

FEEDING BEHAVIOUR OF *EPIPLATYS SENEGALENSIS* (PISCES: CYPRINODONTIFORMES; CYPRINODONTIDAE).

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ABSTRACT

Predation by *Epiplatys senegalensis* (Steindachner) 1870 was significantly influenced ($P < 0.01$; $F = 145.14$; $df = 3, 16$) by changes in light intensity. Higher consumption occurred at a higher light intensity ($0.82 \mu\text{W}/\text{cm}^2\text{-nm}$) than at zero intensity ($0.00 \mu\text{W}/\text{cm}^2\text{-nm}$). Consumption was also higher during the first 10 minutes of the experiment than at a latter time. Prey (mosquito larvae) motion and prey density did not significantly influence the total number of prey consumed by *E. senegalensis* ($P > 0.05$). However, mobile prey were consumed at a faster rate during the first 10 minutes of feeding than the immobile prey. The total number of prey items consumed appears to be limited by gut capacity and eventual satiation. More larvae were eaten (predated upon) when the fish were starved for 24 hours than when starved for 12 hours before feeding. Greater preference was shown by the fish for small-sized prey (0.50 cm) than for large-sized prey (1.0 cm) ($P < 0.05$). The rate of predation was also greater on small-sized prey than on large-sized prey. *E. senegalensis* is suggested for use as an effective biocontrol agent for early larval stages in mosquito breeding grounds.

KEY WORDS: Fish, *Epiplatys senegalensis*, light intensity, prey, mosquito larvae, hunger level, prey density, prey size, prey motion, feeding behaviour.

Running title: *E. senegalensis*, feeding behaviour.

INTRODUCTION

A study conducted after a pesticide treatment in the Ikpoba River, Nigeria (Victor, Unpublished data) showed that there was a negative correlation between the abundance of *Epiplatys senegalensis* (Steindachner) and the abundance of mosquito larvae, *Culex pipiens fatigans* (Weid), suggesting the possibility of using this fish as a potential biocontrol agent for the larvae. Biocontrol measures are preferred for pest control because they do not cause chemical pollution in the environment.

Attempts have earlier been made to use larvivorous piscine predators for mosquito control in many parts of the world and some of the genera tried include *Gambusia*, *Lebistes*, *Panchax*, *Sarotherodon* and *Tilapia* (Green and Imber, 1977; Menon and Rajagopalan, 1978; Solomon, 1985). In the attempt to control mosquito larvae, success has been reported with *Gambusia* in

providing permanent Anopheline control at reduced cost in the Southern United States of America (Hildebrand, 1921) and in some California rice fields (Hoy and Reed, 1971). Hence it has been stated that *Gambusia affinis* and *Poecilia reticulata* are the most commonly used species for mosquito control (Ali and Laird, 1984).

Other species that have been used for mosquito control include those in the genera *Alburnoides*, *Gobio*, *Nemophilus* and *Phoxinus* in Soviet Central Asia (Lindberg, 1974). In Nigeria, the use of *Aphyosemion gardneri* in the control of mosquito larvae has been investigated and found to be potentially viable (Anthony and Nwogu, 1984). *Epiplatys grahami* has also been found to feed vigorously on mosquito larvae (Solomon, 1985).

Ndome and Victor (in Press) in a study conducted in Nigeria have found that *Epiplatys senegalensis* is distinctly larvivorous and both large and small fish feed on dipteran larvae in their natural

habitat. To effectively utilize piscine predators in mosquito control, some knowledge on the feeding behaviour of the fish in question and how this behaviour is influenced by environmental conditions is essential.

Literature showed that no investigation has been conducted on some aspects of the feeding behaviour of *E. senegalensis*. The present study is therefore aimed at evaluating the effects of such factors as light, prey motion, prey density, hunger level and prey size on predation by *E. senegalensis* feeding on mosquito larvae in the laboratory.

