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OBSERVATIONS ON THE FEEDING AND MOULTING OF LABORATORY REARED PHYLLOSOMA LARVAE OF THE SPINY LOBSTER *PANULIRUS HOMARUS* (LINNAEUS) UNDER DIFFERENT LIGHT REGIMES

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ABSTRACT

Phyllosoma larvae of the spiny lobster *Panulirus homarus* hatched under laboratory conditions were fed on 1-2 day old *Artemia salina* nauplii. The feeding intensity and moulting frequency of the larvae were studied. When fed with one day old *Artemia* nauplii, the phyllosoma larvae consumed at an average rate of 15.1 ± 0.94 nauplii/day and moulted five times in 31.2 days to reach the IV phyllosoma stage. But those fed with two day old nauplii consumed 19.3 ± 1.6 nauplii/day and required 34 days to complete the fifth moult under similar environmental conditions.

Studies on the effect of light on the feeding and moulting of phyllosoma larvae indicated that consumption of *Artemia* nauplii was significantly higher in natural day-light periodicity, (15.1 ± 0.94 nauplii/day) than in 24 hr darkness (11.1 ± 0.57 nauplii/day) and 24 hr light (12.2 ± 0.45 nauplii/day). The reduced food consumption in the groups exposed to 24 hr dark and 24 hr light was reflected in the moulting frequency also. The phyllosoma completed the fifth moult in 31.2 days under natural day-light periodicity, while it required 37 days under 24 hr darkness and 35.5 days under 24 hr light.

INTRODUCTION

PHYLLOSOMA LARVAE of *Panulirus homarus* are positively phototactic and swim towards natural and artificial sources of light. Segal (1970) summarised the effect of varying photoperiods on marine invertebrates. But information on the effects of photoperiodism on feeding in crustacean larvae is limited (Templeman, 1936; Huntsman, 1923).

Since the phyllosoma larvae are selective feeders, nutritionally rich and suitable sized prey should be identified and supplied to ensure maximum survival and growth rates. This view has been stressed by earlier workers also (Saisho, 1966; Dexter, 1972; Wickins, 1972). Though early larval stages of *Panulirus inflatus* (Johnson and Knight, 1966) and *Panulirus longipes* (Saisho and Nakahara, 1960) were successfully fed on *Artemia* nauplii, the food consumption and growth in relation to size and nutritive aspects of the prey was not properly understood. The present study is on the effect of different photoperiods on feeding, moulting frequency and survival of phyllosoma larvae of *Panulirus homarus* and the larval feeding on two different sizes of *Artemia salina* nauplii.

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Material and Methods

An ovigerous female of *Panulirus homarus* (Linnaeus) released phyllosoma larvae in the field laboratory at Kovalam during February, 1979. The larvae were transferred to plastic tanks of 45 l capacity with fresh filtered sea water and fed freshly hatched *Artemia salina* nauplii. On the second day after hatching, the healthy larvae were divided into four series, each series having five groups of three larvae each. Two of the four series were exposed to natural day-night cycle (approximately 12 hr L : 12 hr D). Of the other two series, one was exposed to 24 hr darkness. The containers with the larvae were kept in a black wooden box and were exposed to light for 10 minutes everyday while changing the water and feeding. The fourth series of larvae were exposed to 24 hr light by using 40W flourescent lamp fixed 4 feet above the containers.

The larvae were reared in transparent plastic containers (150 ml capacity) with 100 ml of filtered (using 1μ filter) fresh seawater. The salinity of the water ranged from 32 to 34.5‰ and the temperature in rearing containers varied from 25.4 to 30.0°C with a mean of 28.1°C. The water was changed daily.

Of the two series exposed to natural day-night cycle, one was fed on freshly hatched *Artemia salina* nauplii and the other with second day *Artemia* nauplii. The groups exposed to 24 hr L and 24 hr D were fed on freshly hatched nauplii. In each container 125 nauplii were released daily at 1000 hrs after removing the unfed nauplii supplied on the previous day.

The containers were checked daily for exuviae and dead larvae, and the condition of each larva and the date of moulting was recorded. Since the length of the living larvae could not be measured accurately after each moult, the moulting frequency was considered as an index of growth. The experiment was conducted for 40 days.

