 26.00ef±0.31 | 29.00de±0.31 |
| 9 | 8.66ij±0.48 | 27.33def±0.65 | 33.33bc±0.48 |
| 10 | 8.66ij±1.27 | 35.66b±1.27 | 42.66a±0.79 |
| Range & Mean | 6.16C± (3.00-11.00) | 23.10B± (12.66-35.66) | 25.80A± (15.66-42.66) |

In each column, means followed by the same letter are not significant at 0.05% level.

Data in table (3), showed that the predation rate of the *A. sardea* varied significantly at the three constant temperature degrees. The predator was active significantly at 35°C. The average numbers of mosquito larvae consumed by one nymph of the predator ranged between 8.66 to 17.33 with an average of 14.83 larvae/day. However, the predatory efficiency of the predator at 25°C and 15°C was inbetween, consumption of one predator nymph ranged between 8.00 to 17.33 with an average of 12.70 larvae/day, and 3.33 to 18.00 with an average of 9.63 larvae/day, respectively.

The predatory efficiency of the predator *S. selecta* at the three constant temperature degrees is shown in table (4), the predation rate of the predator was high significantly against *Culex* larvae at 35°C than 15°C and 25°C, the numbers of mosquito larvae consumed by one nymph ranged between 0.00 to 2.66 with an average of 1.90 larvae/day, while the efficiency against larvae was low at 15°C and 25°C. the consumption to one nymph of

the predator ranged between 0.00 to 2.00 with an average of 0.83 larvae/day, and 0.00 to 2.00 with an average of 1.00 larvae/day, respectively.

Table (3): Average consumption for the predator *A. sardea* from the 4th instar larvae of Culicine mosquitoes under three constant temperature degrees.

| Days | Average number of mosquito larvae consumed/day | | |
|--------------|--|-------------------------|-------------------------|
| | 15°C | 25°C | 35°C |
| 1 | 4.33h±0.36 | 13.33efg±0.79 | 14.33def±0.36 |
| 2 | 7.00gh±2.21 | 14.66def±1.27 | 18.00a±0.31 |
| 3 | 8.33fgh±1.85 | 12.00fgh±0.54 | 13.66efg±0.18 |
| 4 | 9.00fgh±1.89 | 11.66fgh±1.11 | 15.33bcd±0.36 |
| 5 | 16.66ab±1.01 | 12.00fgh±1.67 | 11.00fgh±3.01 |
| 6 | 7.00gh±1.97 | 13.66efg±0.18 | 16.33ab±0.36 |
| 7 | 5.00h±0.31 | 10.33fgh±0.18 | 16.33ab±0.48 |
| 8 | 8.00fgh±0.63 | 15.00cde±1.13 | 13.00efg±0.31 |
| 9 | 17.00ab±0.83 | 13.00efg±1.44 | 14.33def±0.48 |
| 10 | 10.66fgh±1.19 | 11.33fgh±0.91 | 16.00abc±0.54 |
| Range & Mean | 9.63C± (3.33-18.00) | 12.70B± (8.00-17.33) | 14.83A± (8.66-17.33) |

In each column, means followed by the same letter are not significant at 0.05% level.

Table (4): Average consumption for the predator *S. selecta* from the 4th instar larvae of Culicine mosquitoes under three constant temperature degrees.

| Days | Average number of mosquito larvae consumed/day | | |
|--------------|--|-----------------------|-----------------------|
| | 15°C | 25°C | 35°C |
| 1 | 1.33bcd±0.36 | 1.66bc±0.18 | 0.33cd±0.18 |
| 2 | 1.33 bcd ±0.18 | 1.66bc±0.36 | 0.33cd±0.18 |
| 3 | 1.00 bcd ±0.31 | 1.00bcd±0.31 | 0.33cd±0.18 |
| 4 | 1.00 bcd ±0.00 | 0.00d±0.00 | 1.66bc±0.36 |
| 5 | 1.00 bcd ±0.31 | 1.33bcd±0.18 | 2.33ab±0.18 |
| 6 | 0.33cd±0.18 | 0.33cd±0.18 | 2.33ab±0.18 |
| 7 | 1.00 bcd ±0.00 | 1.00bcd±0.00 | 3.00a±0.00 |
| 8 | 0.33cd±0.18 | 1.00bcd±0.31 | 2.33ab±0.48 |
| 9 | 1.00 bcd ±0.31 | 1.33bcd±0.18 | 3.00a±0.00 |
| 10 | 0.00d±0.00 | 0.66cd±0.18 | 3.33a±0.18 |
| Range & Mean | 0.83B± (0.00-2.00) | 1.00B± (0.00-2.00) | 1.90A± (0.00-2.66) |

In each column, means followed by the same letter are not significant at 0.05% level.