MATERIALS AND METHODS

Stock samples of the fish were collected from a back-water pond in Benin City, Nigeria. Live fish were maintained in the laboratory in aquaria. Stream water from the study site or clean rain water was used to prepare the aquaria which were well aerated and the fish were well fed. Using *E. senegalensis* from these aquaria, experiments were carried out to determine the effects of light intensity, prey motion, prey density, hunger level and prey size on the feeding behaviour of the fish.

Effect of Light Intensity

The prey used here were the larvae of the mosquito, *Culex pipiens fatigans* Weid. All the larvae used were 0.50 cm in length. The predator was *E. senegalensis* with an average length of 3.00 cm (SL) consisting of two females and three males. Each fish was kept in an experimental chamber constructed from transparent plexiglass material with a total volume of 3 litres. The fish were fed with mosquito larvae for 12 hours and then starved for 12 hours before the commencement of each experiment. Four set-ups of the experiment were carried out here with all other conditions being the same except for the changing light intensity. In the first set-up, the ambient light intensity was $0.18 \mu\text{W}/\text{cm}^2\text{-nm}$ measured with a light meter. In this experiment, 30 mosquito larvae each were introduced simultaneously into the five experimental chambers containing the fish. The numbers of larvae left after 120 minutes, counted at 10 minutes intervals, were noted in each chamber.

The same procedure was repeated for the other three experimental set-ups with ambient light intensities of $0.82 \mu\text{W}/\text{cm}^2\text{-nm}$, $0.17 \mu\text{W}/\text{cm}^2$ and $0.00 \mu\text{W}/\text{cm}^2\text{-nm}$. These light intensities were

obtained in the morning, afternoon, evening and in total darkness respectively. There were five replicates in all the set-ups.

Effect of Prey Motion

The predator and prey as well as the experimental chambers involved in this experiment were as stated in the light experiment above. The light intensity here was $0.82 \mu\text{W}/\text{cm}^2\text{-nm}$ in the two set-ups of the experiment.

In the first set-up of the experiment, thirty live mosquito larvae were introduced simultaneously into each of the five experimental chambers containing the fish. The number of mosquito larvae remaining in each of the tanks after 120 minutes, counted at 10 minutes intervals, was noted. The same procedure was used in the second experimental set-up. In this case immobile mosquito larvae, freshly killed by drying on filter paper, were used as food.

Effect of Prey Density

The same predator and prey-type as described in the prey motion experiments were used in these sets of experiments. There were two sets of experiments here. In the first set, the fish were fed simultaneously with 30 mosquito larvae in each chamber and in the second set, the fish were fed simultaneously with 60 mosquito larvae in each chamber. The number of larvae left in the chambers was counted at 10 minutes intervals and the total number consumed after 120 minutes determined.

Effect of Hunger Level

Type and size of predator and prey were the same as in the earlier experiments described above. There were three experimental set-ups here. In these, fish were fed for 12 hours, 18 hours and 24 hours and then starved for 12 hours, 18 hours and 24 hours respectively before the commencement of feeding again. Thirty mosquito larvae were provided for each fish in the chambers at the three hunger levels and the numbers consumed, determined at the end of 120 minutes. There were five replicates in each experiment and counts were made at 10 minutes intervals.

Effect of Prey Size

The prey here were of three sizes (length, 0.50 cm, 0.70 cm and 1.00 cm). Ten mosquito larvae from each size class were put together and introduced simultaneously into each of the experimental chambers containing the predator (*E.*

senegalensis) starved for 12 hours. This gives a total of 30 mosquito larvae in each chamber. The number of larvae of the respective size-classes remaining in the chambers after 120 minutes was counted at 10 minutes intervals and recorded. There were five replicates.

