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PREDATION PROPENSITIES OF THE LARVA OF *ORTHETRUM SABINA* (DRURY) (ANISOPTERA: LIBELLULIDAE)

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Abstract — The predatory propensities of larval *O. sabina* in the spawn of the common carp *(Cyprinus carpio)* were studied under laboratory conditions. The satiation time was about

40 min, and it took 85 s to consume a prey. The dragonfly predatory capacity amounted to about 16 spawn, whereupon the same maximum appetite was restored after 24-36 h of deprivation. It is shown that a decline in predatory efficiency occurs after the first 10 min of feeding. The time required for predation and consumption of a single spawn was less at high than at low prey densities. Quantitative data on the number and rate of attacks, and on the effect of food deprivation are provided.

Introduction

Predation of fish by a number of aquatic insects, such as *Notonecta, Nepa, Dytiscus* and *Cybister,* has been studied by several workers (e.g. GANGULY & MITRA, 1961; DAHEM, 1972; RISE, 1975), but very little experimental work has been done with reference to dragonfly larvae. The Anisoptera were recorded to feed on carp spawn by JHINGRAN (1978), while HATI & GHOSH (1965) reported larvae of *Brachytron pratense* attacking and devouring young fish in absence of other food. NIRMALA KUMARI & NAIR (1983) recorded the predation on fish fray by *Urothemis s. signata.*

Material and methods

Final instar larvae of *Orthetrum sabina* were collected from a nursery pond at Fish-Dale, Shillong. The larvae were maintained individually in aquaria of 300 ml capacity. They were fed on 2-3 days old spawn of common carp *(Cyprinus carpio)* for a period of 7 days to acclimatise them to the test prey and to laboratory conditions. The spawns were brought from Fish-Dale (Shillong) or from Ulubari Fish Farm (Guwahati) on the day of the experiments and were kept in an aquarium (40x48x 40 cm).

Results

Satiation time

When an animal no longer accepts offered food after a period of active feeding, it is considered to be fully satiated. The time from the start of feeding to such voluntary cessation is defined as the satiation time (BRETT, 1971). In the present investigation to determine the satiation time, larvae were starved for a period of 36-42 h before

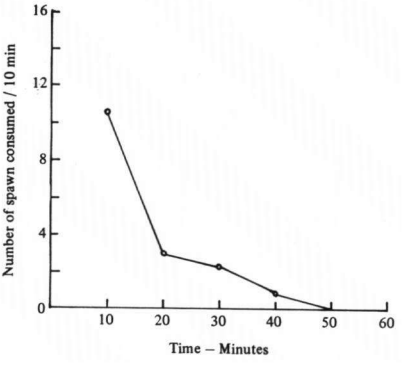

Fig. 1. Number of spawn consumed by the larva of *Orthetrum sabina,* over 6 successive 10-min intervals.

the commencement of feeding experiments. Ten spawns were introduced into each aquarium containing larvae. The number of spawn consumed was recorded for a total period of 60 min at 10-min intervals. Care was taken to maintain the density of spawn (D = 10 spawn/aquarium) constant by adding spawns.

It was observed that during the initial 10 min the larvae consumed nearly 10 spawn, i.e. 62% of the total consumption during the one-hour period. The number of spawn consumed during the subsequent 10 min intervals decreased to 3, 2, 0.9, 0.0 and 0.0 spawn during the second, third, fourth, fifth and sixth 10-min periods respectively (Fig. 1). Thus, within 40 min of feeding

Table I — Number and rate of attacks in the larvae of *Orthetrum sabina* during 6 successive 10 min-intervals of feeding — [Each value represents the average performance of 10 individuals]

Interval	No. of attacks	No. of successful attacks	Rate of attack (No/min)	Rate of successful attack (No/min)
First	16.8 ± 1.93	10.5 ± 0.94	1.68 ± 0.19	1.05 ± 0.18
Second	9.8 ± 1.02	3.0 ± 0.67	0.98 ± 0.10	0.30 ± 0.06
Third	8.6 ± 1.01	2.3 ± 0.47	0.86 ± 0.10	0.23 ± 0.05
Fourth	5.0 ± 0.67	0.9 ± 0.32	0.50 ± 0.07	0.09 ± 0.03
Fifth	0.0	—	—	—
Sixth	0.0	—	—	—

time the larvae consumed 16 spawns.

It was also revealed that the larvae attacks 16.8 times during the first 10 min (Tab. I). However, the number of attacks decreased with advancing time. No attack was made by the larvae during the fifth and sixth 10-min periods. An attack was considered successful when the larva managed to capture and consume the prey. It was seen that not only the total number of attacks decreased with advancing time, but also the number of successful attacks decreased from 10.5 during the initial 10 min to 0.0 during the fifth 10--min period.

It was noted that the rate of attack (number of attacks/minute) was 1.68/min during the first 10 min, of which 1.05 was successful. During the fourth 10 min the rate was 0.9/min, of which only 0.09/min was successful (Tab. I). The number of successful attacks expressed as percentage of total number of attacks made by the larvae gives what may be termed the predatory efficiency (MATHAVAN, 1976). This efficiency decreased in the present experiment from 62% during the first 10 min to 30%, 26% and 18% during the successive 10-min intervals respectively. From the above observations it is clear that within a period of 40 minutes of feeding the larva is fully satiated, which is indicative of the satiation time in *Orthetrum sabina*.

Effect of deprivation time

HOLLING (1966) used voluntary food intake as a measure of appetite. MATHAVAN (1976) used the amount of food consumed by a dragonfly larva in relation to deprivation time as an objective assessment of hunger. In order to study the effect of hunger on the dragonfly larvae, test individuals were deprived of food for 6, 12, 18, 24, 36 and 42 h. They were subsequently exposed to a constant supply of 10 spawn. Observations were made continuously for a period of 1 h.

