# Journal of
# Fisheries and Aquatic Science

ISSN 1816-4927

Academic
Journals Inc.

www.academicjournals.com

Journal of Fisheries and Aquatic Science 6 (7): 771-779, 2011
ISSN 1816-4927 / DOI: 10.3923/jfas.2011.771.779


# Stomach Contents of Sergestid Shrimp *Acetes japonicus* from the Estuary of Tanjung Dawai Peninsular Malaysia

[1]A.A. Amani, [2]S.M.N. Amin and [1,2]A. Arshad

[1]Laboratory of Marine Science and Aquaculture, Institute of Bioscience, Universiti Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia

[2]Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia

*Corresponding Author: S.M.N. Amin, Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia*

## ABSTRACT

The study on food and feeding habits of planktonic shrimp *Acetes japonicus* were done by examining the stomach contents of 164 specimens between June 2008 and May 2009. Samples were obtained from the bag net that was set along the bank of Tanjung Dawai estuary. Diet compositions of *A. japonicus* were grouped into eight major categories: phytoplankton, zooplankton, algae, appendages of crustacean, plant matter, debris, unidentifiable items and sand and mud. Analysis on the percentage of numerical abundance ($C_i$) showed that plant matter (28.18%) and crustacean appendages (18.70%) as the two highest values amongst the eight categories of food items. In addition, percentage frequency of occurrence ($F_{pi}$) values of phytoplankton, zooplankton, algae, plant matter, appendages of crustacean, debris, unidentified items and sand and mud were 3.54, 7.05, 5.07, 27.44, 17.42, 15.80, 8.94 and 19.81%, respectively. On the basis of food composition found in the stomach, it can be concluded that *A. japonicus* is omnivorous in feeding habit.

**Key words:** Feeding habit, sergestid shrimp, *Acetes japonicus*, Peninsular Malaysia

## INTRODUCTION

Sergestid shrimp *Acetes japonicus* is regarded as an important component of the marine zooplanktons in the coastal waters of the western coast of Peninsualr Malaysia (Amin *et al*., 2009a). In term of distribution, *A. japonicus* occurs in the shallow waters of a muddy bottom in the Indo-West Pacific west coast of India to Korea, Japan, China, Indonesia (Omori, 1975) and reported to be present in the Straits of Malacca by Arshad *et al*. (2007). *Acetes* has various uses in the preparation of local delicacies. Besides being used as edible products and ingredients for artificial fish feed formulation, they are also important ecologically as food source for many marine fishes. They are known to feed on both phytoplankton and zooplankton and form a natural highly balanced diet for the fish (Xiao and Greenwood, 1993). There is no specific report available on the feeding habits of *A. japonicus* although other biological aspects were earlier reported by (Arshad *et al*., 2007, 2008; Amin *et al*., 2009a, b, 2010a, b). The present study has been undertaken to specifically examine the feeding habits of *A. japonicus*. Thus, objective of the study was to determine the diet composition of *A. japonicus* and to assess the temporal variation of diet composition over a period of one year.

## MATERIALS AND METHODS

**Study area:** Samples were collected monthly from the local fisherman of Tanjung Dawai (N 5° 40' 48" and E 100° 22' 5"), coastal waters (Fig. 1) between June 2008 and May 2009. However, it was not possible to collect any shrimp samples in November 2008 due to flood problem in the study area. The main fishing gear used by fishermen to catch acetates was the Set Bag Net (SBN). The net was normally set up during high tide and harvesting was done during the low tide. The SBN was fixed mostly between 2 and 3 m depth along the shallow waters in the upper estuary. The mesh size of the SBN was around 0.5 cm at cod end. Fresh samples for study were taken from fisherman's net immediately after hauling and preserved in 5% formalin for laboratory analysis.

