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STOMACH CONTENT AND TROPHIC LEVEL POSITION OF TWO BAMBOO SHARK SPECIES *CHILOSCYLLIUM INDICUM* AND *C. HASSELTII* (HEMISCYLLIIDAE) FROM SOUTH EASTERN WATERS OF PENINSULAR MALAYSIA

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Abstract: A study was carried out to identify the food commonly taken and justify the trophic level positions of two bamboo shark species; the C*hiloscyllium indicum* and *C. hasseltii.* Bamboo shark samples were collected from the south-eastern waters of Peninsular Malaysia. The types of stomach content were determined and grouped according to their taxa. Intestine length (IL) for each of the individual shark was measured for Intestine Length Index (ILI). Shark diet was analyzed numerically, and using the information, the trophic level (TL) for each species was estimated. The diet of these two shark species consisted of fishes, molusk and crustacea. The ILI obtained for the *C. indicum* and *C. hasseltii* were 0.09±0.02 and 0.12±0.02 and their trophic level (TL) were 3.2-4.5 and 2.5-4.5, respectively. These results suggest that both species of hemiscylliid sharks in the area are carnivorous, and slightly below the apex predator category that is with TL value close or equal to 5.0.

KEYWORDS: Bamboo shark, *Chiloscyllium,* stomach content, trophic position

Introduction

A study conducted by Yano *et al.* (2005) reported that a total of 56 species of sharks, 52 species of rays and two species of chimaeras inhabit the Malaysian waters. One of the most common group is the bamboo or longtail carpet shark (Family Hemiscylliidae, Order Orectolobiformes). They are small inshore demersal sharks of continental waters of the Indo-West Pacific, ranging from Madagascar in the west to Japan, Philippines, and the Australian region in the east. Bamboo sharks commonly occupy the intertidal, in tide pools on rocky or inshore coral reefs, sometimes in water sufficient only to cover them, and on soft bottoms inshore and offshore in open and enclosed bays (Compagno 2001; Cavanagh *et al.* 2003).

Little is known about the feeding behaviour and the diet of bamboo sharks. Ahmad *et al*. (2008) described invertebrates, crustaceans, and fish as part of the *Chiloscyllium hasseltii* diet. Most shark species appear to be opportunistic feeders consuming a large diversity of prey (Cortés1999). Presumptions that sharks eat anything it finds and occupy the top trophic level positions in marine food web are perhaps incorrect (Link 2002; Drymon *et al.* 2011). In fact, several studies (e.g. Joyce 2002; Heithaus *et al.* 2002; Bethea *et al.* 2006) reported that sharks' preference of prey selection might be influenced by certain factors such as localities and their stages of life cycle. It is not quite known whether the idea can be clearly applied for the bamboo sharks that live in this region. Therefore, the primary aim of this study was to provide a quantitative description of the prey items for two bamboo shark species, namely *Chiloscyllium indicum* and *C. hasseltii*.

Materials and Methods

The individual samples of bamboo sharks were collected from March to December 2009. All bamboo shark samples were collected from the south eastern waters of Peninsular Malaysia with an average depth of less than 50 m (Figure 1).

Samples were mostly acquired from local fishermen. The samples were collected using

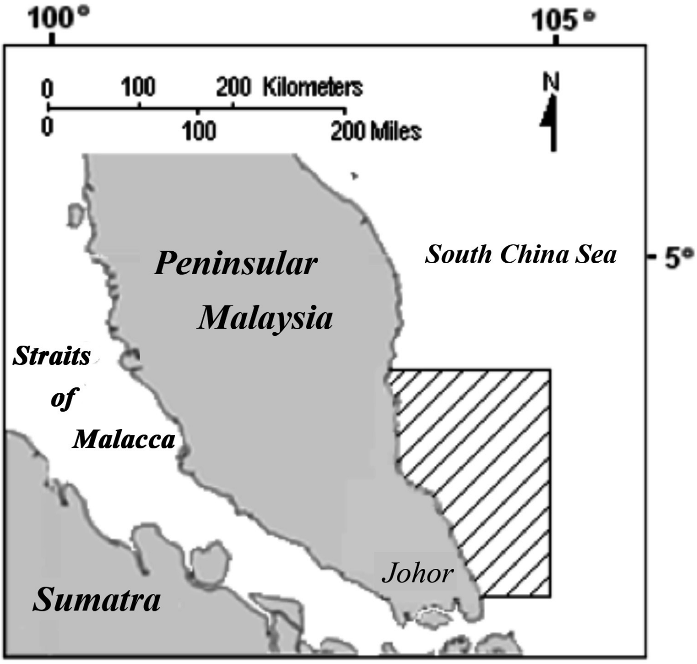

Figure 1: Map of Peninsular Malaysia showing the area (diagonal-line shaded) where the shark samples were collected.