Results and Discussion

The phyllosoma larvae exhibited a higher feeding activity almost alternating with a lower feeding on the subsequent day in all the tested photoperiods (Fig. 1, 2). Average daily consumption of fresh and second day *Artemia* nauplii increased with age of the larvae under natural day-night conditions. Feeding rate increased from 9 nauplii/day on the first day of the experiment to a peak of 31 nauplii on 27th day when fed with freshly hatched nauplii and the consumption increased from 8 nauplii/day to a maximum of 33 nauplii on the 15th day in larvae fed with second day nauplii (Fig. 1a, b). The consumption gradually decreased thereafter to 10 nauplii/day in the former group and 13.2 nauplii/day in the latter at the end of the experiment. The average consumption was higher in groups fed with second day *Artemia* nauplii (19.3 $\pm$ 1.16) than those fed with fresh nauplii (15.1 $\pm$ 0.94). The larvae fed with second day nauplii consumed a total of 656 nauplii to complete the fifth moult and those fed with freshly hatched nauplii consumed only 471 nauplii to complete the same number of moults. Though the consumption was higher, the phyllosoma required 34.0 days to complete the fifth moult when fed with second day nauplii, whereas, they required only 31.2 days to moult five times in the series fed with fresh nauplii (Table 1). Phyllosoma larvae fed with second day nauplii consumed 39% more food than those fed with fresh nauplii. In other words, the phyllosoma larvae increased its stomach capacity to 1.4 times and that the larvae fed to satisfy its energy demand rather than to fill its stomach to the maximum capacity (Rozin and Meyer, 1961). Vivekanandan *et al.* (1976) also found that the freshwater murrel *Ophiocephalus*

The size and activity of the prey also affected feeding in phyllosoma larvae. It is evident from the food consumption that the larvae preferred actively swimming large sized second day nauplii (0.85 mm) than slow moving freshly

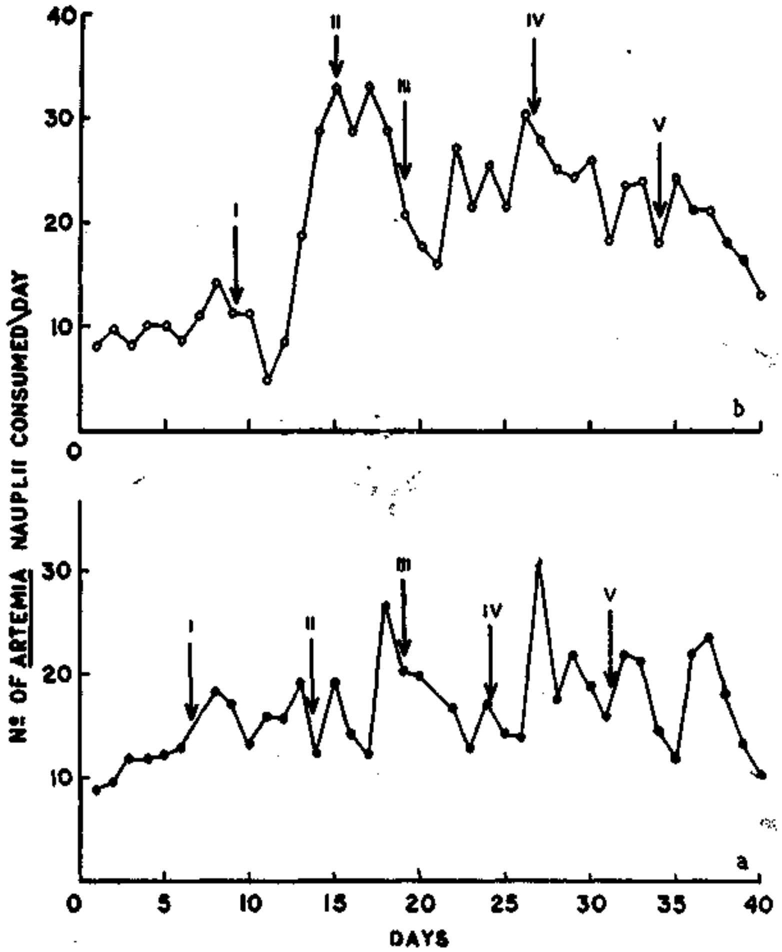

FIG. 1. Daily feeding pattern of phyllosoma larvae of *Panulirus homarus* in natural day-night periodicity: a. fed with freshly hatched *Artemia salina* nauplii and b. fed with second day *Artemia* nauplii. The arrows and numbers indicate the day of moulting and moult numbers of the larvae.

striatus consumed 33% more *Tilapia* muscle than goat liver to satisfy its energy demand as the goat liver contains 20% more energy than *Tilapia* muscle.

hatched nauplii (0.56 mm). Though the swimming activity of the phyllosoma larvae was not measured, visual observation showed that the second day nauplii swims faster than freshly hatched nauplii. The higher energy expenditure by the phyllosoma larvae to catch the actively swimming prey resulted in delayed moulting and growth.

