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GROWTH OF THE SPINY LOBSTER *PANULIRUS POLYPHAGUS* (HERBST) REARED IN THE LABORATORY

E. V. RADHAKRISHNAN* AND K. DEVARAJAN*

Central Marine Fisheries Research Institute, Cochin-682 031, India

ABSTRACT

Growth of *Panulirus polyphagus* from the puerulus stage was studied in the laboratory for twenty eight months on a diet of *Meretrix casta* and *Perna viridis*. The lobsters were kept either in isolation or in groups of three per tank at laboratory temperature ranging between 21.4° and 29.5°C. The survival was higher (70%) in those reared in groups, however, the growth rate was not depressed in individuals held in isolation.

Carapace length positively correlated with total weight in both sexes of the tested individuals. In captivity the male grew faster than the female. For male the increase in carapace length on an average was 3.3 mm for each moult while it was only 2.6 mm for the female. But there was slight difference in intermoult duration between the sexes. The annual growth rate was 34 mm in carapace length for male and 28 mm for female during the first year and 20 mm for male and 20.5 mm for female during the second year. The female attained maturity at an average carapace length of 48 mm. Temperature affected growth ; the intermoult duration was prolonged at low water temperature.

INTRODUCTION

PALINURID LOBSTERS which is a highly priced commodity, forms a meagre fishery in India (CMFRI, 1979). But the occurrence of puerulii has been reported periodically in both east and west coasts of India (Rao and Kathirvel, 1971 ; Girijavallabhan and Devarajan (1972) ; Dutt and Ravindranath, 1975). Tholasilingam (1976) reported abundance of three different species of puerulii off Kovalam. It is possible to culture lobsters from the puerulii available in nature to adult sizes. Chittleborough (1974) and Phillips *et al.* (1977) reared a group of *Panulirus longipes cygnus* from puerulus to adult under subtropical conditions. Fielder (1964) studied the moulting and growth in temperate lobster *Jasus lalandei*. In India, Deshmukh (1966) studied the early metamorphosis of *Panulirus polyphagus*. Thomas (1972) reported the growth of *Panulirus homarus* in captivity and Kathirvel (1973) observed regeneration of a lost antenna with depressed growth in *P. polyphagus*. However, little is known on the growth pattern of tropical palinurid lobsters. The growth of the commercially important palinurid lobster *P. polyphagus* from puerulus to adult stage is reported for the first time in India.

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* Present address : Madras Research Centre of CMFRI, 29, Commander-in-Chief Road, Madras 600 105.

Material and Methods

In early May 1977, fifteen puerulus larvae of the spiny lobster *Panulirus polyphagus* measuring an average of 8.5 mm in carapace length were collected off Kovalam from Mangalore tiles suspended from a floating raft. They were brought to the field laboratory at Kovalam and acclimatized in three plastic tanks with a floor area of 0.16 sq.m. Five puerulii were held in each tank and were fed *ad libitum* on flesh of freshly opened clams *Meretrix casta* collected daily from Kovalam backwaters and green mussel *Perna viridis*. The lobsters seem to prefer mussel to clams. During the first nine months only monthly increase in carapace length and weight of lobsters were recorded.

After nine months, nine healthy individuals were selected and divided into two series. The first series consisted of six animals divided into two groups of three juveniles each and the second series with three animals placed in individual aquarium. Each fibreglass aquarium holding the animals had a floor area of 50×45 cm with 250 litres of filtered sea water. The animals were provided with hollow tiles for shelter.

The water in the aquarium was replaced twice a week by fresh filtered sea water. Salinity of the water in the aquarium varied from 32.5‰ to 36.2‰ and that of temperature from 21.4°-29.5°C. The water was aerated continuously. The aquarium tanks received 16 hr illumination.

The juvenile lobsters were fed on *Meretrix casta*. Food was supplied daily at dusk and the uneaten food was removed on the following morning. Preliminary observations revealed that the animals did not feed during day time. The tanks were cleaned once a week with least disturbance to the lobsters.

Growth measurements of individual lobsters were taken five days after each moult when the exoskeleton had sufficiently hardened. The size was recorded by measuring the carapace length (CL) to 0.1 mm accuracy along the mid-dorsal line from the ridge behind the eyes (between the rostral horns) to the posterior margin of the carapace. This was used as the standard length (Berry, 1971) in the present study. Live bodyweight of the animals was measured after removing free water as described by Chittleborough (1975).

In crustaceans increase in length and weight occur at and just following moulting. So the two interacting components involved in the growth processes are (*a*) moult increment (increase in size per moult), (*b*) intermoult duration (duration of the intermoult period). Here growth is mainly referred to as increase in carapace length and weight and growth rate as growth with time.

