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# Seasonal Variation in Diet Composition of Torpedo Trevally, *Megalaspis cordyla* (L) Depending upon its Size and Sex

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**Abstract.-** Samples of the torpedo trevally, *Megalaspis cordyla* were randomly procured from commercial landings at Karachi Fish Harbour from August 2013 to June 2014. The data of 293 (118 males and 175 females, $\chi^2 = 11.09$, $P<0.05$) individuals were used to estimate size, sex and seasonal feeding preferences. The study revealed that *M. cordyla* categorically feeds on fish (40.62%), digested matter (27.81%), crustaceans (23.39%), mollusks (6.31%), polychaetes (1.11%) and coelenterates (0.76%). The index of relative importance (IRI) and absolute index (AI) were applied to estimate main food item consumed by the fish. The males preferred *Acetes* spp. and female mainly fishes. The feeding rate during post monsoon was relatively higher which was deduced from the number of full stomachs, whereas lower number of prey items was observed during post monsoon followed by pre monsoon. The stumpy feeding was observed during monsoon when most of the stomachs were empty. The gastrosomatic index estimates showed that females feed enormously in May followed by September, while in males high feeding rate was observed in April and June. Present study document diet constituents of an important fish species captured in the Northern Arabian Sea coast of Pakistan as well as variation of feeding habits and intensity relative to size, sex and season.

**Key words:** *M. cordyla*, monotypic, diet composition, Monsoon

## INTRODUCTION

Assessment of feeding is an important aspect to know as to how a species interacts with its surrounding environment. The Torpedo trevally, *Megalaspis cordyla* is monotypic schooling species inhabits which the pelagic region and is distributed in the Western Indian Ocean from Japan to Australia. This species is mainly caught by hook, line, beach seines, trawls, purse seines at the depth of 20-80m (Fisher and Bianchi, 1983).

The contribution of *Megalaspis* among carangids was 24.16% while within the finfish resources of 1.63% was recorded in 2009, whereas its highest landing (9722mt) was recorded in 2001 and the lowest (3559mt) in 2008 (MFD, 2012). Studies on the length frequency, feeding habits and reproductive biology of *M. cordyla* has been reported from other laboratories (Sareenivasan, 1974; Jadhav and Mohilic, 2013). The slower feeding rate during breeding season may be due to enlargement in ovary which spread out and occupied a large portion of the abdominal cavity that produce pressure on the stomach (Thomas, 1969). Recently Qamar and Panhwar (2015) documented feeding habits and food preferences in two carangids, *Scomberoides commersonnianus* and *S. tol.* Panhwar *et al*. (2014) appraised that curb on over-fishing and mesh size regulation would help in sustainable exploitation of *S. commersonnianus* in Pakistan.

The study was aimed to document diet constituents of an important fish species captured in the Northern Arabian Sea coast of Pakistan as well as analyzing quantitative variation of feeding habits and intensity in terms of size, sex and season.

## MATERIALS AND METHODS

### *Collection of samples*

The data of 293 individuals of *Megalaspis cordyla* randomly sampled from Karachi fish harbour from August 2013 to June 2014, except July due to the fishing ban and severe weather conditions. In the laboratory, total length (TL), fork length (FL), standard length (SL) and body circumference for each individual was measured to 0.1cm and weighed to 0.1 g. The abdomen of fish was incised ventrally in which sagittal cut was made from the anal aperture to the pelvic fin. Feeding intensity was estimated and stomach fullness was

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visually classified as full, three-fourth full, half full, one-fourth full, traces and empty. The stomach was cut, weighed and its contents were extracted, flushed with distilled water and placed in a petri dish for binocular microscope examination. Indigestible prey was identified to the lowest possible genera. The number, frequency of occurrence and weight of each prey item was recorded. The digested matter constitutes mixed proportion of the mucus and bulk of assimilated contents of the diet.