Generally, statistical analysis (Table 5) showed that *Orthetrum* spp. devoured more mosquito larvae with highly significant rate as compared with other predators at 25°C and 35°C temperatures. So that, temperature has a great effect on the consumption of larvae and bioactivity of predators. The highest predation rate of aquatic bugs and beetles from mosquito larvae has been previously recorded by many author's (Farghal, 1979; Abo-El-Maged, 2009 and Abou Bakr, 1984).

The most important predators recorded in association with mosquito immature stages in the present study and many parts of the world were

aquatic beetles (Coleoptera: Dystiscidae), aquatic bugs (Hemiptera: Belostomatidae, Corixidae and Gerridae), may fly (Ephemeroptera, Ephemerellidae and Lebtophelbidae) dragon fly and damse fly (Odonata: Coenagriidae and Cordullidae). Das *et al.* (2005), Baumgardner and Bowles (2005), Dehghagni *et al.* (2007), Deepa and Roa (2007).

Table (5): The mean consumption of the four aquatic predators on 4th larval instar of Culicine mosquitoes under three constant temperature degrees during 10 days.

| Predators | Temperatures | | |
|-----------------------|--------------|---------|---------|
| | 15°C | 25°C | 35°C |
| <i>B. regularis</i> | 0.36 C | 9.33 A | 5.40 B |
| <i>Orthetrum spp.</i> | 6.16 C | 23.10 B | 25.80 A |
| <i>A. sardea</i> | 9.63 C | 12.70 B | 14.83 A |
| <i>S. selecta</i> | 0.83 B | 1.00 B | 1.90 A |

In each row, means followed by the same letter are not significant at 0.05% level.

According to Knight *et al.* (2004), the biotic interactions, such as predation and competition, can strongly regulate the number of mosquito larvae by reducing the number of larvae that survive through instars and to emergence, and by increasing the generation time. Shaalan *et al.* (2007) concluded that the aquatic bugs and beetles are effective as predators of mosquito immature and may be useful in biocontrol of medically important mosquitoes. From the viewpoint of efficient and sustainable biological control in the field condition, the aquatic predators should have a wide range of adaptability in the habitats apart from the predation of target mosquito larvae. Temperature between 25°C and 35°C was convenient for predators to devour mosquito larvae, in addition this temperature range are preferable for mosquitoes flourishing. So in integrated mosquito control natural enemies showed be released in mosquito breeding places when temperature reached from 25°C to 35°C. Further work is necessary to determine the proper methodology of mass rearing and augmentative release of bugs and beetles to make this biocontrol procedure possible for wide application.

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تأثير ثلاث درجات حرارة ثابتة علي الكفاءة الإفتراضية لأربع مفترسات مائية علي يرقات بعوض الكيوليسيبي

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تم دراسة معدل الكفاءة الإفتراضية لأربع مفترسات مائية [*Bufo regularis* L., *Orthetrum* spp., *Anisops sardea* Herrich Schaeffer and *Sigara selecta* (Fiebre)] عند ثلاث درجات حرارة ثابتة 15، 25، 35°م علي يرقات بعوض الكيوليسيبي وأوضحت النتائج فروق معنوية في معدل الإفتراس بين الأربعة مفترسات عند كل من درجات الحرارة الثابتة المختبرة. أظهر المفترس من جنس *Orthetrum* spp. كفاءة إفتراضية عالية بمتوسط إستهلاك 18.1 من اليرقات / اليوم الواحد يليه المفترس *A. sardea* (12.2 من اليرقات / اليوم الواحد). أما النوعين الآخرين *B. regularis*، *S. selecta* فقد أظهرتا معدل إفتراس أقل معنويًا حيث كان (5.7 و 1 يرقة / يوم). عموماً فالكفاءة الإفتراضية للأربع مفترسات كانت أعلى عند درجتَي حرارة 25 و 35°م عن درجة الحرارة الأخرى 15°م. وتوضح النتائج أن لدرجة الحرارة تأثير معنوي على معدل الكفاءة الإفتراضية لكل من المفترسات الأربعة المختبرة.

قام بتحكيم البحث

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