RESULTS

Light intensity

The effect of light intensity on predation by *E. senegalensis* on mosquito larvae is illustrated in figure 1. In total darkness ($0 \mu\text{W}/\text{cm}^2\text{-nm}$), the mean number of prey consumed was 6.52 ± 1.25 . In light intensities of 0.17, 0.18 and $0.82 \mu\text{W}/\text{cm}^2\text{-nm}$, the means of numbers of prey eaten were 7.28 ± 1.61 , 9.44 ± 2.22 and 16.68 ± 3.36 larvae respectively. When the numbers of prey consumed in the 4 experimental light intensities were compared using ANOVA, the results revealed a highly significant difference between consumption at the different light intensities ($P < 0.01$; $F = 145.14$; $df = 3, 16$). An *a posteriori* test (DUNCAN's), however, showed that there was no significant difference ($P > 0.05$) between predation in total darkness ($0.00 \mu\text{W}/\text{cm}^2\text{-nm}$) and predation in $0.17 \mu\text{W}/\text{cm}^2\text{-nm}$ light intensity. Nevertheless, consumption at 0.18 and $0.82 \mu\text{W}/\text{cm}^2\text{-nm}$ light intensities were significantly different from each other ($P < 0.05$) with greater consumption recorded in the latter than in the former light intensity. There was also a significant difference between consumption at the higher intensities ($P < 0.05$) than the two lower intensities mentioned earlier. The results (Fig. 2) also showed that in all the experimental light intensities, maximum prey consumption occurred within the first 10 minutes of feeding time after which the consumption rate fell, although the mean number consumed did not.

Prey motion

As shown in figure 3, for mobile and immobile prey, the means of numbers consumed by *E. senegalensis* within 120 minutes were 19.44 ± 7.45 and 20.84 ± 6.97 respectively. A Student's t-test performed to compare these means showed that there was no significant difference between the consumption of mobile and immobile prey by the fish ($t = 2.03$; $df = 4$; $P > 0.05$). However, results in figure 4 show that the mobile prey were consumed at a faster rate than the immobile prey ab initio.

Prey density

The mean number of mosquito

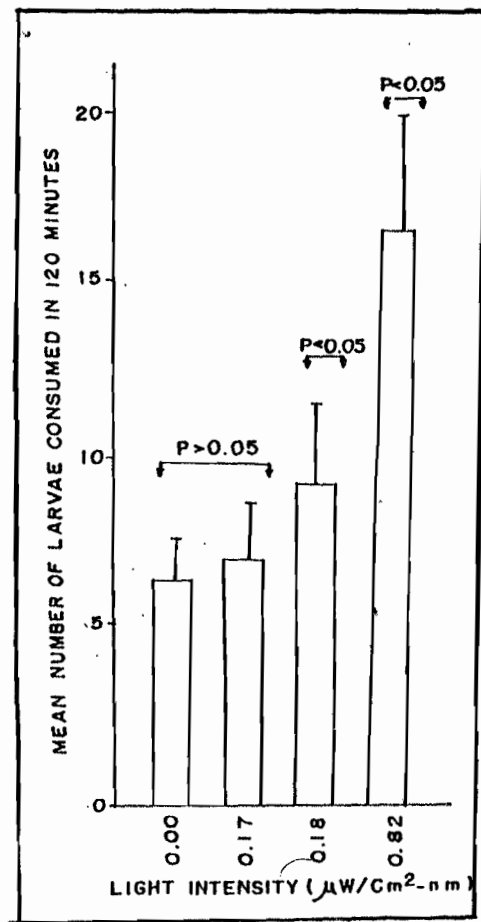


Fig. 1: Effect of light intensity on predation by *E. senegalensis*.

