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Effect of diet on growth of the mud spiny lobster *Panulirus polyphagus* (Herbst, 1793) and the sand lobster *Thenus orientalis* (Lund, 1793) held in captivity

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Abstract

Experiments were carried out to assess the effects of some natural diets on growth performance of the mudspiny lobster *Panulirus polyphagus* and the sand lobster *Thenus orientalis* reared in captivity. Both species showed better response to shelled molluscs. *P. polyphagus* fed with the gastropod *Turbo* sp., and *T. orientalis* fed with the clam *Mercia opima* showed better growth performance. The average daily growth of male and female *P. polyphagus* fed on *Turbo* sp. were 0.14 mm CL (0.47 g) and 0.12 mm CL (0.33 g), respectively. *T. orientalis* fed on fresh clam showed the highest average daily growth rate of 0.17 mm CL and 0.42 g. Analysis of Variance showed significant difference in growth increments (in terms of Carapace Length and Weight) in lobsters reared on different diets.

Keywords: Lobster, *Panulirus polyphagus*, *Thenus orientalis*, diet, growth

Introduction

A major prerequisite for promoting the candidature of a species for aquaculture is to define the nutritional requirements and feed preferences of the animal in captivity and in the wild, so as to enable the formulation of artificial diets that can serve to maintain the health status of the animal over wide culture periods. Information on the natural diet preferences are available for a few homarid and palinurid adult lobsters (Joll and Phillips, 1984; Junio and Cobb, 1992; Mayfield and Branch, 2000; Goni *et al.*, 2001). The dependance of moulting frequency, and thus growth, on feed has been documented (Stewart and Squires, 1968; Chittleborough, 1974, 1975; Newman and Pollock, 1974). Castell and Budson (1974) described the influence of food on moulting and growth rate in homarid lobsters. Chittleborough (1974) studied the role of food on moulting and growth in palinurid lobsters. Most of the studies indicate that lobsters have a wide range of food preference, feeding extensively on slow moving benthic invertebrates including bivalves, polychaetes, echinoderms, gastropods as well as algae and other materials scavenged from the seafloor (Nelson *et al.*, 2006).

Considering this information, experiments were carried out to assess the effects of some natural diets on growth performance of the mudspiny lobster *Panulirus polyphagus* (Herbst, 1793) and the sand lobster *Thenus orientalis* (Lund, 1793) reared in captivity.

Material and Methods

Live juvenile *P. polyphagus* in the size range of 29-42 mm CL and weight range of 26.3-61.2 g, and juvenile *T. orientalis* in the size range of 28.1-38.5 mm CL and weight range of 12.9-37.3 g, collected from gillnet and trawl landings along the Veraval-Mangrol coast were used for the study. The test animals were grouped into 5 sets of 4 animals each, maintaining a sex ratio of 1:1. All animals were tagged, measured and weighed before the start of the experiment. The carapace length (CL, mm) and whole body wet weight (W, g) were used as the standard measures of growth. *P. polyphagus* were stocked in 1 tonne flat bottom cylindrical FRP tanks holding 850 l filtered seawater maintained through a closed recirculatory system with the help of external biofilters. Asbestos shelters were provided in the tanks. *T. orientalis* were stocked in 750 l flat bottom rectangular FRP tanks holding 600 l filtered seawater maintained through a closed recirculatory system with the help of external biofilters and provided with beach sand substrate. Water temperature ranged between 27 and 30°C in all the tanks; salinity and pH were maintained at 36 to 37 ppt and 7.8 to 8.0, respectively.

Feeds used were the gastropod, *Turbo* sp., the clam, *Mercia opima*, fresh meat of the crab *Charybdis feriatus*, fresh meat of the squid *Loligo duvauceli* and fresh meat of the lizardfish *Saurida tumbil*. *Turbo* sp. and *M. opima* were collected from the intertidal stretches while *C. feriatus*, *L. duvauceli* and *S. tumbil* were collected at Veraval trawl landing centre. The lobsters in each experimental tank were fed *ad libitum* twice a day @ 5% of the biomass. *Turbo* sp. and *M. opima* were introduced, with shell, into the tanks. In the case of *L. duvauceli*, the mantle tube was cut into small pieces. The flesh of *S. tumbil* was added as small chunks. In the case of crabs, only the thorax portion with shell, was introduced. Uneaten food and faecal matter were siphoned out daily. Water exchange was carried out @ 30% every day, when the sides of the tanks were also cleaned. Records of molting and increments in morphometrics of whole molts were noted. The experiment was conducted for 90 days, at the end of which the final CL (mm) and wet weight (g) of the animals were recorded. ANOVA on these measures of growth was done to interpret the effects of different diets on the growth.