*Statistical analysis of data*

The data was analyzed for frequency of occurrence numbering, composition, gravimetric composition index of relative importance (IRI) and absolute index (AI) to describe the diet composition of fishes.

Frequency of occurrence (%F) = $Fi * 100 / \sum Fi$

The method gives the percentage ratio of stomach containing prey and total number of stomach containing the prey (Bahou *et al*., 2007).

Numerical composition (%N) = $Ni * 100 / \sum Ni$

The estimation of the numerical composition gives description on number of prey item (Ni) relative to the total number of all prey items.

Gravimetric composition (%W) = $Wi * 100 / \sum Wi$

The method of gravimetric composition describes weight of prey item relative to the total weight of all prey items (Hyslop, 1980)

Index of relative importance IRI = (% F + %N)%W

It was calculated according to the modified formula (Hacunda, 1981).

$$\% IRI = \frac{IRI}{\sum IRI} * 100$$

Index of absolute importance (AI) = %F+%N+%W

$$AI = \% F + \% N + \% W$$

$$\% AI = \frac{AI}{\sum AI} * 100$$

Estimated category of food (Q) = %W x % N

Gastro somatic index (GaSI)

$$GaSI = \frac{Fresh\ weight\ of\ the\ stomach}{Total\ wet\ weight\ of\ fish} X\,100$$

It was calculated to investigate monthly variations in feeding intensity.

*Vacuity index (VI)*

$$VI = \frac{Numberof\ emptystomachs}{Totalnumberof\ nonempty\ stomachsexamined} X100$$

It gives an estimate of the authenticity of the predator fish; the more starved fish species, the lower percentage of empty stomachs.

## RESULTS

The data of 293 (♂=40.27% and ♀=59.73%, $\chi^2$=11.09, P<0.05) individuals of *Megalaspis cordyla* were used to examined size, sex and season wise variations in feeding habits. The study reveals that it is a pelagic carnivorous species, which mainly feeds on fish (40.62%), digested matter (27.81%), crustaceans (23.39%), mollusks (6.31%), polychaete (1.11%) and coelenterates (0.76%) categorized in four size class at an interval of 10 cm, were used (Table I).

*Size wise feeding intensity*

*Size class 15-24.9:* In this size class it is evident that the highest percentages of stomach contents examined by occurrence was digested matter (46.91%), by number, isopods (54.88%) and by weight, partially digested fish (34.98%). The index of relative importance (IRI) and absolute index (AI) estimated highest percentages (49.67 and 27.63 as partially digested fish, respectively (Table II).

*Size class 25-34.9:* The food items estimated in this size range with frequency of occurrence partially digested fishes was 31.82%, by number, *Acetes* spp. 64.77% and gravimetrically partially digested fishes were highest (58.32%). The estimated values of (IRI=53.90% and AI =34.87%) indicated partially digested fishes as the highest food content (Table II).

**Table I.- Monthly percent composition by occurrence (%F) estimated for *M. cordyla* exploited in Pakistan.**

| Prey group | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Annual Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Teleosts | 0 | 63.16 | 85.71 | 50.00 | 60.00 | 52.17 | 10.53 | 30.00 | 42.86 | 0.00 | 52.38 | 40.62 |
| Crustaceans | 0 | 21.05 | 0.00 | 9.38 | 17.50 | 13.04 | 36.84 | 0.00 | 33.33 | 83.33 | 42.86 | 23.39 |
| Molluscs | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 15.22 | 26.32 | 10.00 | 9.52 | 8.33 | 0.00 | 6.31 |
| Coelenterates | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 8.33 | 0.00 | 0.76 |
| Polychaete | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 2.17 | 0.00 | 10.00 | 0.00 | 0.00 | 0.00 | 1.11 |
| Digested matter | 100 | 15.79 | 14.29 | 40.63 | 22.50 | 17.39 | 26.32 | 50.00 | 14.29 | 0.00 | 4.76 | 27.81 |

*Size class 35-44.9:* The feeding habits changed as size increased >35 cm. The estimated highest value of food item (%F) by occurrence, (%N) number and (%W) weight was *Acetes* spp. (52.08%, 91.23% and 49.34%, respectively). Similarly estimated values of the IRI and AI estimated *Acetes* spp. as most preferred food item was 97.60 and 64.22, respectively.

