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Diet Composition in Larval Fishes of the Family Terapontidae (Actinopterygii: Perciformes) in the Seagrass-bed of Johor Strait, Malaysia

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ABSTRACT

Stomach content of fish larvae of family Terapontidae were studied in samples acquired from Merambong Shoal, south western part of Johor, Malaysia from December 2007 to September 2008. Larvae were collected by subsurface towing of a Bongo net. Stomachs were removed from a total of 117 Terapontidae specimens during the study period and the stomach contents were fully examined. Analyses of prey in the stomach showed 24 important food items belonging to six major groups viz., phytoplankton, zooplankton, algae, plant-like matter, debris and unidentified matters. The predominant food items found in the stomach were phytoplankton (74.25%). This was followed by plant matters (8.02%), algae (6.69%), zooplankton (4.95%), debris (3/65%) and unidentified matters (2.45%). Among the food items, phytoplankton was the first rank by simple resultant index (74.25%). Therefore, it could be concluded that the fish larvae of family Terapontidae are mainly herbivorous.

Key words: Stomach content, fish larvae, seasonal variation, phytoplankton, Malaysia

INTRODUCTION

The area Merambong Shoal is located within the single largest seagrass bed in Peninsular Malaysia. Seagrasses afford an important role for feeding, breeding and nursery to a number of aquatic organisms. Some organisms use seagrass habitat as nursery areas, others seek shelter there for their entire lives. Seagrasses are one of the most productive marine ecosystems of Mauritius and often occur in close connection to coral reefs (Daby, 2001, 2003).

Different types of food are consumed by different fishes and feeding pattern of fishes varies from season to season. A dietary preference in the larval stages is therefore an important component in the assessment of feeding conditions and larval chances of meeting food requirement (Robichaud-LeBlanc *et al*., 1997). A lack of empirical data on the diets of fish larvae in the wild, however, again leads to a reliance on results from aquaculture study (Humphries *et al*., 1999). The outputs about the diet composition of fish larvae from the present study can be applied for the development of aquaculture.

Various studies have been carried out in terms of food and feeding habits of the adult fishes (Chrisfi *et al*., 2007; Dadzie *et al*., 2000; Davis and Pusey, 2010; Jardas *et al*., 2007) but there are limited information about the feeding habits of larval fishes (Ara *et al*., 2009, 2010, 2011a;

Grabowska and Grabowski, 2005; Kakareko *et al*., 2005). Therefore, the present study was undertaken to assess the feeding habits and diet composition of larval fishes of the most dominant Terapontidae family in the seagrass ecosystem of Merambong Shoal, Johor Strait, Malaysia.

MATERIALS AND METHODS

The study area and sample collection: The study was conducted in seagrass bed of Merambong Shoal, Johor Strait (N 01°19.414'; E 103°35.628') (Fig. 1). Monthly sampling was conducted during full moon/new moon period in daylight, at high tide between December 2007 to September 2008. Samples of fish larvae were collected by using Bongo net (mesh size 500 µm, mouth diameter 0.3 m and length 1.3 m) through 30 min subsurface tow from seagrass area. A flowmeter

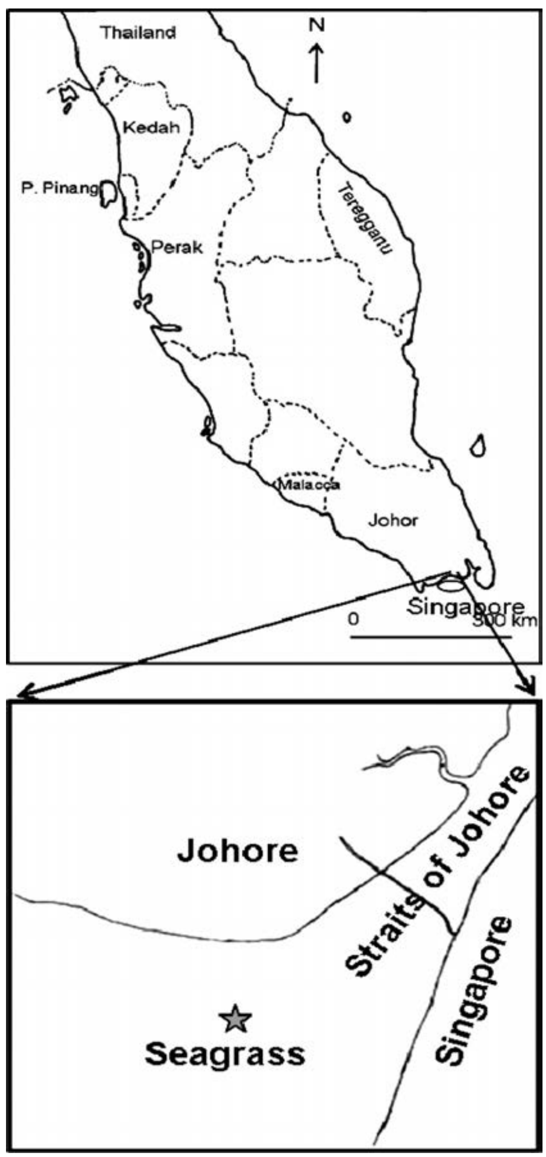

Fig. 1: Geographical local of sampling station (star) in the seagrass beds of Sungai Pulai estuary, Johor Strait, Malaysia