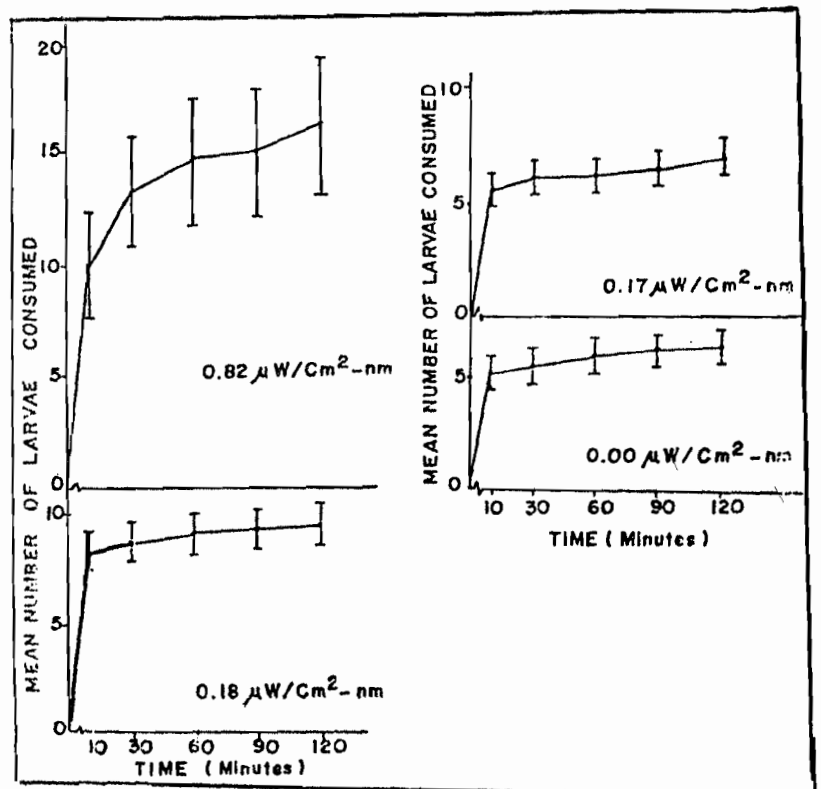


Fig. 2: Relationship between time and mean number of prey consumed by *E. senegalensis* in different light intensities.

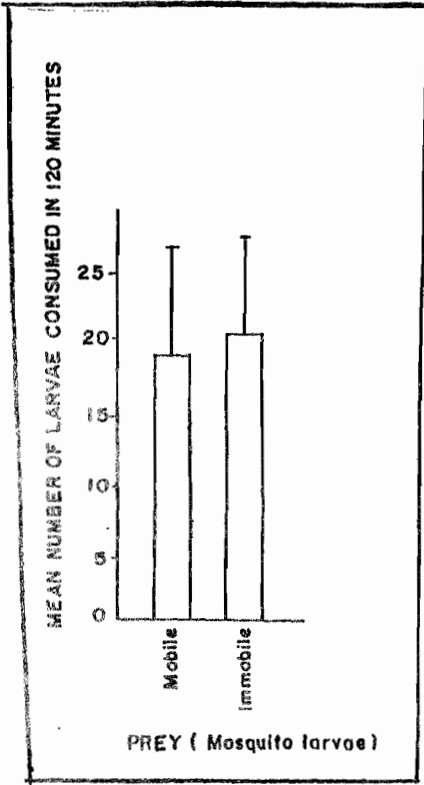


Fig. 3: Effect of prey motion on predation by *E. senegalensis*.