*Size class 45-54.9:* In this size classes digested matter was solely recorded (Table II).

*Sex wise*

The highest feeding preference %F in males was digested matter percentages (27.51), %N and %W estimated *Acetes* spp. (98.09 and 43.96) respectively. Estimated two indices revealed that male mainly prefer *Acetes* spp. was the main prey item comprises of IRI=71.58% and AI = 53.47 respectively. Overall results showed that males mainly prefer *Acetes* spp. (Table III).

In females feeding preference relatively differs estimated with (%F) occurrence was partially digested fishes 39.24, (%N) by number was *Acetes* spp. (80.49) and by %W partially digested fishes 33.73. The main food item was partially digested fish estimated with %IRI=53.85 and %AI=18.39. It was noted that males prefer *Acetes* spp. and the females prefer fishes. This assumption may validate that females can give more egg, which implies that most of the fish species do prefer fish in their daily diet (Table III).

The males were showing more active feeding behavior that of the females noted from the presence of highest number of full stomachs. Empty stomachs denote that the diet of males comprises of tiny organisms which were digested quickly a plausible argument was noted from the highest number of empty stomachs found in males. Our results are justified with the highest number of empty stomach present in males. It was confirmed that the main food item in the male was found to be *Acetes* spp. Moderate feeding was observed in female (Fig. 1).

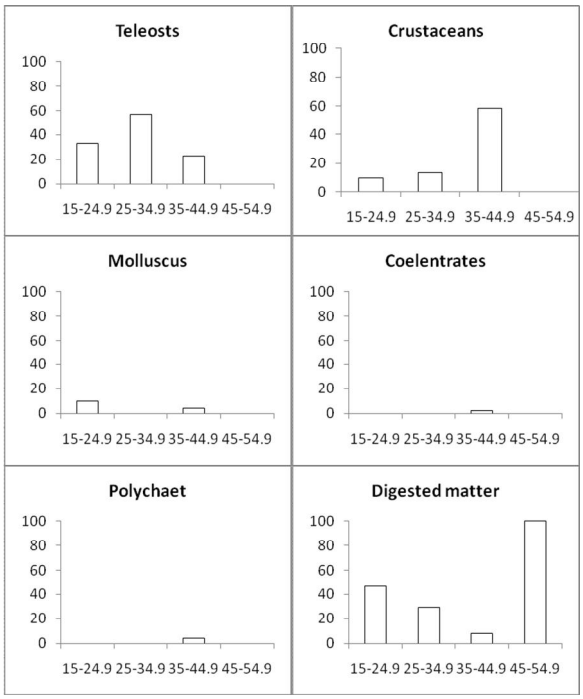


Fig 1. Percentages of food items of different food categories in various size groups estimated for the *M. cordyla* from the Northern Arabian Sea Coast of Pakistan.

*Season wise*

It was noted that during monsoon fish scale was found the most preferred food item followed by *Thyrassa setirostiress* and *Acetes* spp., whereas