**Stomach examination:** Specimens were identified using a Nikon dissecting microscope (Nikon-122764, Japan). *A. japonicus* was identified using the reference of (Omori, 1975). A total of 330 stomachs (30 stomachs per month) of *A. japonicus* were analyzed but only 164 stomachs were either full or half full or quarter full and the remaining 166 were empty stomach. Each stomach was removed from the cephalothorax region using a pin under a dissecting microscope (Omori, 1975). The stomach contents were then incised and laid on a counter glass slide. A drop of distilled water was added to the sample. Food items and frequency of occurrence were counted. Food item identification was made using references by Crane (1973), Lokman (1990), Lewis (1979) and Bougis (1976).

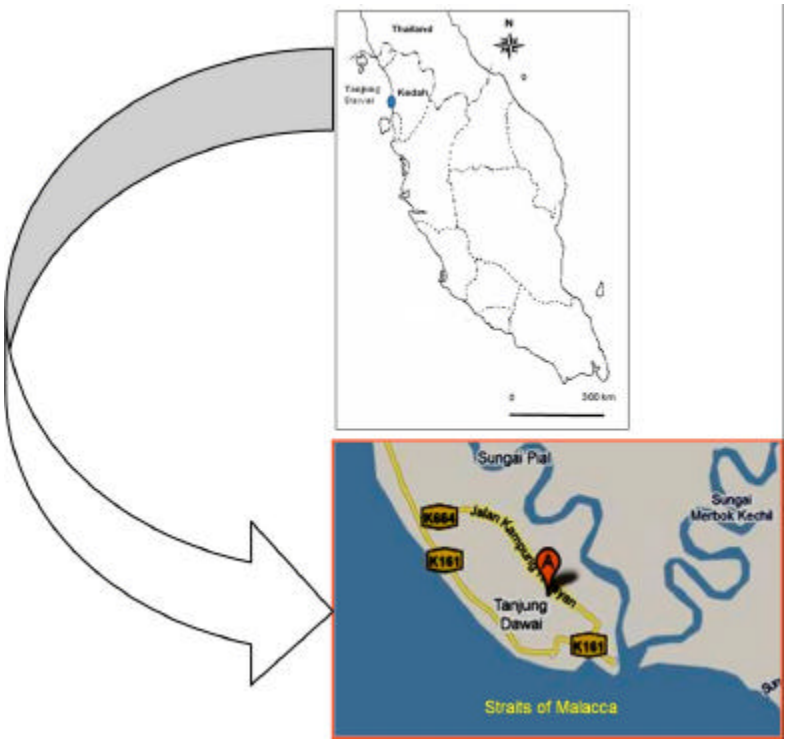


Fig. 1: Geographical location of the study site in the Tanjung Dawai (•), Kedah, Peninsular Malaysia

**Stomach contents analysis:** Percentage frequency of occurrence and percentage numerical abundance methods (Chrisfi *et al*., 2007) were adopted for the analysis of stomach content.

- Percentage frequency of occurrence ($F_{pi}$) = ($N_{1i}/N_p$)×100, where $N_{1i}$ is the number of the stomachs in which food item $_i$ was found and $N_p$ is the number of non-empty stomachs
- Percent numerical abundance:

$$(C_i) = ni / \sum_{i=1}^{m} ni \times 100$$

where, ni is the number of ith food item and m the number of food items.

## RESULTS

**Diet composition:** In total, 23 food items belonging to eight major groups were identified from the stomach sacs of *A. japonicus*. Percentage of diet composition in the stomach of *A. japonicus* is presented in Fig. 2. Plant matter consisted 27.81% of the total composition and was the highest proportion observed. The second highest value was the crustacean appendages (18.06%). This was followed by sand and mud (17.43), debris (14.4%), unidentified items (8.12%), phytoplankton (6.13%), zooplankton (6.05%) and algae (4.46%). Among the phytoplankton diet recorded, dinoflagellate (3.61%) was the most dominant. This was followed by diatom (1.89%), Navicula (1.7%), centric diatom (1%), *Euglena* (0.77%), *Coscinodiscus* (0.41%) and *Ceratium* (0.31%). As for the zooplankton (Table 1), copepod (2.08%) made up the highest percentage and this was followed by the amphipods (1.99%), cladocerans (1.71%), ostracods (1.43%) and mysids (0.92%) (Table 1).