otter bottom trawl net which is the main fishing gear used to harvest the demersal finfish and penaeid prawn resources in Malaysia (Silvestre and Pauly 1997). The trawls were conducted using standard otter trawl with cod end mesh size of 3.3, 5.1 or 10.2 cm. The trawl was towed at a speed of around 3 to 5 knots (~5.6 to 9.3 km/h). Since trawls are non-selective, it sweeps up both marketable and non-commercial fish. Bamboo sharks are considered as minor by-catch that is sold mainly to produce animal feed in this region (Edwards *et al.* 2004).

The samples were put into cold storage soon after they were caught. The belly of each shark samples was injected with preservative solution (10% formalin) to stop the digestion process that usually occurs continuously even after the fish has died. Identification of the shark species followed Ahmad *et al.* (2008). Sex and measurement of standard length (SL) to the nearest 1 centimetre and weight (w) to the nearest 1 gram were recorded before the dissection of the stomach takes place. The stomach was removed by cutting the pyloric sphincter and connective tissue as well as the oesophagus above the oesophageal sphincter. Stomachs were emptied onto a 425 µm sieve and contents were separated and weighed to the nearest 50 gram. The contents were kept in 70% ethanol solution after being identified to the lowest possible taxon. Identification process of living macro organism that was found in the stomach was made using key and field guides by Gremli and Newman (1993). Gastrointestinal duct was removed, distended, measured (intestine length = IL; cm) and conditioned in 70% ethanol solution.

Diet were quantified using an index of relative importance (IRI) combining gravimetric, numeric, and frequency of occurrence measures (Pinkas *et al.* 1971; Hyslop 1980). Cortés (1997) included the IRI = F(W+N) standardized to 100% (%IRI) to facilitate comparisons between dietary studies. Intestine Length Index (ILI= L_i/SL) was obtained for each individual shark based on the model proposed by Hynes (1950), where L_i is the intestinal length and SL is the standard length.

Trophic level for each individual shark was determined prior to the numerically quantified diet using TrophLab software (Pauly *et al.* 2000). TrophLab estimates (TP) the trophic level of any consumer, given the quantitative or qualitative information on the composition of its prey items.

Results and Discussion

Quantitative Study of Diet

A total of 39 bamboo sharks were collected, in which 21 individuals were *Chiloscyllium indicum* (9 male and 12 female sharks) and the other 18 were *Chiloscyllium hasseltii* (6 male and 12 female sharks). Each individual *C. indicum* was in the mature state. On the other hand, 83% of the *C. hasseltii* examined were juveniles. Therefore, comparison on stomach content based on stages of maturity was not possible for both species due to the lack of representative numbers of individuals from different size classes. The stomach of 71% of the *C. indicum* and 66% of the *C. hasseltii* caught were full. The percentage of stomach fullness between the male and female *C. indicum* was not significantly different ($p > 0.05$). However, females of *C. hasseltii* had a significantly higher percentage of stomach fullness than the males ($p < 0.05$).

Cephalopods were the main prey item (33.33%) found in the stomach of the *C. indicum* (Table 1). Among the cephalopods recorded, *Loligo* sp. were the most frequently consumed (28.57%). Teleost fishes was the next largest group consumed (19.05%) by *C. indicum*, which was slightly higher than the consumption of crustaceans (19.04%). Shrimps (*Penaeus* spp.) were the most frequently consumed crustaceans. In terms of wet weight, crustaceans were higher (%W=45.84) than the other groups of prey items found. Overall, the IRI indicated that cephalopods and crustaceans made up about 34.38% and 33.18% of the *C. indicum* diet, respectively.