Results and Discussion

Growth of male and female P. polyphagus

When collected from the sea, the transparent puerulus larvae of *P. polyphagus* had a mean carapace length of 8.5 mm and weighed an average of 260 mg. The larvae did not feed till they completed the first moult. Within 2-4 days of their capture, about 80% of the larvae moulted to the post-larval phase.

As only the monthly averages of carapace length and weight were recorded during the first nine months of growth, the intermoult duration and moult increment for the period could not be studied. Fig. 1 presents the growth of male and female lobsters reared in groups for a period of 840 days from the time of capture. The males exhibited faster growth rate than the females resulting in larger size in unit time. The estimated average annual increment in carapace length was 34 mm in males and 28 mm in females during the first year and 20 mm and 20.5 mm in carapace

length for males and females respectively in the second year. The differential growth between sexes has been reported by earlier workers for both wild and laboratory reared palinurid lobsters. Mohammed and George (1968) observed higher growth rate in males than in females of *P. homarus* from mark-recovery studies. Thomas (1972) also estimated an average annual increase in carapace length of 30 mm in males and 17 mm in females of *P. homarus*. But Chittleborough (1974) and Phillips *et al.* (1977) found no difference in the growth rate of males and females of *P. longipes cygnus*. It is interesting to note from Fig. 1 that the growth curve of the female

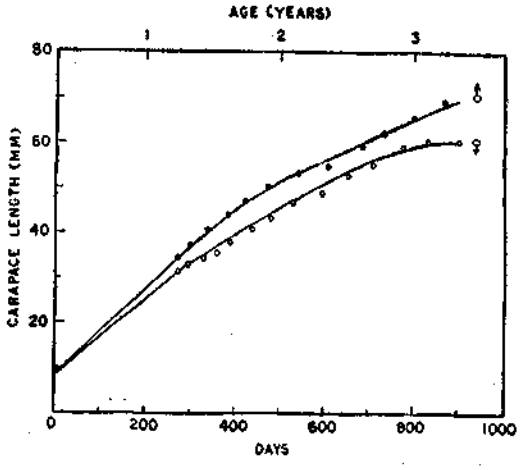

Fig. 1. *Panulirus polyphagus:* Mean increase in carapace length (mm) of males and females reared in groups during 840 days; each point represents the average of about 3 individuals.

tapers off at about 42 mm CL, whereas it is not the case with males. This is apparently due to deceleration of growth rate in females which becomes evident at the time of attainment of sexual maturity (Berry, 1971). The females of *P. polyphagus* attained sexual maturity at an average carapace length of 48 mm when the lobsters were 2.2 years old. Philipps *et al.* (1977) estimated the age of *P. longipes cygnus* as 2.3 years old when the lobsters reached 40-42 mm CL. The difference in age between *P. polyphagus* and *P. longipes cygnus* was not due to the faster growth rate of *P. polyphagus*, but the estimated difference in age of settling puerulus larvae. Chittleborough and Thomas (1969) reported the age of newly settled puerulus larvae of *P. longipes cygnus* as 0.8 years whereas the age of puerulus of *P. polyphagus* was estimated as 0.4 years using the same method. The CL of female *P. polyphagus* in the present study reach asymptotic level when it was three years old during which period the male was still in its upward growth phase (Fig. 1). The differential growth rate may have some far reaching implications as it has been shown that the preponderance of one sex in the population is because of the sexual difference in growth (Qasim, 1966).

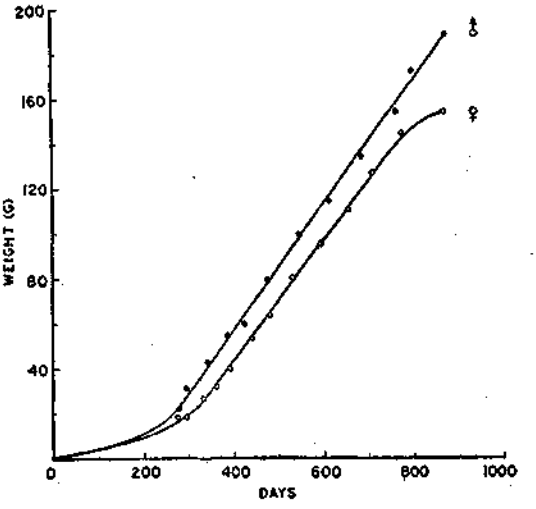

Fig. 2. *Panulirus polyphagus:* Mean increase in weight (g) of males and females reared in groups; each point represents the average of about 3 individuals.

The estimated average annual increase in weight was 47.24 g in males and 33.74 g in females during first year and 117.76 g in males and 111.26 g in females for the second year (Fig. 2). The percentage increase in weight of *P. polyphagus* at moults ranged from 8.8 to 44%. The percentage increase in weight at

a moult decreased with increasing size of the lobsters. Travis (1954) and Fielder (1964) made similar observations for *P. argus* and *J. lalandei* respectively.