Results and Discussion

P. polyphagus fed with *Turbo* sp. showed higher rate of growth as compared to the ones fed on other diets (Fig. 1 & 2). The average daily growth in males and females fed on *Turbo* sp. were 0.14 mm CL and 0.12 mm CL, respectively. Lobsters fed on *Turbo* exhibited maximum daily weight increments 0.47 g and 0.33 g in males and females, respectively. No mortality was recorded in *P. polyphagus* during the experimental period of 90 days in any of the experimental tanks. ANOVA (Table 1) showed that there was a significant difference ($\alpha \leq 0.05$) between

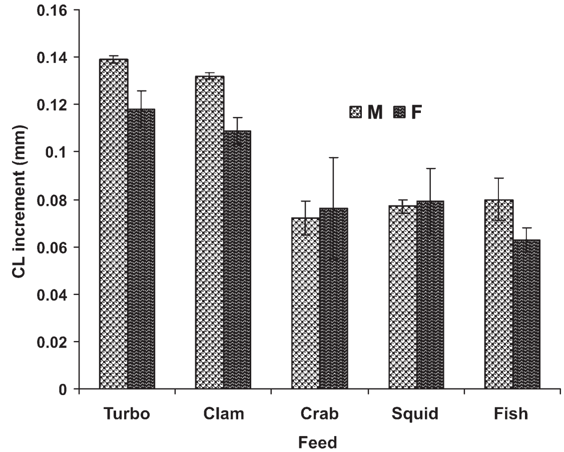

Fig. 1. Average daily CL increment in *P. polyphagus* maintained on different diets in captivity for 90 days

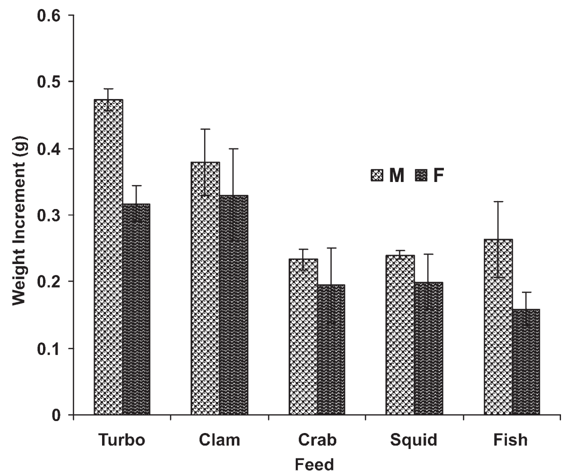

Fig. 2. Average daily weight increment in *P. polyphagus* maintained on different diets in captivity for 90 days

the growth increments, both in terms of carapace length and weight, between animals fed on different diets. Both males and females showed similar growth performance.

Maximum growth rate of *T. orientalis* was observed in the group fed on fresh clams, followed by those fed on fresh gastropods and fresh squid meat (Fig. 3 & 4). The response to crab meat and fish meat was poor. Mortality was recorded among animals fed on fish meat and crab meat before the end of the experiment. Sex-wise comparison of growth

Table 1. Results of Analysis of Variance

***P. polyphagus (sexes pooled)*: CL increments with different diets**					
Source of Variation	*df*	*SS*	*MS*	*F (4,12)*	*F critical*
Replications	3	3.9928	1.3309		
Diets	4	92.7383	23.1846	20.2010*	3.2592
Residuals (Error)	12	13.7723	1.1477		
Total	19	110.5035			
***P. polyphagus (sexes pooled)*: Weight increments for different diets**					
Source of Variation	*df*	*SS*	*MS*	*F (4,12)*	*F critical*
Replications	3	61.1397	20.3799		
Diets	4	989.1688	247.2922	7.5672*	3.2592
Residuals (Error)	12	392.1516	32.6793		
Total	19	1442.4601			
***P. polyphagus (CL increments)*: between sexes for different diets**					
Source of Variation	*df*	*SS*	*MS*	*F (4,12)*	*F critical*
Replications	1	3.9928	3.9928		
Diets	4	0.0061	0.0015	18.5125*	6.3882
Residuals (Error)	4	0.0003	0.0001		
Total	9	3.9992			
***P. polyphagus (Weight increments)*: between sexes for different diets**					
Source of Variation	*df*	*SS*	*MS*	*F (4,12)*	*F critical*
Replications	1	3.9928	3.9928		
Diets	4	0.0633	0.0158	12.0163*	6.3882
Residuals (Error)	4	0.0053	0.0013		
Total	9	4.0614			
***T. orientalis (sexes pooled)*: CL increments with different diets**					
Source of Variation	*df*	*SS*	*MS*	*F (4,12)*	*F critical*
Replications	3	34.236	11.412		
Diets	4	221.208	55.302	3.916*	3.259
Residuals (Error)	12	169.484	14.124		
Total	19	424.928			
***T. orientalis (sexes pooled)*: Weight increments for different diets**					
Source of Variation	*df*	*SS*	*MS*	*F (4,12)*	*F critical*
Replications	3	201.531	67.177		
Diets	4	1362.250	340.562	3.575*	3.259
Residuals (Error)	12	1143.118	95.260		
Total	19	2706.899			