As for the *C. hasseltii*, crustaceans (33.33%) were the main prey item found in its stomachs, followed by teleost fishes with about 22.22% of frequency (Table 2). Shrimps (*Penaeus* spp.) were the most frequently consumed crustaceans by the *C. hasseltii*. Cephalopods (*Loligo* sp.), invertebrate (Polychaeta), and bivalve occured at a small frequency (5.56%), respectively. Crustaceans were also a very important component in terms of number (%N=40) and wet weight (%W=64.26), as they made up 70.49%

Table 1: Stomach content composition of *Chiloscyllium indicum*: frequency (%F), number (%N), and weight (%W) of each item and feeding indexes (IRI and %IRI).

Category		%F	%N	%W	IRI	%IRI
Teleostei	Unidentified	19.05	22.73	23.90	888.30	22.57
Cephalopoda	*Loligo* sp.	28.57	31.81	15.55	1353.07	34.38
	Octopus sp.	4.76	9.09	6.33	73.40	1.87
Crustacea	*Penaeus* spp.	19.04	22.73	45.84	1305.57	33.18
Annelida	*Polichaeta* spp.	14.29	13.64	8.38	314.66	8.00

Table 2: Stomach content composition of *Chiloscyllium hasseltii*: frequency (%F), number (%N), and weight (%W) of each item and feeding indexes (IRI and %IRI).

Category		%F	%N	%W	IRI	%IRI
Teleostei	Unidentified	22.22	33.33	23.14	1254.76	25.45
Cephalopoda	*Loligo sp.*	5.56	6.67	7.45	78.51	1.59
Crustacea	*Panaeus spp.*	33.33	40.00	64.26	3474.98	70.49
Annelida	*Polichaeta spp.*	5.56	6.67	1.99	48.15	0.98
Bivalvia	*Unidentified*	5.56	6.67	0.09	37.58	0.76
Organic matter	Unidentified	3.70	6.67	3.07	36.04	0.73

of the *C. hasseltii* diet (IRI). Other food items or prey categories found in the *C. hasseltii* stomach also included unknown organic materials (%F=3.70). Since the occurrence of these prey items was relatively infrequent, it is likely that their consumption was accidental.

Factors that might affect the selection of prey items in both bamboo sharks are the distribution and abundance of the prey items found in their habitat. Most cephalopods (squids) spawn through out the year with several peaks depending on the species and climate (Costa and Fernandes 1993; Araujo *et al.* 2005; Wang *et al.* 2010). Many studies showed that shrimps also breed continuously throughout the year (Bauer 1989; Nurul-Amin *et al.* 2009w). Therefore, it is suggested that the sharks have a continuous supply of cephalopods and crustaceans (i.e. shrimps), thus these appeared as the main prey items for both species. A similar scenario is also shown for the teleost fishes that are available in abundance all year round (Johannes 1978; Robertson 1996; Robinson *et al.* 2004).

On the other hand, the abundance of those prey items for the sharks are probably influenced by the climate (i.e. monsoon seasons). Malaysia has two monsoon seasons, the Southwest Monsoon from late May to September, and the Northeast Monsoon from November to March. The Northeast Monsoon brings in more rainfall compared to the Southwest Monsoon. For example, the seasonal distribution of the Penaeid shrimps (*Penaeus indicus*) showed that the peak of the spawning activities occur during the post and pre-monsoon seasons with the highest peak observed during the post-monsoon season (Amanat and Qureshi 2011).

Prey Category and Sex Relationship

The occurence of major prey categories were more frequent in males than females for the *C. indicum*. Teleost fish, chepalopods, and crustacea (shrimps) occurred at a total frequency of 14.28% and 9.52% in males and in females, respectively (Table 3). The percentage of occurrence of crutaceans was higher in females

Table 3: Frequency of occurence (%F) of major prey categories of *Chiloscyllium indicum* according to sex (n=21: 9 ♂, 12 ♀).