Fig. 3 shows the length-weight relationship in males and females. Weight is a function of length and is expressed by the equation $W = CL^n$, where W is the weight, L is the carapace length and C and n are constants. The mean CL and weight of the experimental males and females plotted graphically resulted in an exponential curve. The regression of log bodyweight (W in gram) on log carapace length was

Male $\log W = 3.14 \log L - 3.45$

Female $\log W = 3.71 \log L - 4.3$

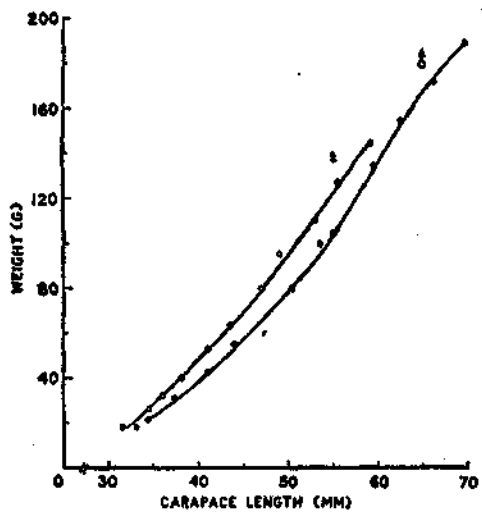

Fig. 3. *Panulirus polyphagus*: Relationship between carapace length (mm) and weight (g) of males and females; each point represents the average of about 3 individuals.

To understand the growth processes in lobsters, intermoult duration and moult increment were studied. The intermoult duration increased with age in both sexes (Fig. 4 a) and in males it was slightly longer than in females (52 and 45.5 days respectively). Though the females moulted 12 times and the males only 11 times in 800 days, females could attain only 60 mm CL, whereas the males attained 65 mm during the same period. Hence, the lobsters were not able to exhibit faster growth by shortening the intermoult duration. The increase in carapace length at moult (moult increment) was plotted against the number of moults (Fig. 4 b). Eventhough there was considerable variations in moult increment among individuals, as also noticed by Phillips *et al.* (1977), the mean moult increment in CL was higher for males (3.3 mm) than for females (2.6 mm). There was a gradual increase in the moult increment at successive moults in females for the first four moults, which thereafter fluctuated considerably. In males the moult increment in CL did not fluctuate much during successive moults; but the increment was clearly higher than the female except in the VI moult (Fig. 4 b). Hence the larger size acquired by the male at unit time was due to a higher moult increment in carapace length than shortened intermoult duration. The differential growth rate may also be due to deceleration of growth rate in females after attainment of sexual maturity resulting in an increasing divergence of the growth curves of males and females with increase in size (Berry, 1971). Morgan (1977) also found that in wild adult *P. longipes cygnus*, moult increment depressed with increasing size with adult males having a higher moult increment than females of the same size. Chittleborough (1976) observed that moult increment of males of the same species increased from ages 3+ to 5+ years, while those of the females did not very significantly between these age groups, and the moult increment of females was significantly below that of males.

The effect of temperature on frequency of moulting in palinurid lobsters has been studied in detail by earlier workers (Travis, 1954; Serfling and Ford, 1975; Phillips *et al.*, 1977). The prolonged intermoult duration in lobsters

reared in groups in this experiment coincided with the fall in water temperature (Fig. 4 a, 4 c).

juveniles (upto an average of 30 mm CL) of *P. polyphagus* were observed to be gregarious and preferred to hide under shelter during day