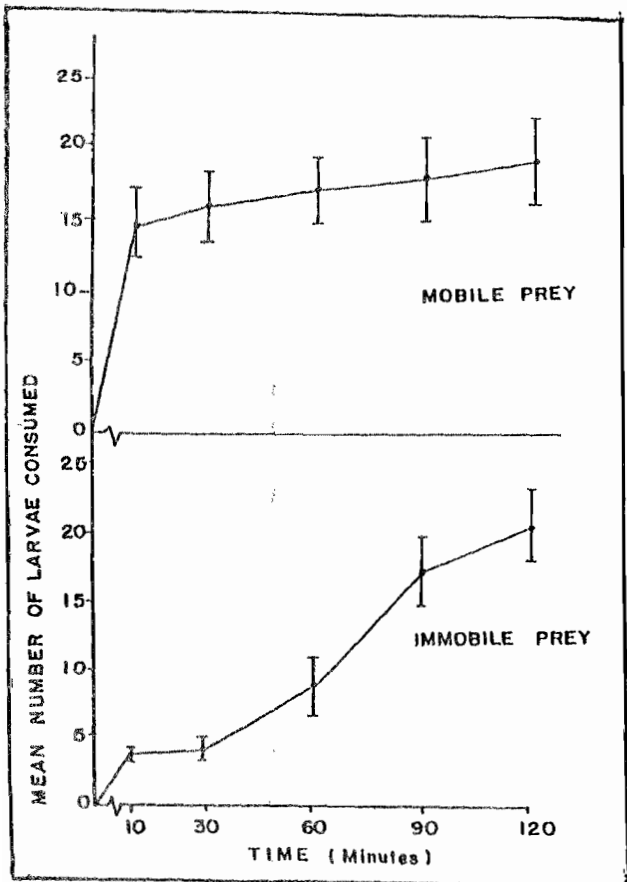


Fig. 4: Relationship between time and consumption of mobile and immobile prey by *E. senegalensis*.

larvae consumed after 120 minutes of predation by *E. senegalensis* at prey densities of 30 and 60 were 21.60 ± 8.84 and 21.80 ± 8.92 respectively (Fig. 5). The comparison of these means using a Student's t-test showed that there was no significant difference ($t = 0.4$; $df = 4$; $P > 0.05$) in consumption at these two levels. The rate of predation from the beginning to the end of the experiment at both densities showed a similar pattern (Fig. 6).

Hunger level

The mean numbers of mosquito larvae consumed by *E. senegalensis* after starvation for 12, 18 and 24 hours were 16.68 ± 3.36 ; 22.72 ± 6.23 and 25.12 ± 5.37 respectively. These means were significantly different from each other ($P < 0.05$; $F = 4.05$; $df = 2, 12$) when compared using ANOVA. The predation at the 12 and 18 hours levels were not significantly different ($P > 0.05$). Similarly the 18 and 24 hours hunger levels did not differ significantly ($P > 0.05$) from each other in terms of consumption. Significant difference in consumption was however seen between the 24 hours hunger level and the 12 hours hunger level ($P < 0.05$). This effect is shown in figure 7. The predation rate showed a similar pattern at all the

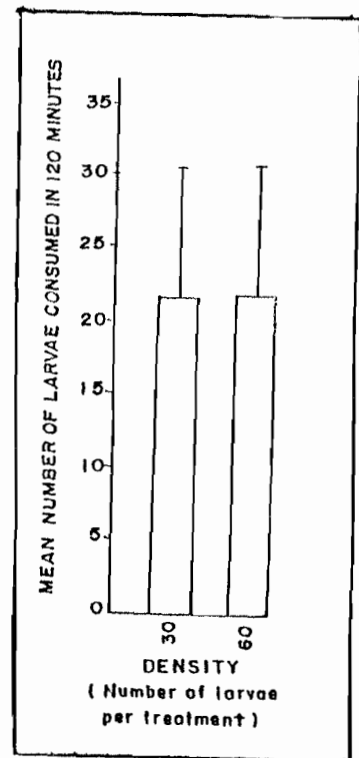


Fig. 5: Effect of prey density on predation by *E. senegalensis*.

