

**FOOD SELECTION PREFERENCE OF DIFFERENT STAGES OF BLACK TIGER SHRIMP
Penaeus monodon FABRICIUS IN TROPICAL PONDS**

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ABSTRACT

The shrimp culture industry has been progressing steadily in many countries during the past decade due to its potential economic value. Beside the progress of culture, considerable research finding was implemented to formulate diets, whereas, studies on the contribution of natural diets to shrimp growth in earthen ponds are still scarce. Therefore, this led to initiation to investigate the food and food selection preference of different stages of *Penaeus monodon* (PL₁₅ to adult) in tropical ponds. Study found that post larvae (9.5-22.0 mm length) and juveniles (52.0-71.0 mm length) foregut contains detritus (unidentified materials) followed by diatoms (*Pleurosigma* sp, *Navicula* sp, *Nitzschia* sp, *Coscinodiscus* sp) crustacea and insecta. Sub adult (75.0-102.0 mm length) and adult (91.0-162.0 mm length) shrimp feed on detritus, crustacea, mollusca, annelida, rotifera, insecta and phytoplankton. The food selection preference of *P. monodon* depends on the availability of food items in the pond bottom; however, there is indication to prefer natural food when available. The benthic organisms declined at the end of culture period. At this stage it is too early to conclude that declining of benthic organisms was due to grazing by shrimp or deterioration of pond bottom. Shrimps are detritivorous when benthic organisms are scarce since it consists of cellulose, lignin, protein, starch, fats, waxes and oils.

Keywords: aquaculture, *Penaeus monodon*, foregut, natural food and Malaysia

INTRODUCTION

Shrimp farming has been developed from extensive to intensive system rapidly in response to dramatic increase of seafood, great economic importance and declining in natural stocks due to pollution and over exploitation. Beside development of culture systems, considerable research finding was implemented to formulate artificial diets. However, the knowledge on the contribution of natural diets to shrimp growth in earthen ponds is still scarce together with artificial diets.

Many workers report on the diet of *Penaeus* species in coastal areas, adjoining mangrove shore and estuaries (Marte 1980, 1982; Chong and Sasekumar, 1981; El Hag, 1984; Leh and Sasekumar, 1984), suggested that shrimps feed mostly on algae (plant macrophytes and phytoplankton) and meio-benthos. In addition, penaeid shrimp able to select its food and the feed selection depended on the locality and availability of food items. Panikkar (1952) observed the food of young penaeids in India and Hall (1962) investigated the food of *P. monodon* in the Straits of Malacca, Malaysia for 35 specimens in the size range of 17-33 mm carapace length (CL), whereas, *P. monodon* was found to feed mainly on crustaceans and plant matters. Tiews *et al.*, (1976) observed *P. merguensis* feeds mainly on phytoplankton and benthic foraminiferans in Manila and San Miguel Bays of the Philippines.

The stomach content of penaeid shrimp has been studied elsewhere. But their studies were for selected type of species size (i.e. sub adult or adult) and carapace length (i.e. 17.0–69.0 mm). Very little study was conducted for *P. monodon* in regard to different size i.e. body weight, body, carapace and rostrum length from post larvae (PL) to adult in the culture ponds. Keeping these views in mind, this study aimed to investigate the feeding behavior PL to adult stage of *P. monodon* during the whole culture period. It is hope that the present paper would help to understand the feeding biology and behavior of *P. monodon* in different life stages of shrimps through out the culture period in tropical aquaculture ponds.

MATERIALS AND METHODS

This study was conducted in LPP (Lembaga Pertubuhan Peladang) shrimp farm Malacca (2° 08' 50" N latitude and 102° 24' 00" E longitude), Malaysia, which is situated along the Straits of Malacca. Two culture ponds were selected for this study. Between the two ponds, one pond was 3 year old and consider aged pond (4225 m²), whereas, another one was newly constructed by clearing mangroves and consider new pond (4355 m²). The culture ponds were prepared by draining and drying. Surface sludge was removed manually by flashing with hosepipe in aged pond. Lime was applied at 4.75 t in aged pond and 3.52 t in new pond. Tea seed cake (TSC) was used at 0.5 t in new pond, whereas, no TSC was applied in aged pond. At the beginning, the pond was filled with about 20.0 – 30.0 cm water, which allows growing phytoplankton and kept for 1 week. Water depth was then adjusted to 1 m prior to stocking. Stocking density was 19 PL 15/m² in aged pond and 26 PL 15/m² in new pond. During the culture period 50% of water was changed once in aged pond. However, in new pond 50% of water was changed three times through out the culture period. The water was discharged through the channel to the adjacent water body and refilled through pump from reservoir.