**Table II.- Estimated feeding parameters in different size classes for *M. cordyla* in this study.**

| Prey item category | 15-24.9 | | | | | 25-34.9 | | | | | 35-44.9 | | | | | 45-54.9 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | %F | %N | %W | %IRI | %AI | %F | %N | %W | %IRI | %AI | %F | %N | %W | %IRI | %AI | %F | %N | %W | %IRI | %AI |
| Clupeid fish | 1.23 | 0.61 | 6.25 | 0.27 | 2.70 | 2.27 | 0.29 | 0.91 | 0.06 | 1.16 | 6.25 | 0.28 | 15.61 | 1.32 | 7.38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Engraulid fish | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.17 | 0.02 | 4.23 | 0.24 | 2.81 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Stolephurus | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.17 | 0.04 | 3.35 | 0.19 | 2.52 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Juvenile of fish | 2.47 | 1.22 | 0.16 | 0.11 | 1.28 | 2.27 | 0.29 | 0.91 | 0.06 | 1.16 | 4.17 | 0.17 | 0.37 | 0.03 | 1.57 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Other fish | 1.23 | 0.61 | 15.99 | 0.66 | 5.95 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fish scales | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 18.18 | 16.23 | 3.27 | 8.25 | 12.56 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fish Hard part | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.27 | 3.80 | 1.26 | 0.27 | 2.45 | 4.17 | 0.17 | 0.37 | 0.03 | 1.57 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Part. digest. fishes | 28.40 | 19.51 | 34.98 | 49.67 | 27.63 | 31.82 | 14.47 | 58.32 | 53.90 | 34.87 | 0.00 | 0.69 | 23.83 | 0.00 | 8.18 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Penaeid shrimps | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.14 | 0.15 | 2.69 | 0.07 | 1.32 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Acetes* spp. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 12.50 | 64.77 | 9.84 | 21.71 | 29.04 | 52.08 | 91.23 | 49.34 | 97.60 | 64.22 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Shrimps larvae | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.08 | 0.02 | 0.05 | 0.00 | 0.72 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Euphausids | 2.47 | 15.24 | 0.42 | 1.24 | 6.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.17 | 7.27 | 1.03 | 0.46 | 4.16 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Lucifers | 2.47 | 1.22 | 0.87 | 0.17 | 1.52 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Isopods | 4.94 | 54.88 | 3.58 | 9.27 | 21.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Loligo* spp. | 7.41 | 5.49 | 10.36 | 3.77 | 7.75 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.17 | 0.02 | 0.37 | 0.02 | 1.52 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Sepia* spp. | 2.47 | 1.22 | 4.55 | 0.46 | 2.75 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sea anemone | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.08 | 0.01 | 0.47 | 0.01 | 0.86 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Polychaete | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.17 | 0.06 | 0.38 | 0.02 | 1.53 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Digested matter | 46.91 | 0.00 | 22.84 | 34.40 | 23.25 | 29.55 | 0.00 | 22.79 | 15.67 | 17.45 | 8.33 | 0.00 | 0.59 | 0.07 | 2.97 | 100 | 0.00 | 100 | 100 | 100 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 0 | 100 | 100 | 100 |