Prey Category		Male ♂		Female ♀	
		No. of items	%F	No. of items	%F
Teleostei	Unidentified	3.00	14.28	2.00	9.52
Cephalopoda	*Loligo* sp.	3.00	14.28	2.00	9.52
	Octopus sp.	0.00	0.00	2.00	9.52
Crustacea	*Penaeus* spp.	3.00	14.28	2.00	9.52
Annelida	*Polichaeta* spp.	2.00	9.52	1.00	4.76

Table 4: Frequency of occurence (%F) of major prey categories of *Chiloscyllium hasseltii* according to sex (n=18: 6 ♂, 12 ♀).

Prey Category		Male ♂		Female ♀	
		No. of items	%F	No. of items	%F
Teleostei	Unidentified	3.00	16.67	2.00	11.11
Cephalopods	*Loligo* sp.	0.00	0.00	1.00	5.56
Crustacea	*Penaeus* spp.	1.00	5.56	5.00	27.78
Annelida	*Polichaeta* spp.	0.00	0.00	1.00	5.56
Bivalvia	Unidentified	0.00	0.00	1.00	5.56
Organic matter	Unidentified	1.00	5.56	1.00	5.56

(27.8%) than in males (5.56%) for the *C. hasseltii*. However, teleost fish category was higher in males (16.67%) than in females (11.11%) of the species (Table 4). McCord and Campana (2003) suggested that the differences in prey item category that occurred among the sexes of the same fish species may be due to segregation caused by habitat selection, feeding behavior, and reproduction stages. Similar phenomenon was also reported for other fishes such as the pipefish (*Stigmatopora argus*). According to Steffe *et al.* (1989), most pipe fish greatly preferred long, high-density seagrass leaves to short or low-density leaves. The exception was the female *S. argus*, which were found in thinned long seagrass as often as in densed long seagrass. Females of the species had fuller guts than the males. Irrespective of habitat, this is consistent with the idea that males suffer some loss of feeding efficiency due to adaptations for the brooding of the young.

Trophic Level (TL) Position

The intestine of sharks is modified in the form of spiral valve or folds to increase the surface area, and thus effectively absorb nutrients. This region with such a structure that is common to sharks and rays is also known as the *bursa entiana* (Crow *et al.* 1990; Hassanpour and Joss 2009). This chamber-like enlargement of the pyloric part of the stomach adds more space for storage (Hamlett 1999). The intestinal valves counted were 14 to 15 (n=6) for the *C. indicum* and 15 (n=1) for the *C. hasseltii*. The calculated value of ILI is used to determine the feeding mode. According to Marcos *et al.* (2003), the relationship between intestinal length and SL varies amongst carnivores (0.2 - 2.5), omnivores (0.6 - 0.8) and herbivores (0.8 - 15.0). Carnivorous intestines are relatively shorter and straight or with few curvature. The intestines of Chondrichthyes are generally shorter relative to its body length. It was found that the value of ILI were 0.09±0.02 and 0.12±0.02 for the *C. indicum* and *C. hasseltii,* repectively. These very low ILI values (< 0.2) demonstrated that they are carnivorous.

Cortès (1999) calculated an index of standardized diet composition based on weighted average that allows incorporation of data from multiple quantitative dietary studies of a particular species and takes into account