**Seasonal variation of prey items:** Monthly percentage frequency of occurrence ($F_{pi}$) of prey items are presented in Table 2. Phytoplankton was found in every month of the stomach samples. Slightly higher frequency of occurrence of phytoplankton was recorded in September (5.1%), January (6.9%), March (5.5%), April (6.6%) and May (8.4%). Among the phytoplankton

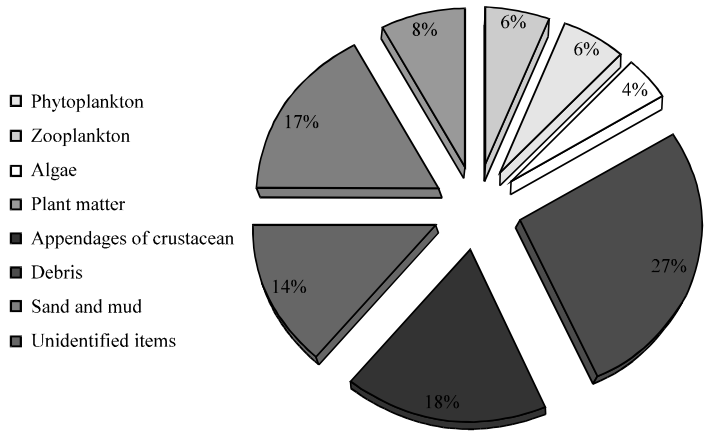


Fig. 2: Percentage of major groups of diet composition of *A. japonicus* from the estuary of Tanjung Dawai, Kedah

Table 1: Combined mean percentage of diet composition of *A. japonicus* in the estuarine waters of Kedah

| Food items | $F_{pi}$ | $C_i$ | Average |
|---|---|---|---|
| Phytoplankton | 3.54 | 8.73 | 6.13 |
| Chromophyta | 0.18 | 0.55 | 0.36 |
| Chlamydomonas | 0.24 | 0.59 | 0.41 |
| Dinoflagellate | 2.94 | 4.28 | 3.61 |
| Centric diatom | 0.62 | 1.39 | 1.00 |
| Diatom | 0.94 | 2.84 | 1.89 |
| *Euglena* | 0.46 | 1.08 | 0.77 |
| *Navicula* | 1.09 | 2.32 | 1.07 |
| *Coscinodiscus* | 0.24 | 0.59 | 0.41 |
| *Ceratium* | 0.13 | 0.05 | 0.31 |
| Others | 2.32 | 4.42 | 3.37 |
| Zooplankton | 7.05 | 5.06 | 6.05 |
| Copepod | 1.27 | 2.09 | 2.08 |
| Cladocera | 0.92 | 2.51 | 1.71 |
| Ostracod | 0.86 | 2.01 | 1.43 |
| Amphipod | 1.27 | 2.72 | 1.99 |
| Mysid | 0.54 | 1.03 | 0.92 |
| Algae | 5.07 | 3.86 | 4.46 |
| Plant matter | 27.44 | 28.18 | 27.81 |
| Appendages of crustacean | 17.42 | 18.07 | 18.06 |
| Debris | 15.08 | 13.11 | 14.04 |
| Sand and mud | 19.81 | 15.05 | 17.43 |
| Unidentified items | 08.94 | 07.31 | 08.12 |

composition, dinoflagellate, diatom and *Naviculla* were consistently dominant throughout the year. Zooplankton was observed around the year except in the month of July. The occurrence of zooplankton were particularly higher during March (11.1%) and April (16.2%). Copepod and ostracod showed diverse distribution throughout the year compared to other zooplankton. Algae were found from April-July and September-December. Apart from these months, no algae diets were found. Plant matter was found in most months of the year and its occurrence frequency ranged from 5.4 to 32.8%. Appendages of crustacean and debris were also recorded throughout the study period. The highest occurrence of plant matters was observed during June to August. High occurrences of crustacean appendages were found between October 2008 to February 2009. The highest percentage frequency of debris was seen in February and this is similar to the highest percentage frequency showed by the crustacean appendages (Fig. 3).