Collection of Shrimp

Shrimp sample at various stages of their life cycle were collected in every three weeks interval from the culture ponds. A total of 98 shrimps in different stages from selected ponds were studied. Post larvae (PL 15) were collected from the supplied hatchery before stocking into the ponds. Other shrimp samples were collected during every visit from the feeding try prior to give feed. Shrimps were preserved in 10% buffer formalin as soon as possible after collection and brought back to laboratory for further analysis. Morphological characteristics i.e. body weight, body length, carapace length and rostrum length were recorded for each specimen prior to dissection.

Estimation of Foregut Content

The foregut contents of shrimp were examined for their composition and occurrence. Only the food of anterior chamber of the stomach was considered to avoid the food that grinded as a fine powder by the gastric armature in the posterior chamber. The fullness of the foregut was determined visually and classified as follows: 1- fully swallowed with food; 3/4 – full, but not swallowed; 1/2 – half full; 1/4 – containing a few but considerable amount of food; 0-empty with very few amount of fine debris (Chong and Sasekumar, 1981).

The gut from each shrimp (PL₁₅ - adult) was opened under a dissecting microscope and then emptied into 70% alcohol in a petri dish and thoroughly examined. Gut content were examined microscopically and all identifiable food items were noted to determine the percentage of volumetric composition and frequency of occurrence of the food items present. The percentage of volumetric composition of each food item is the ratio of the volume displaced to the total volume of stomach contents detected by the procedure Thong and Sasekumar, (1984). The eye estimation method using a grid marking (0.5 cm x 0.5 cm) was used. The number of squares occupied by each food item was counted and then converted into the percentages of the total number of squares occupied by all the food items.

The percent occurrence of each food item in the foregut was estimated as follows-

$$\frac{(\text{Number of individual food item in the shrimp foregut}) \times 100}{(\text{Total number of foregut examined for that species})}$$

Food items were identified as far as possible in most cases to the family level. The food items were classified as unidentified debris (pellets, decaying plant fragments, algae, mangrove roots, grit and unrecognizable material) insecta, rotifera, phytoplankton, crustacean, mollusca, and annelida. In case of larger stomach, sub samples of the homogenized contents were investigated.

Collection of Benthos

The abundance of macro and meio-benthos was investigated in every three weeks interval. Ekman grab sampler covering an area 225 cm² was used for macro-benthos collection. Three samples were collected at every three weeks interval in a diagonal direction (corner to corner) from each pond. For meio-benthos collection, Ekman grab sampler was brought down into the sediment as slow as possible by using a long bar instead of rope to avoid the turbulence of pond bottom. Later on 2 cm tube core was used inside the Ekman grab to collect meio-benthos (Prof Dr Yoshihisa Shirayama, University of Tokyo, personal communication). All samples were preserved immediately with 10% buffered formalin mixed with rose bengal. In the laboratory, samples were sieved through 1000 µm mesh screen to retain macro-benthos and 53 µm mesh screen for meio-benthos. The organisms were counted and calculated for total amount in m² for macro-benthos and 10 cm² for meio-benthos.