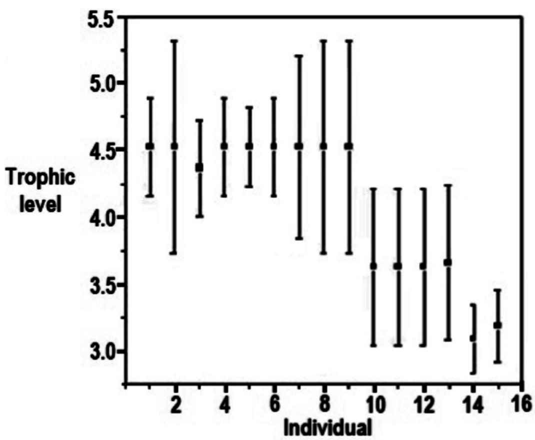

Figure 2: Trophic level for the individual *Chiloscyllium indicum.*

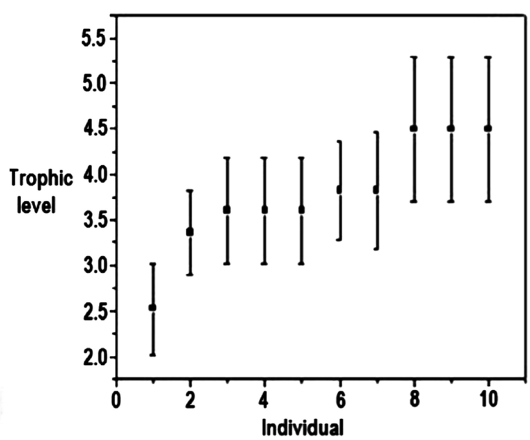

Figure 3: Trophic level for the individual *Chiloscyllium hasseltii.*

the sample size in each study. It is indicated that sharks as a group are predominantly tertiary consumers (TL>4), but it is also found that orectolobiforms (including hemiscyllids) and heterodontiforms are secondary consumers (TL<4). The trophic levels obtained for the *Chiloscyllium indicum* that were collected from the south eastern waters of Peninsular Malaysia was between 3.2 to 4.5 (4.1±0.5) (Figure 2). However, the *C. hasseltii* showed a wider range of trophic level value, which was between 2.5 to 4.5 (3.8±0.6) (Figure 3). The value of TL<3 in the *C. hasseltii* could be due to the occurrence of unidentified organic matters in a significant number, and thus influenced the overall trophic level value that was calculated.

Romanuk *et al.* (2011) determined that the trophic level (TL) and body size (SL) in fishes were positively correlated. Similar result was also shown for the *Chiloscyllium* in this study ($r^2 = 0.062$, $P < 0.05$) with a slope of 0.081. In other words, the body size indicates the stage of life of the individual fish including sharks. Throughout their life cycle, they usually experience ontogenetic dietary shift, and thus their thropic position (Winemiller 1989; Bethea *et al.* 2006; Cotta-Ribeiro & Molina-Ureña 2009). In this study, it was observed that the *C. hasseltii* were mostly found to be in the immature stage with sizes (SL) of between 150 and 360 mm. These young *C. hasseltii* seem to prefer crustaceans than any other type of prey items (Table 2). However, the relatively larger *C. indicum* (450 – 610 mm, SL) collected suggest that they were adult stage which are able to prey on larger sizes of food such as the teleost fishes and cephalopods.

With trophic level (TL) ranging between 2.5 and 4.5, both species of hemiscyllids fall into the secondary and tertiary comsumers of carnivore category, but are not in an apex predator. It is because there are equally or higher trophic level predators found in the area such as dolphines and whales (Ponnampalam 2012). According to Pauly *et al.* (1998), marine mammals (e.g. dolphines and whales) mostly have TL values above 4.0. Generally, among the top predators in marine communities, sharks are seeded above seabirds, and below marine mammals in terms of tropic position. Being a high level predator in the ocean, sharks as a group play an important role in maintaining the ecosystem and thus, eliminating them means a significant change to the food chain of the ecosystem.

Conclusion

This study provided some basic information on the food consumed and trophic level position of the two bamboo shark species namely C*hiloscyllium indicum* and *C. hasseltii* from the south eastern waters of Peninsular Malaysia. These sharks are carnivorous species that prey on small demersal and benthic marine animal including teleost fishes, cephalopods and crustaceans.

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References

Ahmad, A., Lim, A.P.K., Abdul Rahman, M., Raja Bidin, R.H., Gambang, A.C. & Nor-Azman, Z. (2008). *Panduan Mengenali Spesies Ikan Yu di Malaysia, Brunei Darussalam, Indonesia dan Thailand*. Jabatan Perikanan Malaysia.

Amanat, Z. & Qureshi, N.A. (2011). Ovarian Maturation Stages and Size at Sexual Maturity of *Penaeus indicus* (H. Milne Edwards, 1937) in the Lagoon Water of Sonmiani Bay, Balochistan. *Pakistan J. Zool.,* 43(3): 447-459.

Araújo, F.G., Andrade, C.C., Santos, R.N., Santos, A.F.G.N & Santos, L.N. (2005). Spatial and Seasonal Changesin the Diet of *Oligosarcus hepsetus* (Characiformes, Characidae) in a Brazilian Reservoir. *Braz. J. Biol.*, 65(1): 1-8.