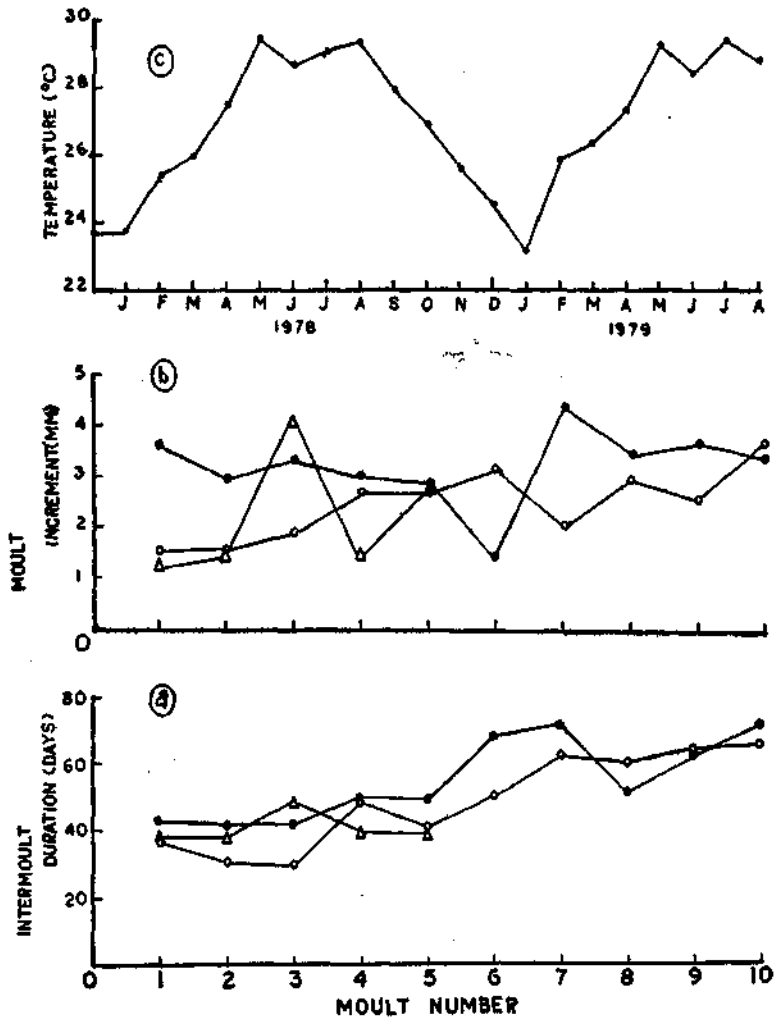

Fig. 4. *Panulirus polyphagus*: a. Mean intermoult duration against number of moults of male (●) and female (○) reared in groups of three. (△) represents the mean intermoult duration of three isolated individuals; b. Mean moult increment in carapace length against number of moults of male (●) and female (○) reared in groups of three. (△) represents the mean moult increment in CL of isolated individuals and c. Monthly mean water temperature in the laboratory during 1978 and 1979.

Effect of social pressure on growth

Social pressures influence moulting and growth in crustaceans as this is presumably a reflection of their gregarious or solitary behaviour in nature (Aiken, 1977). The early

time. The isolated individuals confined to the shelter during the commencement of the experiment; later they were foraging the bottom of the aquarium as they were acclimatized. *P. polyphagus* did not show significant

difference in growth rate when reared in isolation or in groups (Fig. 5). The intermoult duration (Fig. 4 a) and moult increment (Fig. 4 b) were almost similar in both the series, but the isolated individuals did not survive beyond the sixth moult (*i.e.* after 525 days). Phillips *et al.* (1977) also found no significant difference in the growth of isolated and grouped individuals of *P. longipes cygnus* until they were 3 years old and Chittleborough (1975) reported depressed growth rate in isolation for the same species which were more than 3 years old.

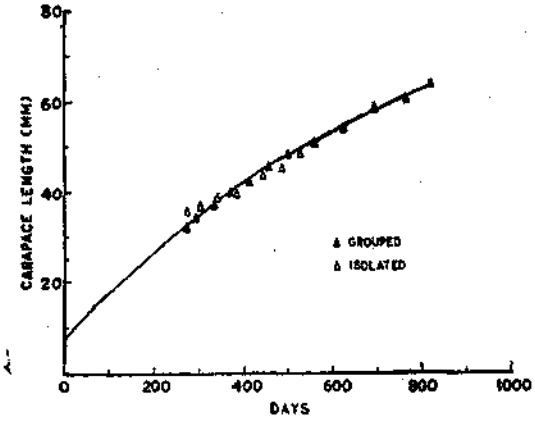

Fig. 5. *Panulirus polyphagus :* Mean increase in carapace length (mm) of grouped (▲) and isolated (△) individuals ; each point of grouped series represents the average of about 6 individuals and that of isolated series 3 individuals.

Feeding behaviour during moulting

The animals stopped feeding 2-3 days before ecdysis ; moulting took place mostly during night. The moulting pattern was similar to other palinurid lobsters (Travis, 1954). After moulting the animals were inactive and were hiding under shelter. Feeding commenced 2-3 days after ecdysis. The peak consumption of food was 5-6 days after moulting, which gradually reduced as the next moult was nearing.

Mortality

Mortality in the aquarium was about 30% in those reared in groups during the experimental period of 840 days whereas all the animals in isolation died within 525 days. The mortality was mainly during moulting when the carapace or walking legs were entangled in the old exoskeleton and the animals were unable to free themselves. Moulting abnormalities were also noticed in early juveniles. The antennae and the head folded-back interfering with the normal feeding of the animals. The lobsters below 25 cm CL autotomised limbs on handling, but it is uncommon in larger numbers of the species.

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