*Significant

performance could not be made since 75% of the animals that died were females. Lobsters fed on fresh clam showed the highest average daily growth rate of 0.17 mm CL and 0.42 g. ANOVA (Table 1) showed significant difference ($p \leq 0.05$) between growth increments, both in terms of carapace length and weight, among animals fed on different diets.

Although clams are known as the preferred diet of lobsters (Nelson *et al.*, 2006), both, *P. polyphagus* and *T. orientalis* appear to be well adapted to feeding on gastropods also. When live gastropods were introduced into the tank holding *P. polyphagus*, the lobsters were found to take hold of the gastropods using the II and III pereiopods, and suck the meat

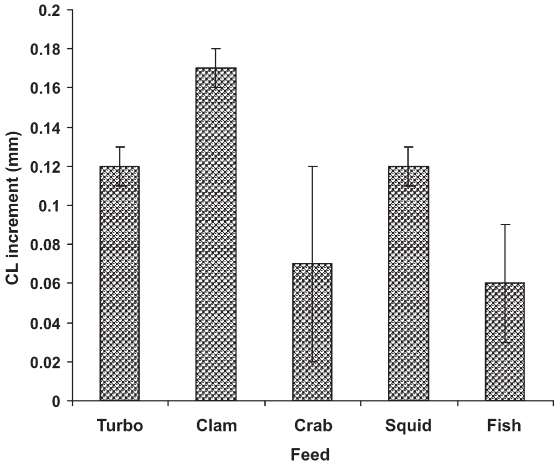

Fig. 3. Average daily CL increment in *T. orientalis* maintained on different diets in captivity for 90 days

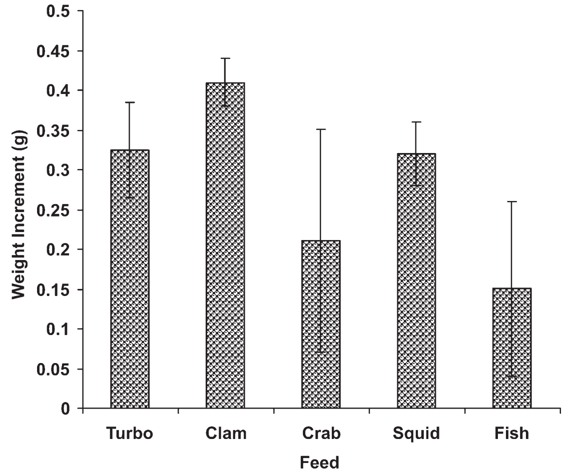

Fig. 4. Average daily weight increment in *T. orientalis* maintained on different diets in captivity for 90 days

out after grinding a hole through the gastropod shell with the aid of hard dentition on the mandibles. The entire process took at least an hour for completion. Those fed with bivalves used their mandibles to bite the edges of the bivalve and scoop out the flesh.

T. orientalis, when fed with live bivalves, hold the shell with the I, III and IV pairs of pereiopods and probe the edges with the dactyli of the II pair of pereiopods. The tip of the dactyli are wedged into the shell and the shell is pried open to cut the mantle. When the valves are opened, the adductor muscle is cut with the II pair of pereiopods and the meat is scraped out and passed to the III maxilliped.

Dietary differences between species and between individuals of the same species are known to occur in relation to differences in food availability in different habitats, variations in environmental factors and changes in growth and maturation cycles. Nelson *et al.* (2006) mentions the uniqueness of fresh, live mussels as a natural diet of most lobsters. Bivalves in general are known for their consistent use as a default reference diet as they appear to perform consistently well as food for lobsters (Radhakrishnan and Vijayakumaran, 1984; James and Tong, 1997, 1998; Johnston *et al.*, 2003; Kizhakudan *et* al., 2004; Kizhakudan, 2005; 2006) Nelson *et al.*, (2006) commented that slipper lobsters in particular appear to have become specialized for feeding on bivalves or clams, mussels and oysters, with mechanisms that enable them to 'shuck' bivalves (Lau, 1987; Spanier, 1987).

The results of the feeding experiments, examination of the mouth parts and observations on the feeding behaviour of *P. polyphagus* and *T. orientalis* in captivity reveal that these lobsters are adapted to feed on shelled molluscs. The observations in the present study underline the importance of right type of food in determining growth response of lobsters reared in captivity.

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