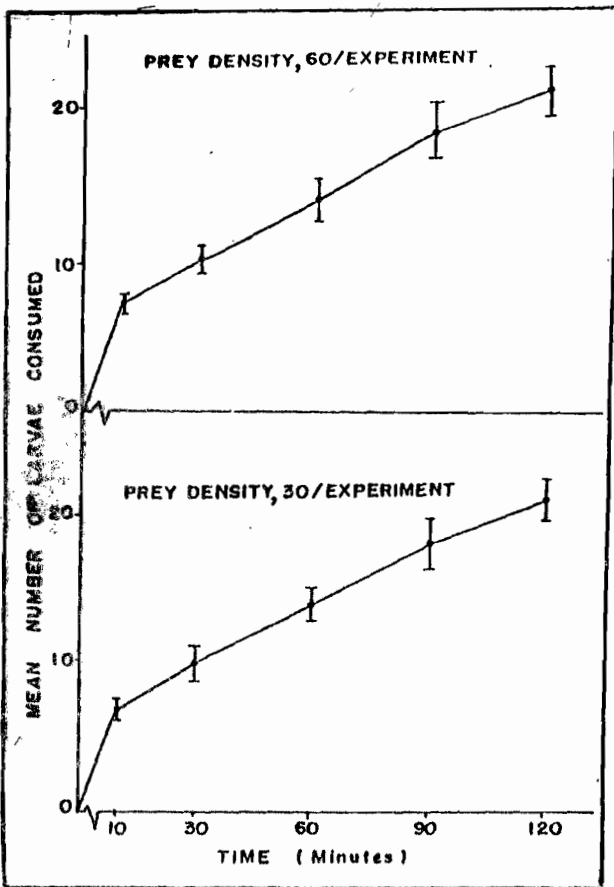


Fig. 6: Relationship between time and prey consumption at different prey densities by *E. senegalensis*.

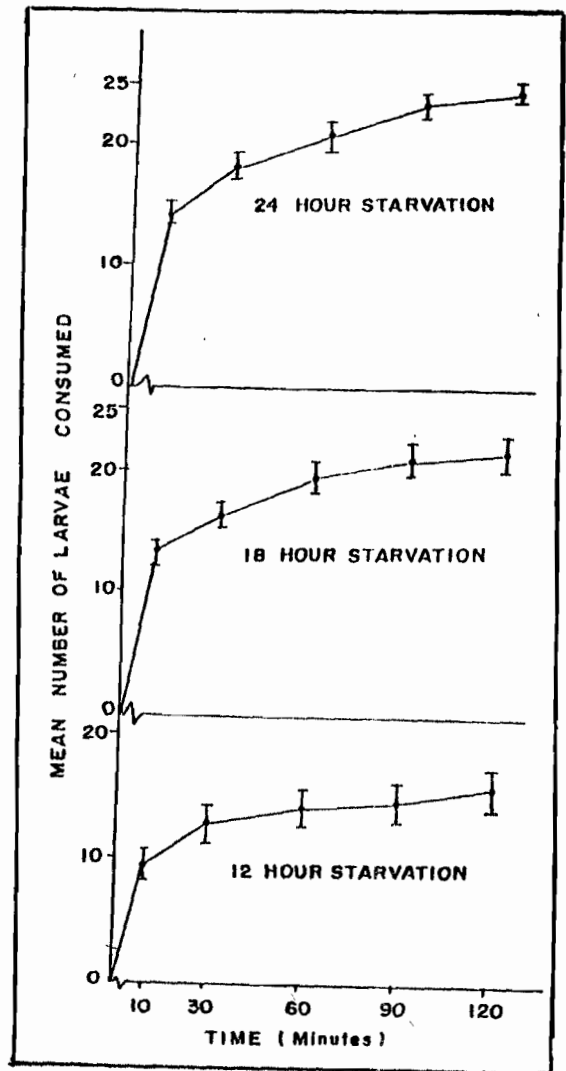


Fig. 8 Relationship between time and prey consumption at different hunger levels by *F. senegalensis*.

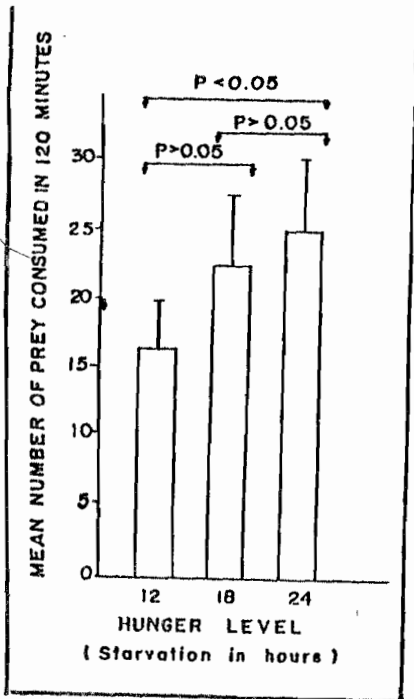


Fig. 7: Effect of hunger level on predation by *E. senegalensis*.

hunger levels but the mean number of larvae consumed after the first 10 minutes was highest at the 24 hours hunger level

(14.52 ± 0.75) and lowest at the 12 hours hunger level (10.00 ± 1.09) (Fig. 8).