RESULTS AND DISCUSSION

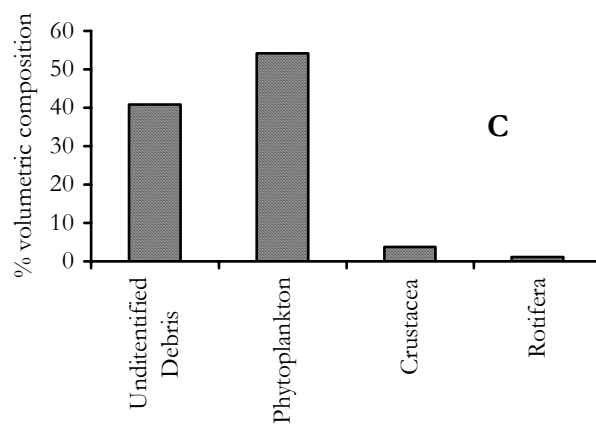
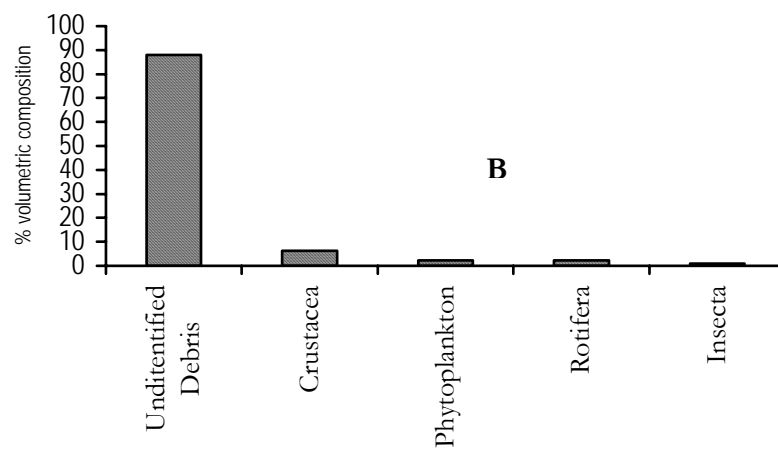
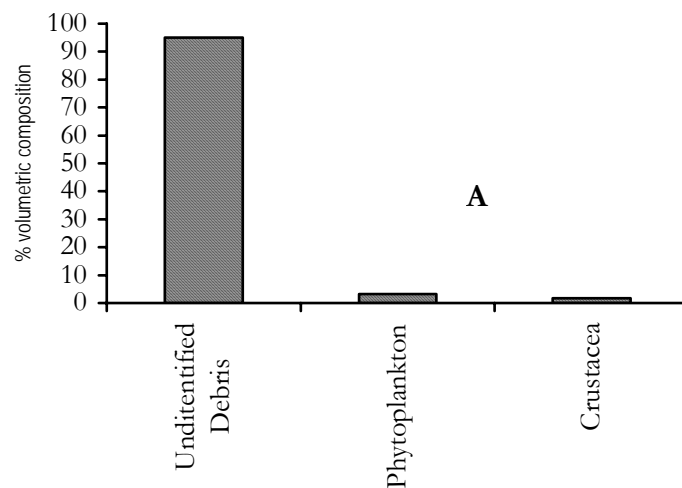
The frequency of foregut studied in different ages and sizes of *P. monodon* shrimp in regard to fullness shows in Table 1. The foregut of shrimp contained a wide variety of food and depends on shrimp size and age as well as availability of benthic and pelagic organisms in the ponds. Unidentified debris was common and found in all sizes and ages of foregut of shrimps throughout the culture period. The percentage of volumetric composition of unidentified debris ranged from 27.72-95.01%. Compare to other food items, unidentified materials found higher amount during the early stages of shrimps (PL₁₅ - PL₃₀). These stages shrimps prefer to consume plant materials such as lablab, small particles and phytoplankton, which may easily decomposed as amorphous mass and difficult to identify due to their poor physical state. Phytoplankton was present 54.1% in juvenile shrimps followed by crustacea (9.79-28.06%), rotifera (5.26-22.66%), annelida (3.88-18.67%) and gastropoda (1.01-6.03%) at the sub adult through adult stage of