Percentage numerical abundance ($C_i$) of prey items is presented in Table 3. High percentage of phytoplankton was recorded in September (11.4%) and April to May (90%). Zooplankton was highest in March 2009 (16.6%). The lower number of zooplankton percentage was found between August and December 2008. Algae abundance was highest in the month of July (12.32%). Plant matter was found highest in June (30.2%) and lowest in September (5.9%). Crustacean appendages ranged from 10.5 to 19.6%. No definite pattern on food composition occurrence was observed. The percentage numerical abundance also did not fully agree with the frequency of occurrence amongst the diets. In term of numerical abundances, there were three major food components found in the stomach in each month (Fig. 4). These were phytoplankton, plant matters and crustacean

Table 2: Percentage frequency of occurrence ($F_{pi}$) of food items of *A. japonicus* in the coastal waters of Kedah

| | No. of Guts | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jun | Jul | Aug | Sep | Oct | Dec | Jan | Feb | Mar | Apr | May |
| Food items | 20 | 23 | 19 | 10 | 7 | 5 | 11 | 17 | 2 | 25 | 25 |
| Phytoplankton | 1.63 | 1.11 | 1.73 | 5.10 | 0.80 | 0.97 | 6.90 | 0.27 | 5.5 | 6.60 | 8.40 |
| Chromophyta | - | - | - | - | - | - | - | - | - | 0.24 | 0.13 |
| Chlamydomonas | - | - | - | - | - | - | - | - | - | 0.24 | - |
| *Gonyaulax* | - | - | - | - | - | - | - | - | - | - | - |
| Dinoflagellate | - | 2.23 | - | 1.50 | - | - | 2.70 | 1.62 | 8.3 | - | 1.30 |
| Centric diatom | - | - | - | 0.50 | - | - | - | - | - | 0.74 | - |
| Diatom | 0.60 | 0.74 | 1.03 | 0.50 | 1.61 | - | 2.10 | 0.27 | - | - | 0.68 |
| *Euglena* | 0.60 | - | 0.34 | - | - | - | 0.96 | 0.27 | - | - | 0.13 |
| *Avicula* | 0.60 | - | 3.11 | 1.50 | - | 0.97 | 0.96 | 0.27 | - | 0.24 | - |
| *Coscinodiscus* | - | - | - | - | - | - | - | - | - | 0.24 | - |
| *Ceratium* | - | - | - | - | - | - | - | - | - | - | 0.13 |
| Others | 1.55 | 1.48 | - | 3.00 | 0.80 | 4.80 | - | - | - | - | 2.30 |
| Zooplankton | 3.48 | - | 1.38 | 4.50 | 0.40 | 0.97 | 7.60 | 1.80 | 11.1 | 16.20 | 3.14 |
| Copepod | 1.16 | 0.74 | - | 0.50 | 1.20 | 1.94 | 0.96 | 2.40 | - | - | - |
| Cladocera | - | - | 1.03 | 0.50 | - | - | - | 0.27 | 2.7 | - | 0.13 |
| Ostracod | 0.77 | 1.48 | 2.42 | 0.50 | 0.40 | 0.97 | - | - | - | 0.24 | 0.13 |
| Amphipod | 1.93 | - | 0.69 | 0.50 | - | - | - | - | 2.7 | 1.70 | 0.13 |
| Mysid | - | - | - | - | - | - | 0.96 | 0.27 | - | - | 0.40 |
| Algae | 3.87 | 3.71 | - | 5.50 | 2.01 | 4.80 | - | 2.40 | - | 8.10 | 10.20 |
| Plant matter | 25.19 | 27.88 | 32.20 | 22.30 | 25.40 | 20.30 | 32.80 | 8.60 | 16.6 | 5.40 | 15.10 |
| Appendages of crustacean | 15.50 | 23.42 | 12.10 | 11.60 | 21.70 | 19.40 | 21.60 | 24.60 | 8.3 | 21.20 | 12.20 |
| Debris | 9.68 | 14.86 | 21.50 | 5.10 | 4.43 | 12.90 | 13.90 | 31.70 | 19.4 | 22.40 | 18.03 |
| Sand and mud | 29.06 | 16.72 | 15.60 | 28.90 | 34.30 | 17.40 | 9.10 | 20.30 | - | 11.10 | 15.70 |
| Unidentified items | 3.87 | 5.57 | 6.92 | 7.60 | 6.85 | 14.50 | - | 2.98 | 25.0 | 4.90 | 11.30 |