**Table III.- Summary of the parameters estimated for *M. cordyla* collected in this study.**

| | Prey item category | Male | | | | | Female | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | %F | %N | %W | %IRI | %AI | %F | %N | %W | %IRI | %AI |
| Teleosts | Stolephorus | 2.041 | 0.041 | 2.785 | 0.158 | 1.622 | 1.899 | 0.087 | 3.153 | 0.215 | 1.622 |
| | Mix clupeid fish | 3.061 | 0.061 | 3.657 | 0.312 | 2.260 | 2.532 | 0.693 | 17.280 | 1.589 | 2.260 |
| | Engraulid fish | 2.041 | 0.061 | 3.828 | 0.218 | 1.977 | 1.899 | 0.115 | 8.093 | 0.544 | 1.977 |
| | Other fish | 2.041 | 0.041 | 0.069 | 0.006 | 0.717 | 0.000 | 0.000 | 0.000 | 0.000 | 0.717 |
| | Fish scales | 9.184 | 0.669 | 0.908 | 0.397 | 3.587 | 3.797 | 2.251 | 0.777 | 0.402 | 3.587 |
| | Fish Hard part | 3.061 | 0.101 | 1.146 | 0.105 | 1.436 | 1.899 | 1.097 | 0.229 | 0.088 | 1.436 |
| | Part. digest. fishes | 23.469 | 0.710 | 31.002 | 20.418 | 18.394 | 39.241 | 4.877 | 34.407 | 53.848 | 18.394 |
| Crustaceans | Penaeid shrimps | 1.020 | 0.020 | 1.431 | 0.041 | 0.824 | 0.633 | 0.029 | 0.994 | 0.023 | 0.824 |
| | *Acetes* spp. | 18.367 | 98.093 | 43.961 | 71.580 | 53.474 | 10.127 | 80.491 | 14.887 | 33.739 | 53.474 |
| | Shrimp larvae | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 3.797 | 1.270 | 0.333 | 0.213 | 0.000 |
| | Euphausid | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.633 | 0.722 | 0.128 | 0.019 | 0.000 |
| | Lucifers | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.633 | 0.058 | 0.266 | 0.007 | 0.000 |
| | Isopods | 1.020 | 0.020 | 0.018 | 0.001 | 0.353 | 2.532 | 7.504 | 1.598 | 0.805 | 0.353 |
| | Stomatopod | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.633 | 0.029 | 0.003 | 0.001 | 0.000 |
| Molluscs | *Loligo* spp. | 6.122 | 0.162 | 2.174 | 0.392 | 2.820 | 7.595 | 0.577 | 8.474 | 2.401 | 2.820 |
| Coelenterates | Jelly fish | 1.020 | 0.020 | 0.615 | 0.018 | 0.552 | 1.266 | 0.058 | 0.217 | 0.012 | 0.552 |
| Polychaetes | Polychaete | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.266 | 0.144 | 0.298 | 0.020 | 0.000 |
| Digested matter | Digested matter | 27.551 | 0.000 | 8.406 | 6.353 | 11.986 | 19.620 | 0.000 | 8.864 | 6.075 | 11.986 |

**Table IV.- Seasonal feeding preferences and estimated indexes for *M. cordyla* in this study.**

| | Prey item category | Monsoon | | | | | Post monsoon | | | | | Pre Monsoon | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | %F | %N | %W | %IRI | %AI | %F | %N | %W | %IRI | %AI | %F | %N | %W | %IRI | %AI |
| Teleosts | Clupeid fish | 3.33 | 1.46 | 1.19 | 0.22 | 1.99 | 1.42 | 4.29 | 10.44 | 0.85 | 5.38 | 0.59 | 0.04 | 12.03 | 0.05 | 4.22 |
| | Stolephorus | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.42 | 0.41 | 2.51 | 0.17 | 1.45 | 0.59 | 0.04 | 5.49 | 0.02 | 2.04 |
| | *Colia dussumeri* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.71 | 0.20 | 6.59 | 0.19 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | *Thyrassa setirostiress* | 5.00 | 3.65 | 19.16 | 2.79 | 9.27 | 1.42 | 0.41 | 6.72 | 0.41 | 2.85 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Trichurid | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.59 | 0.03 | 0.52 | 0.00 | 0.38 |
| | Unknown fish Juveniles | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.55 | 1.02 | 0.54 | 0.22 | 1.70 | 0.30 | 0.34 | 0.26 | 0.00 | 0.30 |
| | Other fish | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.42 | 5.51 | 0.36 | 0.34 | 2.43 | 5.34 | 0.34 | 6.43 | 0.24 | 4.04 |
| | Fish scales | 16.67 | 73.72 | 2.35 | 31.00 | 30.91 | 2.84 | 3.47 | 0.84 | 0.49 | 2.38 | 0.30 | 0.69 | 2.40 | 0.01 | 1.13 |
| | Fish hard part | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 19.15 | 19.18 | 30.19 | 38.24 | 22.84 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Part. digest. fish | 15.00 | 0.00 | 38.46 | 14.11 | 17.82 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 89.02 | 98.47 | 69.79 | 99.65 | 85.76 |
| Crustaceans | Peneaid shrimps | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.38 | 31.84 | 3.98 | 9.25 | 14.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | *Acetes* spp. | 6.67 | 21.17 | 1.95 | 3.77 | 9.93 | 4.26 | 23.27 | 1.70 | 4.30 | 9.74 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Euphausids | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.42 | 0.41 | 0.36 | 0.04 | 0.73 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Lucifers | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.96 | 5.10 | 0.17 | 1.06 | 3.41 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Cymothoa | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.71 | 0.20 | 0.00 | 0.01 | 0.31 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Molluscs | *Loligo* spp. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 7.80 | 4.29 | 9.74 | 4.43 | 7.28 | 1.19 | 0.05 | 1.72 | 0.01 | 0.99 |
| | *Sepia* spp. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.42 | 0.41 | 1.87 | 0.13 | 1.23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Coelenterates | Sea anemones | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Polychaetes | Polychaete | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.30 | 0.01 | 0.16 | 0.00 | 0.16 |
| | Digested matter | 53.33 | 0.00 | 36.90 | 48.12 | 30.08 | 41.13 | 0.00 | 23.97 | 39.88 | 21.70 | 1.78 | 0.00 | 1.21 | 0.01 | 1.00 |