Bauer, R.T. (1989). Continuous reproduction and Episodic Recruitment in Nine Shrimp Species Inhabiting a Tropical Seagrass Meadow. *Jour. Experimental Mar. Biol. Ecol.,* 127: 175-187.

Bethea, D. M., Carlson, J.K., Buckel, J.A. & Satterwhite, M. (2006). Ontogenetic and Site-related Trends in the Diet of the Atlantic Sharpnose Shark R*hizoprionodon terraenovae* from the Northeast Gulf of Mexico. *Bull. Mar. Sci.,* 78(2): 287-307.

Cavanagh, R. D., Kyne, P. M., Fowler, S. L., Musick, J. A. & Bennett, M. B. (2003). *The Conservation Status of Australasian Chondrichthyans: Report of the IUCN Shark Specialist Group Australia and Oceania Regional Red List Workshop.* The University of Queensland, School of Biomedical Sciences, Brisbane, Australia.

Compagno, L.J.V. (2001). *Sharks of the World. An Annotated and Illustrated Catalogue of Shark Species Known to Date. Vol. 2. Bullhead, mackerel, and carpet sharks (Heterodontiformes, Lamniformes and Orectolobiformes)*. FAO Species Catalogue for Fishery Purposes. Roma, FAO. 2(1): 269.

Cortés, E. (1997). A Critical Review of Methods of Studying Fish Feeding Based on Analysis of Stomach Contents: Application to Elasmobranch Fishes. *Can. J. Fish. Aquat. Sci.,* 54: 726-738.

Cortés, E. (1999). Standardized diet compositions and trophic levels of sharks. *ICES J. Mar. Sci.,* 56: 707–717.

Costa, A.S. & Fernandes, F.C. (1993). Reproductive Cycle of *Loligo sanpaulensis* (Cephalopoda: Loliginidae) in the CaboFrio Region, Brazil. *Mar. Ecol. Prog. Ser.,* 101: 91-97.

Cotta-Ribeiro, T. & Molina-Ureña, H. (2009). Ontogenic Changes in the Feeding Habits of the Fishes *Agonostomus monticola* (Mugilidae) and Bryconbehreae (Characidae), Térraba River, Costa Rica. *Int. J. Trop. Biol*., 57(1): 285-290.

Crow, G.L., Howe, J.C., Uchida, S., Kamolnick, S., Wisner, M.G. & Caira, J.N. (1990). Protrusion of the Valvular Intestine Through the Cloaca in Sharks of the Family Carcharhinidae. *Copeia,* 1: 226-9.

Drymon, J.M., Powers, S.P. & Carmichael, R.H. (2011). Trophic Plasticity in the Atlantic Sharpnose Shark (*Rhizoprionodon terraenovae*) from the North Central Gulf of Mexico. *Env. Biol. Fish.* DOI 10.1007/s10641-011-9922-z.

Edwards, P., Tuan, L. A. & Allan, G. L. (2004). A survey of marine trash fish and fish meal as aquaculture feed ingredients in Vietnam-Australian Centre for International Agricultural Research (ACIAR) Working Paper, 57: 1-56.

Gremli, M.S. & Newman, H.E. (1993). *Marine Life in the South China Sea*. American Psychological Association (APA) Publication.

Hamlett, W.C. (1999). *Sharks, Skates, and Rays: The Biology of Elasmobranch Fishes*. Baltimore: John Hopkins University Press.

Hassanpour, M. & Joss, J. (2009). Anatomy and Histology of the Spiral Valve Intestine in Juvenile Australian Lungfish, *Neoceratodus forsteri*. *The Open Zool. Jour.,* 2: 62-85.

Heithaus, M.R., Dill, L.M., Marshall, G.J. & Buhleier, B. (2002). Habitat Use and Foraging Behavior of Tiger Shark (*Galeocerdor cuvier*) in a Seagrass Ecosystem. *Mar. Biol.,* 140: 237-248.

Hynes, H.B.N. (1950). The Food of Fresh Water Sticklebacks (*Gasterosteus aculeatus* and *Pygosteus pungiteus*) with a Review of Methods Used in Studies of Food of Fishes. *J. Anim. Ecol*., 19: 36-58.