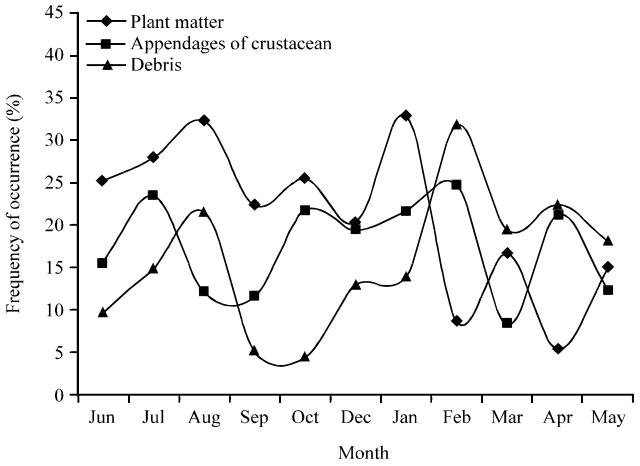


Fig. 3: Percentage frequency of occurrence ($F_{pi}$) of three groups of diets in the different sampling months

appendages. The highest occurrences of phytoplankton were observed in September and in January-May. The peak occurrences of plant matters were found in June-October and January.

Table 3: Percentage of numerical abundance ($C_i$) of food items of *A. japonicus* in the coastal waters of Kedah