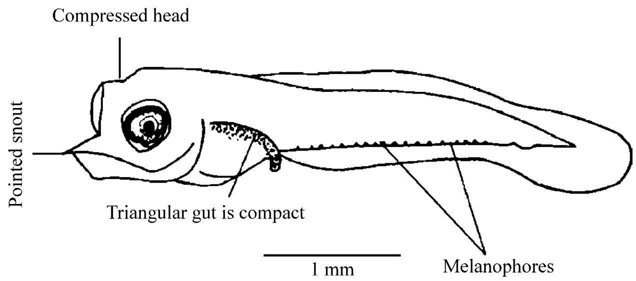

Fig. 2: Biological sketch of Terapontidae larvae

Table 1: Total number of larval fishes Terapontidae family was taken for the study of feeding habits

Month	Terapontidae (No.)	Length (mm)
December, 2007	7	2.44-3.43
January, 2008	2	3.13-3.99
February, 2008	30	2.20-4.22
March, 2008	5	2.13-3.78
April, 2008	6	1.90-4.08
May, 2008	30	2.20-4.53
June, 2008	10	2.09-4.93
July, 2008	10	2.31-3.56
August, 2008	10	3.05-4.09
September, 2008	7	1.95-3.99
Total	117	1.90-4.93

(Hydro-Bios) was attached to the net in order to determine the volume of the water filtered. After each tow, samples were immediately fixed in 5% formalin and then all specimens were transported to the laboratory for further analysis.

Sample processing and identification: In laboratory, the fish larvae were sorted from the rest of the zooplankton and they were preserved in 75% alcohol. Individuals of Terapontidae larvae (Fig. 2) were identified to the family level using the appropriate literature (Leis and Carson-Ewart, 2000; Russell, 1976; Okiyama, 1988; Ghaffar *et al.*, 2010).

Stomach examination: In total 117 terapontidae (Table 1) were taken for stomach examination. Total length for each species was measured prior to dissection using Keyence digital microscope (VHX-500). The mean length of Terapontidae larvae was varied from 1.90-4.93 mm. The fish larva was laid on a counter slide and a dropped of water was laid onto it. The stomach sac was carefully sorted from the larvae body using a probe under a stereomicroscope. The stomach contents were then shattered using a fine needle. A drop of distilled water was dripped onto the stomach content and the cover glass was laid on the slide to keep the thickness of each food items as equivalent as possible. The food items and the numbers were counted and identified to the possible lowest taxonomy under the microscope.

Stomach content analysis: To analyze the composition of the stomach content, the percentages frequency of occurrences and the percentages of numerical abundance were followed:

$$\text{Percentage frequency of occurrence } (F_{pi}) = \frac{N_{fi}}{N_p} \times 100$$

where N_{li} is the number of the stomachs in which food item i was found N_p is the number of non-empty stomachs (Chrisfi *et al*., 2007):

$$\text{Percentage of numerical abundance } (C_i) = \frac{n_i}{\sum_{i=1}^{m} n_i} \times 100$$

where, n_i is the number of ith food items and m is the number of food items (Chrisfi *et al*., 2007).

The relative importance of the food items were assessed and calculated by simple resultant index (%Rs) according to Mohan and Sankaran (1988):

$$\text{Simple resultant index (\%Rs): } \frac{\sqrt{C_i^2 + F_{pi}^2}}{\sum_{i=1}^{m} \sqrt{C_i^2 + F_{pi}^2}} \times 100$$

where, C_i is the percentages numerical abundances and F_{pi} is the percentages frequency of occurrence.

RESULTS

Stomach content compositions: The overall diet compositions of fish larvae from family Terapontidae ranked by simple resultant index (%Rs) are presented in Table 2. The analysis of

Table 2: Overall diet composition of Terapontidae larvae ranked by simple resultant index (%Rs)