Hyslop, E.J. (1980). Stomach content analysis: A Review of Methods and Their Application. *J. Fish Biol.,* 17: 411-422.

Johannes, R.E. (1978). Reproductive strategies of coastal marine fishes in the tropics. *Env. Biol. Fish,* 3: 65-84.

Link, J. (2002). Does Food Web Theory Works for Marine Ecosystems? *Mar. Ecol. Prog. Ser*., 230: 1-9.

Marcos, F.P.G., Brbola, I.F. & Duboc, L.F. (2003). Feeding Habits and Morphometry of Digestive Tracts of *Geophagus brasiliensis* (Osteichthyes, Cichlidae), in a lagoon of High Tibagi River, Parana State, Brazil. PR: Brasil. *Publ. UEPG Ci. Biol. Saúde, Ponta Grossa,* 10(1): 37-45.

McCord, M.E. & Campana, S.E. (2003). A Quantitative Assessment of the Diet of the Blue Shark (*Prionace glauca*) off Nova Scotia, Canada. *J. Northw. Atl. Fish. Sci.,* 32: 57-63.

Nurul-Amin, S.M., Arshad, A., Bujang, J.S., Siti, S.S. & Goddard, S. (2009). Reproductive Biology of the Sergestid Shrimp *Acetes indicus* (Decapoda: Sergestidae) in Coastal Waters of Malacca, Peninsular Malaysia. *Zool. Stud.,* 48(6): 753-760.

Pauly, D., Trites, A., Capulib, E. & Christensen, V. (1998). Diet Composition and Trophic Levels of Marine Mammals. *ICES C.M.,* 13: 1-22.

Pauly, D., Froese, R., Sa-a, P.S., Palomares, M.L., Christensen, V. & Rius, J. (2000). *TrophLab Manual*. ICLARM, Manila.

Pinkas, L.M., Oliphant, S. & Iverson, I.L.K. (1971). Food Habits of Albacore, Bluefin Tuna and Bonito in Californian waters. *Calif. Fish Game,* 152: 1–105.

Ponnampalam, L.S. (2012). Opportunistic Observations on the Distribution of Cetaceans in the Malaysian South China, Sulu and Sulawesi Seas and an Updated Checklist of Marine Mammals in Malaysia. *Raffles Bull. Zool.,* 60(1): 221-231.

Romanuk, T.N., Hayward, A. & Hutchings, J.A. (2011). Trophic Level Scales Positively with Body Size in Fishes. *Global Ecol. Biogeogr*., 20: 231-240.

Robertson, D.R. (1996). Egg Size in Relation to Fertilization Dynamics in Free-swimming Tropical Reef Fishes. *Oecologia,* 108: 95-104.

Robinson, J., Isidore, M., Marguerite, M.A., Öhman, M.C. & Payet, R.J. (2004). Spatial and Temporal Distribution of Reef Fish Spawning Aggregations in the Seychelles - An interview-based Survey of Artisanal Fishers. *West. Ind. Ocean J. Mar. Sci.,* 3(1): 63–69.

Silvestre, G.T. & Pauly, D. (1997). Status and Management of Tropical Coastal Fisheries in Asia. *ICLARM Conf. Proc.,* 53: 208.

Steffe, A.S., Westoby, M. & Bell, J.D. (1989). Habitat Selection and Diet in Two Species of Pipefish from Seagrass: Sex Differences. *Mar. Ecol. Prog. Ser.,* 55: 23-30.

Wang, K.Y., Lee, K.T. & Liao, C.H. (2010). Age, Growth and Maturation of Swordtip Squid (*Photololigo edulis*) in the Southern East China Sea. *J. Mar. Sci. Technol.,* 18(1): 199-105.

Winemiller, K. O. (1989). Ontogenetic Diet Shifts and Resource Partitioning Among Piscivorous Fishes in the Venezuelan llanos. *Env. Biol. Fish,* 26: 177-199.

Yano, K., Ahmad, A., Gambang, A.C., Idris, A. H., Solahuddin, A.R. & Aznan, Z. (2005). Sharks and Rays of Malaysia and Brunei Darussalam, SEAFDEC-MFRDMD/SP/12. Perpustakaan Negara Malaysia. 8: 66.