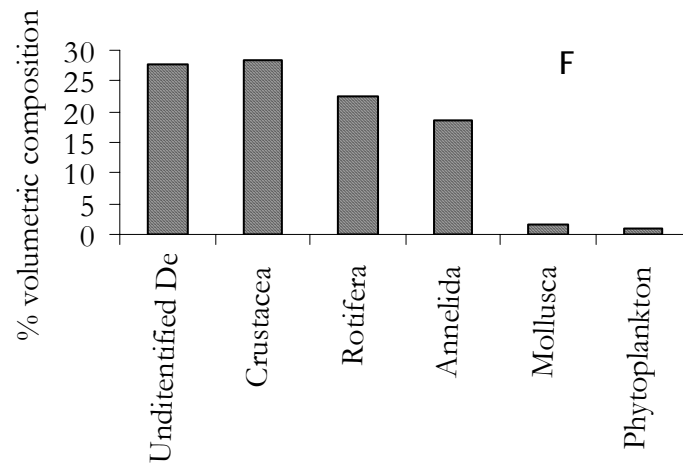
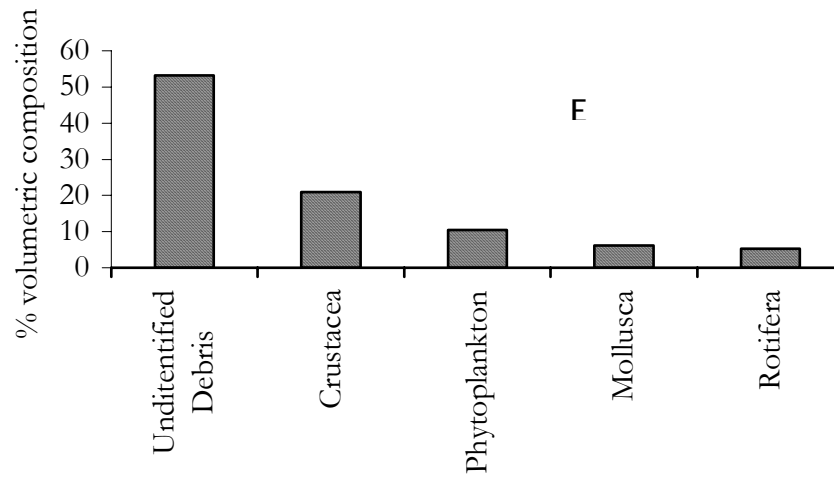
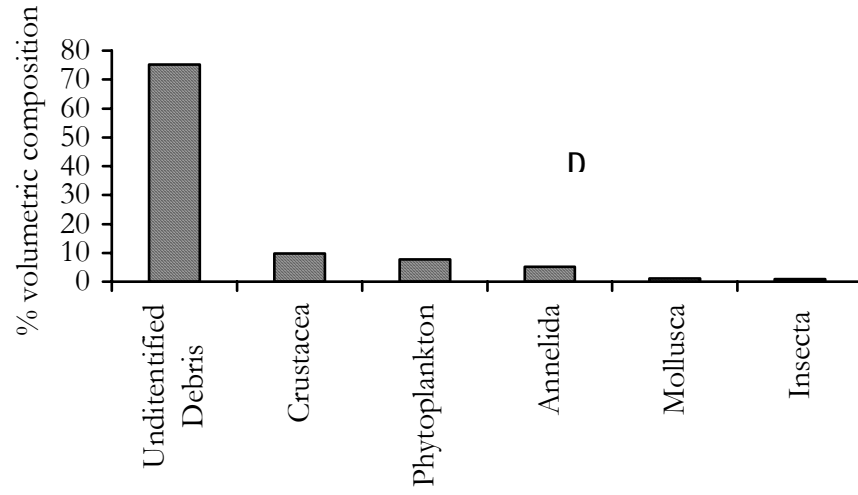
shrimps (Figure 1). Mysid consists 16.24% of volumetric composition of foregut for the adult shrimps in 16th week. It is still unknown whether prey organisms by shrimps were dead or alive before consumption. Marte (1982) stated that the large and first moving organisms were probably not preyed upon, and consumed while dead.

Beside detritus, the other food items consist of crustacea (mainly copepoda), rotifera and phytoplankton in the foregut of PL₁₅ to juvenile stages (Table 1). Various earlier researches support this study that detritus is the primary food in shrimp ponds, regardless of the abundance of different live food organisms. Bombeo *et al.*, (1993) also found that detritus was the common food item in the foregut of *P monodon* post larvae followed by copepoda remains and diatoms. Kumari *et al.*, (1978) stated detritus have higher nutritive energy value than the live phytoplankton and zooplankton. Panikkar (1952) also observed that the food of penaeid shrimps consist of organic detritus, algal materials and microorganisms.

Table 1: Frequency of Stomach Studied in Different Ages and Sizes of *Penaeus monodon* from the Aquaculture Ponds

Shrimp size	Stomach fullness					Shrimp studied
	0	1/4	1/2	3/4	1	
PL₁₅						
BL 9.5-13.0 mm						
RL 1.0-2.0 mm						
CL 2.0-3.0 mm						
BW 2.2-7.3 mg	2	-	9	-	2	13
1st Week (PL₃₀)						
BL 16-22 mm						
RL 4.0-5.0 mm						
CL 4.0-5.0mm						
BW 18.9-67.1 mg	1	-	4	2	4	11
4th Week (Juvenile)						
BL 52-71mm						
RL 11-13 mm						
CL 11-16mm						
BW 0.963-1.59gm	2	-	7	2	2	13
7th Week						
BL 75-102mm						
RL 13-18 mm						
CL 18-24mm						
BW 2.51-5.99gm	7	-	6	2	2	17
10th Week						
BL 91-125 mm						
RL 16-24 mm						
CL 22-32 mm						
BW 4.31-13.18gm	2	3	3	4	3	15
13th Week						
BL 125-155 mm						
RL 24-35 mm						
CL 31-39 mm						
BW 13.38-24.39 gm	5	3	5	1	3	17
16th Week						
BL 155-162 mm						
RL 30-34 mm						
CL 41-45 mm						
BW 24.81-30.81 gm	-	1	2	2	7	12