The effect of 24 hr darkness and light on feeding and moulting are shown in Fig. 2a and b. The daily consumption of nauplii did not fluctuate much in both the series. However, the consumption gradually reduced at the end of the experiment. The observed reduction in consumption in later stages of reared larvae of *P. homarus* can probably be attributed at least in part to either a qualitative deficiency in the diet of *Artemia* nauplii or to the inability of the phyllosoma larvae to capture sufficient quantities, or both (Robertson, 1968 ; Vijayakumaran and Radhakrishnan, 1980). The food consumption was significantly low in both 24 hr D (11.1 ± 0.57 nauplii/day ; students 't' = 6.45 ; p = <0.01 and 24 hr L (12.2 ± 0.45 nauplii/day; 't' = 4.9; p = <0.01) when compared to natural day-night periodicity (15.1 ± 0.94 nauplii/day). Those exposed to 24 hr D consumed a total of 410 nauplii to complete the fifth moult in 37.0 days and those in 24 hr L fed 435 nauplii to complete the same number of moults in 35.5 days (Table 1). It may be recalled that the larvae reared under natural day-night conditions consumed 417 nauplii and moulted five times in 31.2 days. The "continuous light"

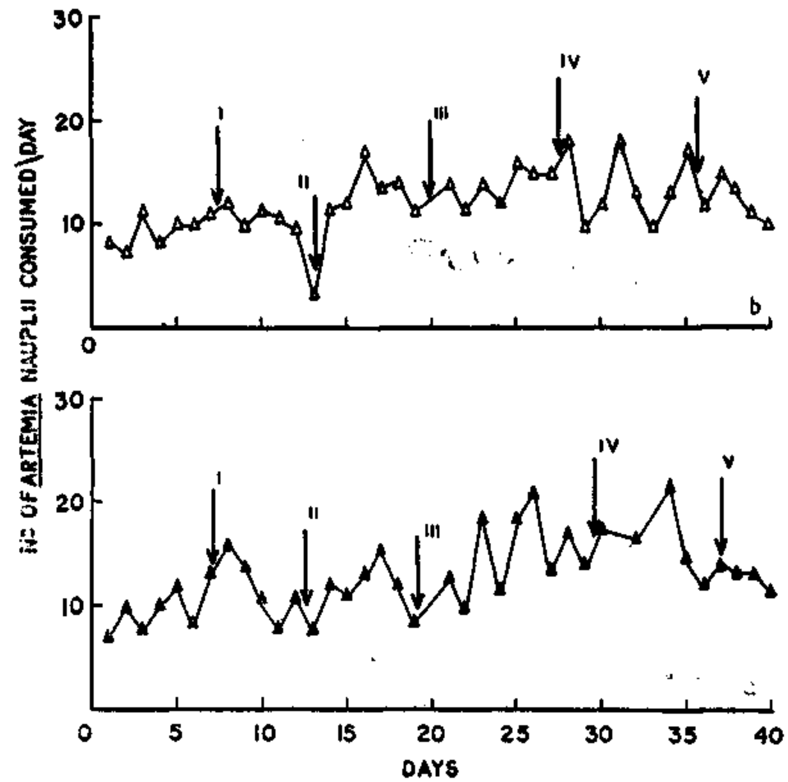

FIG. 2. Daily feeding pattern of phyllosoma larvae of *Panulirus homarus* fed with freshly hatched *Artemia salina* nauplii : a. in 24 hr. darkness and b. in 24 hr light. The arrows and numbers indicate the day of moulting and moult numbers of the larvae.

TABLE 1. *Effect of different photoperiods and size of prey on moulting frequency of phyllosoma larvae of* Panulirus homarus