It was revealed that the number of prey consumed by a larva previously starved for 6 h amounted to 3 spawns (Tab. II). The number increased to 7, 10 and 15 in larvae starved for 12, 18 and 24 h, respectively. However, the number remained constant at 16 spawns in larvae starved for 36 to 42 h. An increased number of prey organisms caught and consumed by larvae previously starved for different periods increased the satiation time. Larvae deprived for 6 h were satiated after predating 3 spawns in about 18 min; the values progressively increased for larvae deprived for 12, 18 and 24 h (15 spawns in 36 min). In larvae deprived for 36 and 42 h, both the maximum number of spawn predated (16.8) and the satiation time (38 min) were more or less similar to those of the larvae deprived for 24 h. Thus it can be inferred that between 24-36 h of starvation the maximum appetite is returned.

Table II — The effect of food deprivation duration (h) on the number of spawn predated, satiation time (min) and rate of attack in the larvae of *Orthetrum sabina* — [Each value is based on 6 observations]

h	Spawn consumed	Satiation time	Rate of attack (No./min)
6	3	18	0.23
12	7	24.8	0.37
18	10	28.8	0.40
24	15	36.2	0.62
36	16.8	38.2	0.69
48	16.8	38.3	0.69

Taking the initial feeding period of 60 min, the mean rate of attack of the larvae exposed to a constant supply of 10 spawns after periods of 6, 12, 18, 24, 36 and 42 h of starvation was calculated (Tab. II). It was seen that the rate of attack was low (0.23/min) in larvae fed after 6 h

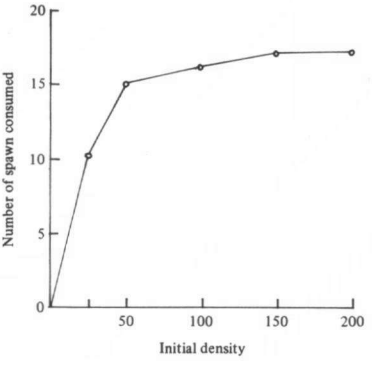

Fig. 2. Effect of prey density on the number of spawn predated by the larva of *Orthetrum sabina*.

of deprivation. However, the attack increased to 0.62 attack per minute in larvae fed after deprivation of 24 h and levelled off at 0.69 attack per minute in larvae fed after 36 h of deprivation.

Effect of prey density

For studying the effect of prey density on the predatory behaviour of the larva of *O. sabina*, test larvae were starved for a period of 36 h. They were offered spawn of *C. carpio* at densities of 25, 50, 100, 150 and 200 spawn/aquarium for a period of 30 min. It was revealed that the mean number of spawn consumed by the larvae increased from 10.2 spawns at the density of 25/aquarium to 15, 16.1, 17 and 17.2 spawn at the density of 50, 100, 150 and 200 per aquarium respectively (Fig. 2). The satiation time (to predate 16 spawn) for the larvae was about 40 min at prey density of 10 spawn/aquarium, whereas it took only 30 min for a larva exposed to a density of 200/aquarium.

Discussion

As it goes from the above, *Orthetrum sabina* deserves consideration as a potential predator of fish spawn in nursery ponds. ALIKUNHI et al. (1952) stated that a dragonfly larva of 15 mm length can swallow up to 7 carp spawn within 3 h in the laboratory. NIRMALA KUMARI & NAIR (1983) observed that larvae of *Urothemis s. signata* can consume 7.06 fish fry. The present investigation, however, shows that *Orthetrum sabina* has far greater predatory capacity, consuming as many as 16 fish spawn, though there was a considerable decline in predation rate after 10 min of feeding. ELLIS & BORDEN (1970) and MATHAVAN (1976) recorded a similar precipitous decline of predation rate in *Notonecta undulata* and *Mesogomphus lineatus*, respectively. It was observed that as flies were killed by the mantid *Hiarodula crassa*, there was an apparent decrease in its hunger, causing a precipitive decline in attack rate until the hunger was stabilized (HOLLING, 1966). MATHAVAN (1976) noted that, when the stomach of the predator is full, they cease feeding and attacking prey. He pointed out that predators like *M. lineatus* made random attacks when an undigested bulk of food is present in the stomach, but these are not usually rewarded with success. In the present investigation, it was seen that the predatory efficiency of the larvae decreased gradually from 62% in the first 10 min to 18% in the fourth 10 min interval. A similar decrease of predatory efficiency was also noted by MATHAVAN (1976) and SRIVASTAVA & SURI BABU (1982) in dragonfly larvae.

MATHAVAN (1976) observed that in a prey-predator interaction in which both the predator and the prey are mobile, satiation time involves two important aspects: predation and consumption (= handling time). In the present study the larvae required 85 s to consume a captured spawn. Thus, the handling time for 16 spawn is about 22 min. The remaining 18 min of the 40 min satiation period were spent by the larvae on predation.

It was also revealed that more spawn were predated and consumed by larvae deprived of food for different periods of time with a corresponding increase in satiation time. The predators renewed attack on the prey when appetite was partially or fully resumed, which, for this species, was after 24-36 h of deprivation.

Our observations indicate that at high prey density, the satiation time to predate and consume 16 spawn is only 30 min. At high prey densities the larvae frequently captured a spawn, while the one caught previously was being consumed. Therefore, the time required for predation and consumption could not be very clearly demarcated and recorded. However, the time required for predation and consumption of a single spawn was less at high than at low prey densities. MATHAVAN (1976) also evidenced a similar phenomenon.

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