| | No. of Guts | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jun | Jul | Aug | Sep | Oct | Dec | Jan | Feb | Mar | Apr | May |
| Food items | 20 | 23 | 19 | 10 | 7 | 5 | 11 | 17 | 2 | 25 | 25 |
| Phytoplankton | 5.31 | 5.47 | 7.31 | 11.4 | 4.76 | 3.33 | 8.50 | 1.08 | 8.3 | 10.10 | 10.50 |
| Chromophyta | - | - | - | - | - | - | - | - | - | 0.59 | 0.50 |
| Chlamydomonas | - | - | - | - | - | - | - | - | - | 0.59 | - |
| *Gonyaulax* | - | - | - | - | - | - | - | - | - | - | - |
| Dinoflagellate | - | 4.10 | - | 1.6 | - | - | 3.38 | 4.30 | 8.3 | - | 4.02 |
| Centric diatom | - | - | - | 1.6 | - | - | - | - | - | 1.19 | - |
| Diatom | 1.06 | 2.73 | 4.20 | 1.6 | 7.14 | - | 3.38 | 1.08 | - | - | 1.50 |
| *Euglena* | 1.06 | - | 1.05 | - | - | - | 1.69 | 1.08 | - | - | 0.50 |
| *Navicula* | 1.06 | - | 5.30 | 3.2 | - | 3.33 | 1.69 | 1.08 | - | 0.59 | - |
| *Coscinodiscus* | - | - | - | - | - | - | - | - | - | 0.59 | - |
| *Ceratium* | - | - | - | - | - | - | - | - | - | - | 0.50 |
| Others | 3.19 | 2.73 | - | 3.2 | 2.38 | 10.00 | - | - | - | - | 5.02 |
| Zooplankton | 6.38 | - | 2.10 | 3.9 | 2.38 | 3.33 | 10.86 | 4.30 | 16.6 | 11.30 | 7.50 |
| Copepod | 3.19 | 2.73 | - | 1.6 | 2.38 | 3.33 | 1.69 | 5.40 | - | - | - |
| Cladocera | - | - | 1.05 | 1.6 | - | - | - | 1.08 | 8.3 | - | 0.50 |
| Ostracod | 1.06 | 5.47 | 1.05 | 1.6 | 2.38 | 3.33 | - | 2.10 | - | 0.59 | 0.50 |
| Amphipod | 2.12 | - | 2.10 | 1.6 | - | - | - | 3.20 | 8.3 | 1.19 | 0.50 |
| Mysid | - | - | - | - | - | - | 1.69 | 1.08 | - | - | 1.00 |
| Algae | 5.32 | 12.32 | - | 7.1 | 6.14 | 10.00 | - | 7.60 | - | 7.90 | 9.50 |
| Plant matter | 30.20 | 16.43 | 18.90 | 5.9 | 16.60 | 10.00 | 18.60 | 11.80 | 16.6 | 11.90 | 13.10 |
| Appendages of crustacean | 11.63 | 14.60 | 10.50 | 14.7 | 19.60 | 13.30 | 15.20 | 14.10 | 16.6 | 14.40 | 11.10 |
| Debris | 18.08 | 13.60 | 11.50 | 11.4 | 9.50 | 13.30 | 16.90 | 17.30 | 8.3 | 11.90 | 12.50 |
| Sand and mud | 13.82 | 13.60 | 20.00 | 14.7 | 16.60 | 16.60 | 15.20 | 13.04 | - | 14.90 | 12.10 |
| Unidentified items | 7.44 | 6.84 | 16.80 | 11.4 | 10.90 | 10.00 | - | 9.70 | 7.3 | 9.70 | 10.10 |

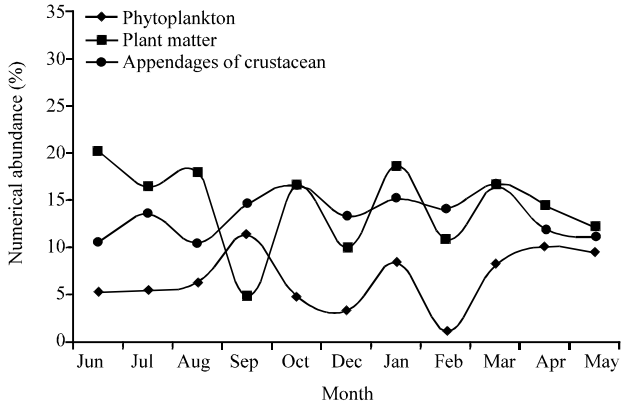


Fig. 4: Percentage numerical abundance ($C_i$) of three groups of diets in the different sampling months

The peak occurrences of appendages of crustacean in the stomach were observed during the month of August- October and January-May (Fig. 4).