Food items	C_i	F_{pi}	% Rs
Phytoplankton	71.08	54.55	74.25
Chromophyta	27.80	15.77	29.12
Dinoflagelate	0.77	2.74	0.62
Centric diatom	0.87	4.10	0.62
Nitzschia sp.	14.58	6.41	15.95
Biddulphia sinensis	2.12	1.64	2.10
Dactylococcopsis fascicularis	12.94	6.61	13.80
Euglena sp.	0.23	0.92	0.18
Navicula sp.	0.80	0.18	0.96
Rhizosolenia araturensis	1.88	2.00	1.77
Fragilaria sp.	1.36	1.82	1.24
Other species	7.73	12.36	7.89
Zooplankton	5.58	10.85	4.95
Ostracod	0.57	1.11	0.50
Copepod	1.30	2.41	1.14
Amphipod	0.69	0.96	0.62
Larvaceans	0.30	2.67	0.20
Larval stage (nauplii)	0.26	0.47	0.23
Thaliacians (Tunicates)	1.31	1.93	1.18
Siphonophores	1.15	1.30	1.08
Algae	7.57	2.77	6.68
Plant like matter	8.64	10.09	8.02
Debris	4.13	6.89	3.65
Unidentified materials	3.75	4.42	2.45

C_i: Percentage numerical abundance, F_{pi}: Percentage frequency of occurrence, %Rs: Simple resultant index food item in the gut showed that the most important prey according to the %Rs were phytoplankton (75%). This is followed by plant-likes matter (8%), algae (7%), zooplankton (5%), debris (4%) and unidentified materials (3%).

Monthly variation of diet compositions: Monthly percentage frequency of occurrence (F_{pi}) of food items in the 117 stomachs of Terapontidae are showed in Table 3. The highest occurrences of phytoplankton were in January (80%). The highest zooplankton was found in April (35.71%), plant-like matters were in May (17.20%), same things goes for debris (16.07%) occurred in June. While, in the highest occurrence of algae was observed in December (27.78%). Furthermore the highest occurrences of unidentified materials were in September (10.71%).

Numerical abundances (C_i) of food items in the stomachs of Terapontidae are given in Table 4. Most dominant food item phytoplankton was the highest in December (86.07%) and the lowest in February (49.72%). However, the highest zooplankton was found in March (17.5%) whereas the lowest was in July (0.38%). Algal component was observed around the year consistently and varied between 3.67% (February) and 12.50% (December).

Table 3: Monthly (December-September) percentage frequency of occurrence (F_{pi}) of food items in the guts of Terapontidae larvae

	Frequency of occurrence (%)									
Food items	Dec. 07	Jan. 08	Feb.08	Mar. 08	Apr. 08	May 08	Jun. 08	Jul. 08	Aug. 08	Sep. 08
Phytoplankton	66.67	80	38	45	32.14	60.23	38.22	60.70	60.78	53.57
Chromophyta	33.33	40	18	15	21.43	27.96	-	-	1.96	-
Dinoflagelate	5.56	-	2	10	-	4.30	-	-	1.96	3.57
Centric diatom	-	-	1	15	7.14	3.23	1.79	1.79	3.92	7.14
Nitzschia sp.	-	-	-	-	-	-	0.71	17.86	17.65	17.86
Biddulphia sinensis	-	-	-	-	-	-	5.36	7.14	3.92	-
Dactylococcopsis fascicularis	-	-	-	-	-	-	16.07	16.07	19.61	14.29
Euglena sp.	-	-	2	-	-	3.23	-	-	3.92	-
Navicula sp.	-	-	-	-	-	-	1.79	-	-	-
Rhizosolenia araturensis	-	-	-	-	-	-	3.57	8.93	3.92	3.57
Fragilaria sp.	-	-	-	-	-	-	3.57	7.14	3.92	3.57
Other species	27.78	40	15	5	3.57	21.51	5.36	1.79	-	3.57
Zooplankton	-	-	19	22	35.71	4.31	10.72	3.58	5.88	10.71
Ostracod	-	-	4	-	3.57	-	-	-	-	3.57
Copepod	-	-	3	10	7.14	2.15	1.79	-	-	-
Amphipod	-	-	1	5	3.57	-	-	-	-	-
Larvaceans	-	-	4	3	14.29	-	3.57	1.79	-	3.57
Larval stage (nauplii)	-	-	-	-	-	1.08	3.57	-	-	-
Thaliacians (Tunicates)	-	-	3	2	7.14	-	1.79	1.79	-	3.57
Siphonophores	-	-	4	2	-	1.08	-	-	5.88	-
Algae	27.78	20	16	13	7.14	16.11	5.36	5.36	9.80	7.14
Plant like matter	5.56	-	10	10	10.71	17.20	12.5	12.5	11.76	10.71
Debris	-	-	10	5	14.29	-	16.08	12.5	3.92	7.14
Unidentified materials	-	-	6	5	-	2.15	7.14	5.36	7.84	10.71

Table 4: Monthly (December-September) percentage of numerical abundance (C*i*) of food items in the guts of Terapontidae larvae