Prey size

Figure 9 shows the effect of prey size on predation by *E. senegalensis*. When offered 0.50 cm; 0.70 cm and 1.00 cm long mosquito larvae, the means of numbers eaten after 120 minutes were 8.0 ± 0.83; 6.28 ± 2.86 and 1.20 ± 2.00 respectively. Comparison of these means using ANOVA revealed a significant difference (P < 0.01; F = 7.99; df = 2, 12). An *aposteriori* comparison of means using Duncan's multiple range test showed that the consumption of small and medium-sized larvae (0.50 cm and 0.70 cm) were not significantly different (P > 0.05). However, the consumption of large-sized larvae (length, 1.00 cm) was significantly lower (P < 0.05) than the consumption of small and medium-sized larvae. Figure 10 shows

the relationship between predation rate and time, indicating that, in the first 10 minutes of predation, the small-sized larvae were consumed at a faster rate with a mean consumption of 4.56 ± 0.34 and the large-sized larvae consumed at the slowest rate with a mean consumption of 0.88 ± 0.28 larvae.

DISCUSSION

The present study shows that light intensity affects the predation by *E. senegalensis* with higher consumption at higher intensities than at lower intensities. Most fishes in nature lack tactile and electrical cues for locating their food and have to rely on the availability of light for vision and prey visibility (Zaret and Kerfoot, 1975). This could be applicable to *E. senegalensis*. Suffern (1973) observed that there was low feeding on *Daphnia galeata* by Golden Shiner, a cyprinid, at low light intensity. Similarly, Wood (1976) also demonstrated that the exposure of *Tilapia zilli*, *T. macrocephala* and *T. melanopleura* to day light increased their swimming ability resulting in greater food consumption. Hopkins (1983) remarked that the ability of fish to see is related to the efficiency of prey capture. The present result is therefore not surprising. The fall in the rate of consumption after 10 minutes shown by *E. senegalensis* could be attributed to gut fullness and satiation.

Statistical analysis did not show any significant difference in the number of mobile and immobile prey consumed by *E.*

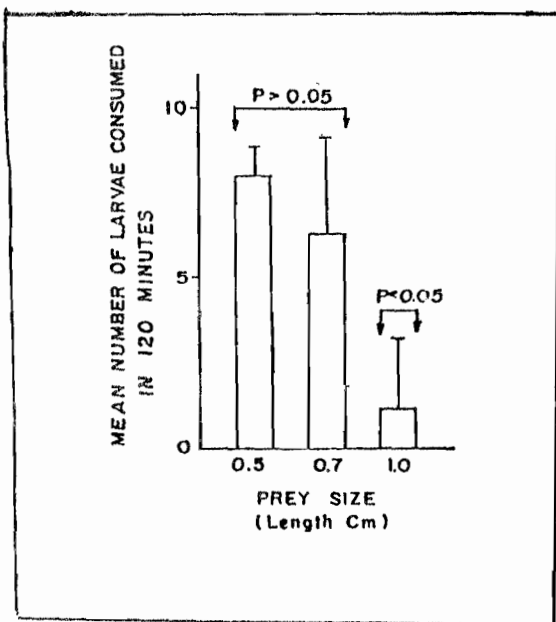


Fig. 9: Effect of prey size on predation by *E. senegalensis*.