## DISCUSSION

In the present study, diet compositions of *A. japonicus* were grouped into eight major categories viz phytoplankton, zooplankton, algae, appendages of crustacean, plant matter, debris, unidentified items and sand and mud. Amongst all diets, plant matter showed the highest percent (27.81%). This is similar in result with Amin *et al.* (2007) who found the plant matter was also highest in the stomach of *A. indicus* from the coastal waters of Malacca. Phytoplankton was the highest diet composition (45.51%) in *A. intermedius* in the coastal waters of south-western Taiwan (Chiou *et al.*, 2005) and the dinoflagellate (27.03%) was also the most important diet discovered. However, phytoplankton is not the major food item in the present study. This could be attributed to the non specific food requirement characteristic of this shrimp and the diversity in food source at different geographical location. It is reported that *A. paraguayensis* grazing the phytoplankton group such as *Ankistrodemus* sp., *Oedogonium* sp., *Bulbochaeta* sp. and *Navicula* sp. (Collins and Williner, 2003). This result in different main food items may be due to the different resource availability in those places. It is reported by Zafar (2000) that the stomachs of *A. indicus* in the coastal waters of Bangladesh contained diatoms (30.08%), copepods (8.34%), sagitta (7%), foraminifera (1.66%), crustaceans appendages (1.25%), detritus (27.5%), sand and mud (22.58%) and molluscan parts (1.58%). Copepods were also recorded in the stomachs of *A. japonicus* but no diatoms were found in the stomachs of *A. japonicus* collected in the Ariake Sea (Ikematsu, 1957).

Deshmukh (2002) reported that detritus as the most frequent food item (39.70%) in the stomachs of *A. indicus* in the coastal waters of India. The foraminiferans, eggs and larvae were rare, whereas food items commonly observed in the foreguts of shrimp such as polychaetes, molluscs, filamentous algae and sand. It is concluded that the shrimp *A. indicus* is omnivorous. Although detritus is not the major found items in the stomach of *A. japonicas* but it is omnivores in the coastal waters of Tanjung Dawai. Xiao and Greenwood (1993) had reported that copepods were the primary item consumed by *Acetes* shrimp. The variety of food ingested by *A. japonicus* indicates that they are omnivore, similar as other species of *Acetes* (Xiao and Greenwood, 1993; Xu, 1957). Based on the results obtained, it can be said that *A. japonicus* is an active feeders and can be classified as omnivore since it consumed food of both plants and animal origins.

## CONCLUSIONS

According to combined mean percent of diet composition, plant matter was observed as the highest percentage 27.81% in the stomach of *A. japonicus*. This was followed by crustacean appendages 18.06%, sand and mud 17.43%, debris 14.4%, unidentified items 8.12%, phytoplankton 6.13%, zooplankton 6.05% and algae 4.46%. There was no definite pattern of food consumption between months and different peak of occurrence was observed. The various percentage composition of food items further reiterated that this shrimp species is a bottom feeder omnivore.

## ACKNOWLEDGMENTS

This study is part of a research project funded by the Ministry of Science, Technology and Innovation (MOSTI), Malaysia (grant No. 05-01-04-SF0613). The authors like to acknowledge MOSTI for providing financial funding to carry out present research work and UPM for the providing of the research facilities and technical assistance.

**REFERENCES**

Amin, S.M.N., A. Arshad, S.S. Siraj and S.B. Japar, 2007. The biology and life history of sergestid shrimp *Acetes indicus* (Decapoda: Sergestidae) in the coastal waters of Malacca, Peninsular Malaysia. Bioscientist, 5: 9-17.

Amin, S.M.N., A. Arshad, S.S. Siraj and B.J. Sidik, 2009a. Population structure, growth, mortality and yield per recruit of sergestid shrimp, *Acetes japonicus* (Decapoda: Sergestidae) from the coastal waters of Malacca, Peninsular Malaysia. Indian J. Mar. Sci., 38: 57-68.

Amin, S.M.N., A. Arshad, J.S. Bujang, S.S. Siraj and S. Goddard, 2009b. Reproductive biology of sergestid shrimp *Acetes indicus* (Decapoda: Sergestidae) in coastal waters of Malacca, Peninsular Malaysia. Zool. Stud., 48: 753-760.