	Natural Day-night Cycle I day nauplii*	Natural Day-night cycle II day nauplii*	24 hr darkness I day nauplii*	24 hr light I day nauplii*
Total days to moult 1	6.6±0.58 (6.0—7.0 days)	9.3±0.49 (9.5—10.0 days)	7.2±0.26 (7.0—7.5 days)	7.4±0.25 (7.0—7.5 days)
Total days to moult 2	13.6±1.2 (12.5—15.0 days)	15.0±0.65 (14.5—16.0 days)	12.5±0.25 (12.0—13.0 days)	13.3±0.64 (12.5—14.0 days)
Total days to moult 3	19.2±2.4 (17.5—22.0 days)	20.0±0.65 (19.5—21.0 days)	19.1±1.3 (17.5—21.0 days)	19.9±0.79 (19.9—20.5 days)
Total days to moult 4	25.1±4.2 (22.5—30.0 days)	26.7±1.2 (26.0—28.5 days)	29.4±1.8 (7.0—31.5 days)	27.6±0.63 (27.0—28.5 days)
Total days to moult 5	31.2±5.2 (27.0—37.0 days)	34.0±0.1. (33.0—35.0 days)	37.0±2.2 (34.0—39.5 days)	35.5±1.1 (34.0—36.5 days)

* Each average figure is based on about 15 individuals.

and "continuous darkness" would have affected the normal feeding activity of the phyllosoma larvae, resulting in slow growth. Chittleborough (1975) reported depressed growth in juvenile *P. longipes cygnus* under conditions of continuous darkness. Aiken and Waddy (1976) also reported increased moulting frequency and moult increment in *Homarus americanus* larvae when exposed to long photoperiods. But Bliss and Boyer (1964) observed faster growth in the crab *Gecarcinus lateralis* reared in constant darkness. From the present

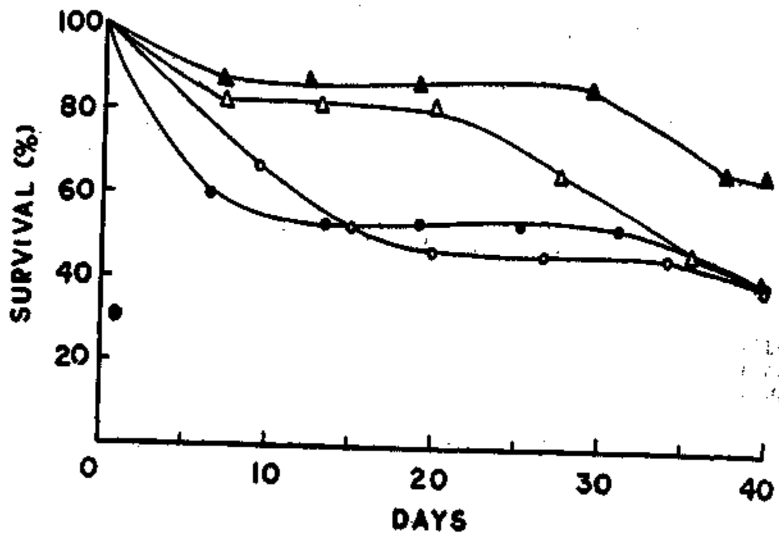

FIG. 3. Percentage survival of phyllosoma larvae of *Panulirus homarus* in natural day-night periodicity fed with freshly hatched nauplii (●), second day nauplii (O) and 24 hr darkness (▲) and 24 hr light (△) fed with freshly hatched nauplii.

study it appears that the tested photoperiods have altered the feeding rate first and in turn influenced the moulting frequency. It is clear from the observations that the moulting frequency was accelerated when the larvae consumed more nutritively rich food. Vivekanandan (1977) also concluded from his studies on *O. striatus* that environmental factors first altered feeding rate which in turn influenced metabolism and growth of fishes. The direct effect of darkness and light on growth through neuro-endocrine pathways is not known in phyllosoma larvae of *P. homarus*.

The percentage survival of phyllosoma larvae in the tested photoperiods during the experimental period is shown (Fig. 3). Though the growth rate was slow in 24 hr D, the maximum survival of the larvae (65%) was obtained in this photoperiod. The survival was low in all the other light regimes (40%). Templeman (1936) also reported higher survival rate of *H. americanus* larvae in complete darkness. At the end of the first moult of phyllosoma larvae, the lowest survival was in those reared in natural day-night periodicity fed with freshly hatched nauplii and the maximum in 24 hr D. In 24 hr L the highest mortality of larvae occurred during the fourth moult. The mortality of the larvae was caused by ciliate attack and change in feeding behaviour of the larvae. The late stage phyllosoma larvae seem to have difficulty in catching *Artemia* nauplii. A wide variety of protozoans attacked the phyllosoma larvae interfering in the swimming and feeding activity.

The positive phototactic behaviour of the phyllosoma larvae may be an advantage in feeding if an equally photopositive prey could be provided. Since long and short photoperiods does not have an accelerating effect on growth, alternating periods of light and dark and nutritionally rich food may be favourable for rearing phyllosoma larvae.

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