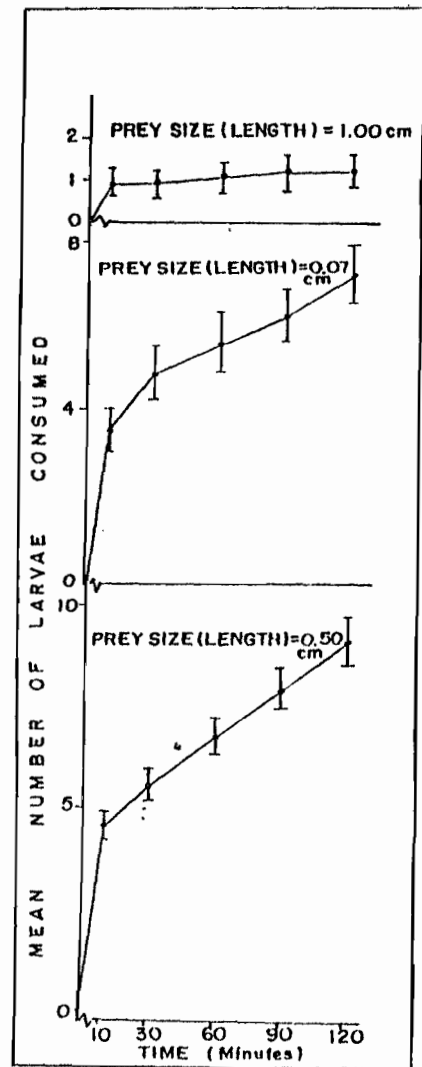


Fig.10 Relationship between time and the consumption of different prey sizes by *E. senegalensis*.

senegalensis. This indicates that motion is not a very important factor affecting prey location and capture. The prey motion as a factor of predation could be due to a combination of many factors. In other words, success can be achieved by learning to recognize the prey present (Popham, 1942). This study also revealed that prey motion significantly affected prey capture in the first 10 minutes of predation. So it is clear that prey motion has a definite effect on predation rate in *E. senegalensis* and not the number of prey consumed which obviously is limited by gut capacity and eventual satiation.

In this study, prey density did not affect the total number of prey consumed after 120 minutes. However, predation rate was highest in the first 10 minutes of the experiment and decreased thereafter. It seems that as long as the quantity of prey

in the environment is enough to satiate the fish, any further increase in prey density may have no effect on predation by *E. senegalensis*. According to Lowe-McConnell (1975), the problem of focusing on any one prey item at a given time may even arise at high prey densities hence hampering predation rate.

As seen in the present study, hunger level has a definite effect on predation rate. This is reflected in the predation at the 12 hours and 24 hours hunger levels. Welcomme (1979) has also shown that after a long interval of enforced deprivation between feeding bouts in stickle backs (*Gasterosteus aculeatus* L.) the feeding that follows is, in some respects, more rapid suggesting increased motivation.

The prey size also affects the predation by *E. senegalensis* on mosquito larvae. Studies utilizing predation constants (Kpr) in the assessment of prey preferences have revealed that prey size is an important parameter in predation on mosquitoes (Marian *et al.*, 1983). In *E. senegalensis*, small-sized prey were consumed more than the large-sized prey suggesting that the fish could be a 'gape limited predator' (Ivlev, 1961). Much work has already been done on size-dependent predation. Brooks and Dodson (1965) observed that the sizes of the zooplankton prey determined the prey detection in alewife (*Alosa pseudoharengus*) which selectively removed large items. Similar findings have also been recorded by Brooks (1968) for the *Alosa pseudoharengus/Diaptomus minutus* predator/prey system; Elliot (1975) for *Salmo trutta*; Ponniah (1978) for *Macropodus cupanus* and Pandian *et al.* (1979), for *Mesogomphus lineatus*. In the natural environment, there exists a positively significant correlation between gape size and food size of *E. senegalensis* (Ndome, 1986). Since it has been shown by this study that *E. senegalensis* is a more efficient predator on small-sized larvae of *Culex p. fatigans*, the predation pressure exerted by this fish in the field is likely to be intensive on larval stages.

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