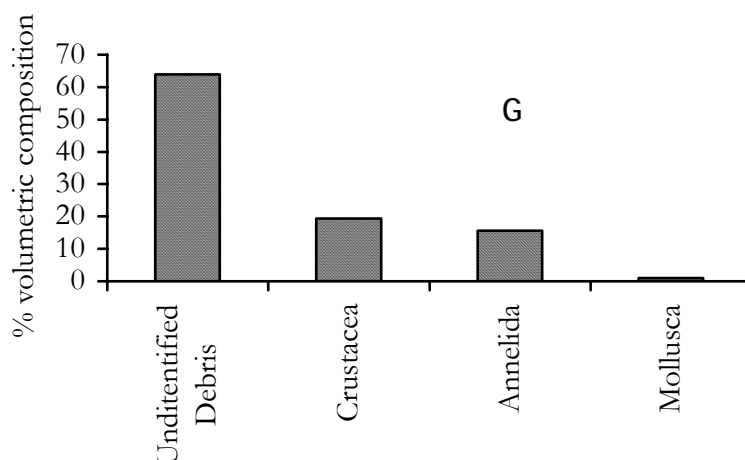


Figure 1: Percentage Volumetric Composition of Different Stages of *P. monodon* in Aquaculture Ponds; [A] PL₁₅ (Carapace length [CL] 2.0-3.0 mm), [B] 1st week PL₃₀ (CL- 4.0-5.0 mm), [C] 4th week, Juvenile (CL-11.0-26.0 mm), [D] 7th week, Sub-adult (CL-18.0-24.0 mm), [E] 10th week, adult (CL-22.0-32.0 mm), [F] 13th week, Adult (CL-31-39 mm), [G] 16th week, Adult (CL-41.0-45.0 mm).

The sub adult and adult shrimps foregut contains detritus, crustacea, annelida, gastropoda and rotifera (Table 1). Detritus (unidentified materials) ranked the highest in terms of frequency of occurrence in all shrimp gut contents (58.82-100%). The percent occurrence of detritus was increased to 100% at the end of culture period, while other benthic organisms were less in the foregut of shrimps. This symptom indicates that the foregut of all studied shrimps was full with detritus in the end of culture cycle coinciding with lower amount of edible benthos in the ponds (Table 1; Figure 2 and 3). Quasim and Easterson (1974) reported that shrimps were shown to assimilate 93% of estuarine detritus. In the group of crustacea, copepoda was the major food item preyed by all size and age of shrimps throughout the culture period, which cover 16.67-90.91% of the occurrence. May be it is due to presence of copepoda throughout the duration of culture period in the ponds. Chen and Chen (1992) stated that post larvae and juveniles *P. monodon* feed heavily on live zooplankton and found a significant decreased in ponds after inoculation of post larval shrimps in Taiwan. Rubright *et al.*, (1981) suggested that the transformation of zooplankton populations into detritus could enrich the benthic food chain in culture ponds. Compare to other stages of shrimps (PL₁₅ - sub adult), the zooplankton items were less in the foregut content of adult shrimps indicating that the small size of zooplankton may be the main reason for the rejection of its role as a direct food source for the adult benthic shrimps. Mollusca were presence in the foregut of sub-adult (CL 18.0–24.0 mm) and adult (CL 22.0–45.0 mm) shrimps, while they are available in the ponds and able to prey by these stages of shrimps.