estimated value of %F 53.33 was digested matter as preferred food item, %N was fish scale 73.7 and %W by weight, (38.45) partially digested fishes were most preferred. Food preference estimated with two indices IRI and AI were 31.0%, fish scales 30.91%, respectively (Table IV). During post monsoon, fish hard parts were found to be the most preferred food item, by occurrence digested matter percentages 41.13, by number Penaeid shrimps were highest 31.83% by weight, fish hard parts 30.19% was most preferred food item. The values estimated with %IRI was digested matter 39.88, whereas, AI was fish hard parts 22.84% as highest (Table IV).

Seasonal divergence in feeding preference during pre monsoon showed partially digested fishes as dominant food commodity. The estimated preference by occurrence, number and weight was partially digested fishes 89.02%, 98.4% and 69.79%, respectively. The main food item calculated with two indices of IRI and AI as partially digested fishes 99.65% and 85.76% respectively (Table IV).

The highest number of full stomach was observed in post-monsoon, and maximum number of empty stomachs was noted in monsoon. Fishes were more active during post monsoon and poorly fed during monsoon due to spawning (Fig. 2)

GaSI showed that female feeds more in May followed by September, while male showed high feeding in April and June while little feeding in March and October (Fig. 3).

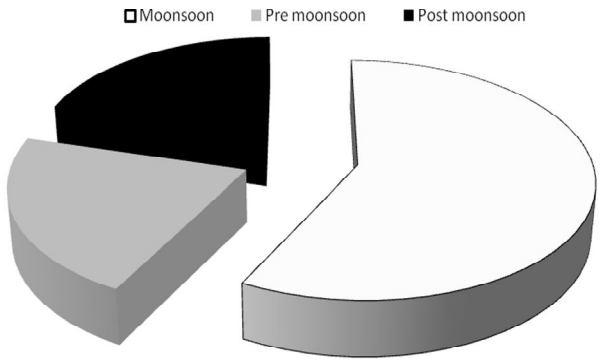


Fig. 2. Calculated seasonal vacuity index (VI) for *M. cordyla.*

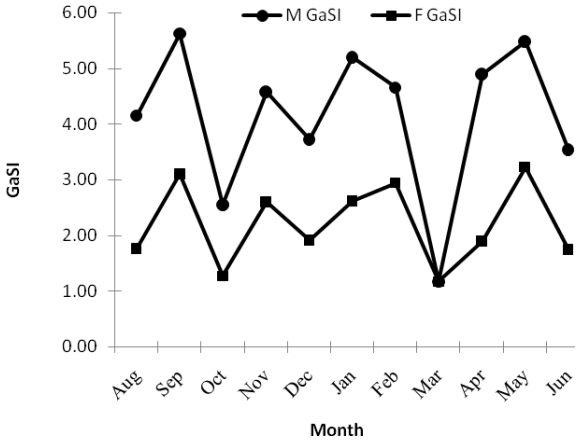


Fig. 3. Monthly assessment of gastrosomatic index (GaSI) for *M. cordyla*.