Amin, S.M.N., A. Arshad, N.H. Ismail, M.H. Idris, J.S. Bujang and S.S. Siraj, 2010a. Morphometric variation among the three species of the genus *Acetes* (Decapoda: Sergestidae) in the coastal waters of Malacca, Peninsular Malaysia. Pertanika J. Trop. Agric. Sci., 33: 341-347.

Amin, S.M.N., A. Arshad, S.S. Siraj and J.S. Bujang, 2010b. Reproductive seasonality and maturation of the sergestid shrimp, *Acetes japonicus* (Decapoda: Sergestidae) in coastal waters of Malacca, Peninsular Malaysia. Afr. J. Biotechnol., 9: 7747-7752.

Arshad, A., S.M.N. Amin, S.S. Siraj and S.B. Japar, 2007. New distribution records of sergestid shrimp, *Acetes intermedius* (Decapoda: Sergestidae) from Peninsular Malaysia with notes on its population characteristics. J. Biol. Sci., 7: 1305-1313.

Arshad, A., S.M.N. Amin, G.T. Yu, S.Y. Oh, J.S. Bujang and M.A. Ghaffar, 2008. Population characteristics, length-weight and length-length relationships of *Acetes vulgaris* (Decapoda: Sergestidae) in the coastal waters of Pontian, Johor, Peninsular Malaysia. J. Biol. Sci., 8: 1298-1303.

Bougis, P., 1976. Marine Plankton Ecology. North-Holland Publishing Company, Amsterdam, Pages: 355.

Chiou, W.D., J.J. Hwang, L.Z. Cheng and C.T. Chen, 2005. Food and feeding habit of Taiwan mauxia shrimp *Acetes intermedius* in the coastal waters of Southwestern Taiwan. Fish. Sci., 71: 361-366.

Chrisfi, P., P. Kaspiris and G. Katselis, 2007. Feeding habits of sand smelt (*Atherina boyeri*, Risso 1810) in Tichonis Lake (Western Greece). J. Applied Ichthyol., 23: 209-214.

Collins, P.A. and V. Williner, 2003. Feeding of *Acetes paraguayensis* (Nobili) (Decapoda: Sergistidae) from the Parana River, Argentina. Hydrobiologia, 493: 1-6.

Crane, J.M., 1973. Introduction to Marine Biology (A Laboratory Text). Merrill, Ohio, ISBN: 9780675089548, Pages: 179.

Deshmukh, V.D., 2002. Biology of *Acetes indicus* milne edwards in Bombay waters. Indian J. Fish., 49: 379-388.

Ikematsu, W., 1957. An estimation of secular variation of Ami (*Acetes japonicas* and mysis) yield based on the past records of catch statistic in Saga prefecture. Rep. Invest. Ariake Sea, 88: 35-41.

Lewis, W.M., 1979. Zooplankton Community Analysis Studies on a Tropical System. Springer-Verlag, New York, USA., ISBN-10: 0387904344, pp: 10-21.

Lokman, S., 1990. Marin Diatom in Malaysia. 1st Edn., Ministry of Education Malaysia, Malaysia, pp: 179-203.

Omori, M., 1975. The systematics, biogeography and fishery of epipelagic shrimp shrimps of the genus *Acetes* (Crustacea, Decapoda, Sergestidae). Bull. Ocean Res. Inst. Univ. Tokyo, 7: 1-91.

Xiao, Y. and J.G. Greenwood, 1993. The biology of acetes (Crustacea: Sergestidae). Mar. Biol. Ann. Rev., 31: 259-444.

Xu, C.Y., 1957. Studies on the diet composition of Acetes chinensis Hansen in Liaotung Bay: A survey of Acetes chinensis Hansen in Liaotung Bay, North China. Liaotung Marine Fisheries Laboratory, Liaotung, China, pp: 71-87.

Zafar, M., 2000. Study on sergestid shrimp acetes in the vicinity of mathamuhuri river confluence, Bangladesh. Ph.D. Thesis, University of Chittagong, Bangladesh.