The present result indicates that sub-adult and adult *P. monodon* are omnivorous scavengers, which feed on variety of benthic materials and organisms i.e. detritus, copepoda, ostracoda, mysidacea, nauplii, insecta, gastropoda, bivalvia, ploychaeta, rotifera and phytoplankton, and eating these food items when available. Hall (1962) found that the penaeid shrimps consume crustacea, plant matter, annelida, mollusca and small fish in estuarine water. Chong and Sasekumar (1981) stated that organic detritus probably supplements when other

preferred food items are inadequate. It is not well known whether shrimps directly utilize detritus; however, unidentified detritus was observed in the foregut. The detritus is known to serve as a substrate for microorganisms i.e. bacteria, fungi, protozoan. These microbes are probably more important for the culture species since it consists of cellulose, lignin, protein, starch, fats, waxes and oils (Boyd, 1995 and Darnell, 1967). Dall, (1968) also suggested that the bacterial colonies might be an important component of diet for penaeid shrimps.

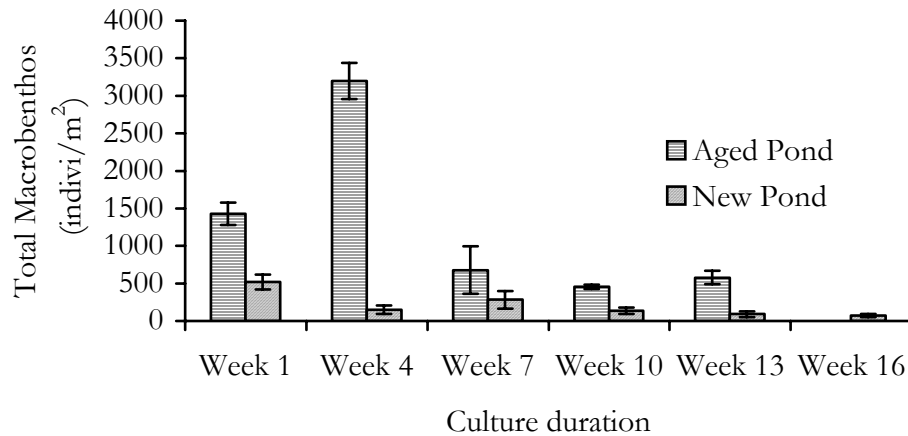


Figure 2: Total Macro-benthos Populations of *P monodon* Aquaculture Ponds Throughout the Culture Cycle.

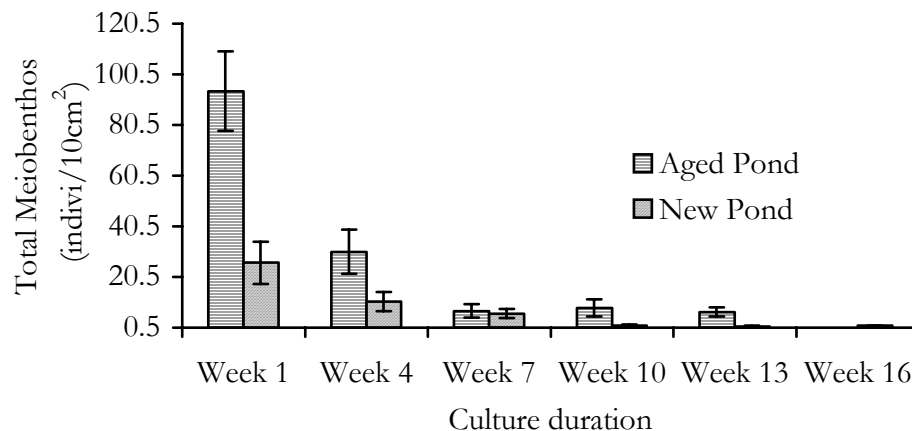


Figure 3: Total Meio-benthos Population of *P monodon* Aquaculture Ponds Throughout the Culture Cycle.

Generally, with the exception of gastropoda, the total benthos abundance in both ponds was decreased gradually throughout the culture period (Figure 2). This fluctuation of gastropoda abundance may be due to the rejection of bigger size (1.0–2.0 cm) of *Teloscopium telescopium*, which shrimps may unable to prey and consume cause of hardy shell. The meio-benthos declined gradually toward the progress of culture period (Figure 3). The indication to prefer natural food

by shrimp was found when available and selection of food preference of *P. monodon* depends on the availability of food items in the ponds. Comparatively, higher percent of food items was found in the foregut of the shrimps those collected from aged pond since it contained higher amount of benthic organisms than new pond (Figure 2 and 3). The decreasing of overall benthic organisms probably due to predation of shrimp throughout the culture period or may be cause of organic matter input into ponds from uneaten feed, faecal matters and dead organisms, which produce toxic gases for benthic dweller as well as for culture species shrimp.

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