## DISCUSSION

Our findings reveal that *M. cordyla* is a pelagic carnivorous species which prefers categorically fishes, crustaceans and cephalopods. Jadhav and Mohilic (2013) reported from Indian waters that *M. cordyla* prefers fish, cephalopods and crustacean as the preferred food. Generally the variations in prey items might occur due to different rate of digestion, large prey being digested slower than smaller prey. The prey size increases with increasing predator size in order to optimize the energy per unit effort (Stoner and Livingston, 1984). This gradual change of diets may be due to rising need for proteins and lipids for body growth and gonad development. In general, width and gape of the mouth of any predator are linearly related to its prey size (Stoner and Livingston, 1984). The increased body and mouth size permits fish to capture a broader range of prey size and prey type. Such changes in food habits with size could decrease interspecific competition. When *M. cordyla* achieved the size of 44.9cm TL after attaining maturity, they were more active and able to consume variety of prey items. At that stage almost all the main groups were observed as prey items such as crustaceans, teleosts, digested matter, mollusks, polychaete and coelenterates. When fish became older stomachs were one-fourth full. This is

in agreement with Jadhav (2013) that size variation in the diet occurs with fish, crustaceans, mollusks as preferred food, whereas smaller size fish consumed planktonic organism with the presence of more digested matter in the group. Seasonally, *Acetes* spp. is found higher during monsoon and post monsoon, while Euphausid were found only in pre monsoon. One of the possible reasons of occurrence of digested food may be decreased during spawning season as much of the body cavity would be occupied with increased gonad size. The lower feeding intensity was noted during monsoon indicating initiation of spawning and GaSI. However, Sivakami (1995) found more empty stomach in *M. cordyla* from May to November. Sreenivasan (1974) reported prolonged spawning period from December to July with peak spawning in May to July in monsoon. The results of this study indicated that during the monsoon period, feeding intensity became passive with the little availability of food items and initiation of the spawning period as breeder feeds less than mature and juvenile. The percent composition by occurrence confirmed the presence of teleosts, crustaceans and digested matter during the entire season, while mollusks were found in January and February. Moreover, clupeid fishes, fish juveniles, hard parts, Penaeid shrimps, euphausid and lucifer and *Loligo* spp. were found that substantiate more food items available during post monsoon. This could be justified with presence of more full stomach and low vacuity index. In general, metabolic rate of fish cannot increase unless the water temperature rises. Therefore, the food cannot be assimilated even though present in high amount in the environment. On feeding intensity studies Sreenivasan (1974) reported that *M. cordyla* feeds better during the post monsoon with lesser percentage of empty stomachs in immature and juvenile fish. From the GaSI results it may be assumed that feeding intensity increased during post monsoon whereas during spawning feeding rate decrease. However, males and females require more food before and after spawning period. Nevertheless, no significant differences in feeding habits were noted in males and females. Sivakami (1995) studied feeding habit of *M. cordyla* from Cochin water and reported *Stolephorus* spp. as a, followed by occasional *Leiognathus* spp. *Squilla* spp. flat fishes and perches. Crustaceans and mollusks were preferred food found considerably in the stomach.

The nocturnal migration is a common adaptation considered for the feeding purpose among carangid fishes. The carangids mainly exhibits higher rate of feeding during the night which is attributable to their nocturnal migrations to the sea surface. This behavior can be utilized to capture them using bag nets and trawlers (Tiews, 1968).

To conclude *M. cordyla* is a pelagic carnivore which feed on fish, digested matter, crustaceans, mollusks and polychaete. It is a nocturnal feeding fish which often attacks the animals having luminous or shiny skins. Nevertheless, at early stage male prefer scales and the female feed on fishes. The data presented here would help in better understanding of ecology and issues related to the management of this species in future.

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