	Frequency of occurrence (%)									
Food items	Dec. 07	Jan. 08	Feb.08	Mar. 08	Apr. 08	May 08	Jun. 08	Jul. 08	Aug. 08	Sep. 08
Phytoplankton	86.07	91.67	49.72	51.20	52.97	77.16	67.61	85.16	84.11	67.58
Chromophyta	74.29	61.11	28.99	20.00	48.21	44.83	-	-	0.43	-
Dinoflagelate	0.36	-	0.55	5.00	-	1.01	0.20	-	0.21	0.34
Centric diatom	-	-	0.55	1.25	3.57	-	0.80	0.50	0.64	1.38
Nitzschia sp.	0.71	-	-	3.70	-	1.01	20.48	36.98	34.55	48.28
Biddulphia sinensis	-	-	4.95	-	-	-	3.98	6.04	6.22	-
Dactylococcopsis fascicularis	-	-	-	20.00	-	-	31.61	28.30	36.70	12.76
Euglena sp.	-	-	0.55	-	-	0.72	-	-	1.07	-
Navicula sp.	-	-	-	-	-	-	0.80	-	-	-
Rhizosolenia araturensis	-	-	-	-	-	9.00	0.40	6.04	3.00	0.34
Fragilaria sp.	-	-	-	-	-	0.14	1.59	6.42	1.29	4.14
Other species	10.71	30.56	14.13	1.25	1.19	20.45	7.75	0.88	-	0.34
Zooplankton	-	-	15.40	17.50	14.30	0.71	1.99	0.38	1.93	3.44
Ostracod	-	-	2.20	-	1.79	-	-	-	-	1.72
Copepod	-	-	0.55	10.00	1.79	0.43	0.20	-	-	-
Amphipod	-	-	0.18	3.75	2.98	-	-	-	-	-
Larvaceans	-	-	0.73	-	-	-	0.60	0.25	-	1.38
Larval stage (nauplii)	-	-	0.18	1.25	-	0.14	0.99	-	-	-
Thaliacians (Tunicates)	-	-	4.40	2.50	5.36	0.14	0.2.	0.13	-	0.34
Siphonophores	-	-	7.16	-	2.38	-	-	-	1.93	-
Algae	12.50	8.33	3.67	20.00	4.76	5.32	7.36	4.03	3.86	5.86
Plant like matter	1.43	-	19.45	1.25	10.12	16.38	9.74	7.42	7.51	13.10
Debris	-	-	5.87	5.00	17.86	-	5.96	1.76	1.72	3.10
Unidentified materials	-	-	5.69	5.00	-	0.43	7.36	1.26	0.86	6.90

DISCUSSION

Our study indicates that the Terapontidae larvae are herbivore. According to the overall data, their main preys were the phytoplanktons. This prey group represents 74.25% of simple resultant index (%Rs) in Terapontidae (Table 2). Phytoplankton was observed in the stomach of fish larvae in every month around the year and overall annual percent was 82.53% which is slightly higher than the present study (Ara *et al.*, 2011b).

Among the phytoplanktons, Chromophyta (29.12%) was the highest, followed by *Nitzschia baccata* (15.95%) and *Dactylococcopsis fascicularis* (13.80%) (Table 2). The choice of specific group of diets could be attributed to the opportunistic behavior of the larvae. This is supported by the report of Ara *et al.* (2010) who stated that Chromophyta is naturally dominant in the Sungai Pulai seagrass ecosystem for their abundance.

Among zooplanktons, Thaliacians (1.18) was the highest quantity and most important food items in the stomachs of Terapontidae fish larvae (Table 2). The second and third items were Copepod (1.14). Marine fish larvae that hatch and grow in nature typically feed on zooplanktons in their surrounding environment.

Encounter rates may be critical factor for larval feeding success because the early larval stage of most fishes is characterized by poor swimming ability and image acuity (Margulies, 1990). Several predominantly herbivorous fishes in the family Terapontidae are found across northern Australia in catchments characterised by a wide range of water transparencies (Allen *et al.*, 2002; Pusey *et al.*, 2004).

Furthermore, instead of phytoplankton and zooplankton, the other important food items consumed by the fish larvae are plant-like matters (dried roots, stems, grass leaves and unidentified parts of plant), algae and debris. From the recent study it is proven that planktonic shrimp *A. indicus* is omnivorous where the major food items was plant-like matter (Amin *et al*., 2007). The various food items consumed by the larvae indicate that the fish larvae of Terapontidae families are herbivore.

CONCLUSION

Stomachs sac were removed from a total of 117 Terapontidae specimens during the study period and the contents were examined. In total 24 important items belonging to six major groups' phytoplankton, zooplankton, algae, plant-like matter, debris and unidentified matters were identified in the stomachs. According to simple resultant index (Rs), the predominant food items found in their stomach were phytoplankton is 74%. Since the study on feeding habits and diet composition of larval fishes have various importance in fishery biology, hopefully the knowledge from this study can be used as information for successful fish aquaculture and development.

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