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DIET COMPOSITION OF COBIA FISH, *Rachycentron canadum* (LINNAEUS, 1766) FROM NORTHEASTERN WATERS OF PENINSULAR MALAYSIA

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ABSTRACT

A study was conducted to investigate the food and feeding habits of cobia, *Rachycentron canadum* from the northeastern waters of Peninsular Malaysia. Stomach content of 82 *R. canadum* fish were analyzed with reference to gender and size classes. Fish was the most dominant diet component for *R. canadum* with % IRI value of 95.3%, followed by squid (3.1%), crab (1.5%), and shrimp (0.07%). Fish was also predominant regardless of gender and size classes of the *R. canadum* in the study area. Shrimp was not taken by the male, but found in females with sizes ranged between 80 and 120 cm TL. *Rachycentron canadum* that was larger than 120 cm TL also did not prefer crab as part of its diet component. Their feeding intensity increased with size accordingly that was indicated by the increase in the percentage of active feeder. This research finding will contribute to the development of *R. canadum* culture in Malaysia.

Key words: Cobia, stomach content, feeding intensity, size-class variation

INTRODUCTION

Cobia, *Rachycentron canadum* (Linnaeus, 1766) is the only species in family Rachycentridae. It is also known by common name in Malaysia as *Aruan Tasek*. Cobia belongs to large pelagic fish which could be found in tropical and subtropical water except in the central and eastern Pacific Ocean (Shaffer & Nakamura, 1989). These species occur both inshore and offshore waters. Adult fish are often found in the bay or the estuary (Robin & Ray, 1986) whereas most eggs and larvae are found in offshore water (Shaffer & Nakamura, 1989). This fish normally occurs singularly or in small pods, and are commonly associated with any structure in the water such as shipwreck and artificial reefs or even larger animals such as sharks (Hammond *et al.,* 1977).

In western hemisphere, particularly in the tropical Americas and the Caribbean countries, Cobia is one of the species identified as having the greatest potential for commercial aquaculture due to its extraordinary growth rate, overall aquaculture performance, market demand and price (Benetti *et al.,* 2003). In Malaysia, it is also considered as it is one of the most potential species for aquaculture due to the similar reasons (Chu *et al.,* 2013).

Knowledge on the food and feeding habits of fishes is essential to understand the life history of fish including growth, breeding and migration (Bal & Rao 1984; Mazlan *et al.,* 2007). This will also help to understand the predicted changes on ecosystem due to natural or anthropogenic (Sajeevan & Kurup, 2013). Feeding studies conducted recently in Gulf of Mexico and North Carolina water reported that there were differences in cobia's diet caused by geography factor (Arendt *et al.,* 2001). In Gulf of Mexico, Franks *et al* (1996) reported that fish (especially anchovy, *Anchoa* spp.) dominated cobia's diet while in juvenile stage. It was reported that 79.1% crustacean (especially portunid crab) contains in cobia's stomach and it is 77.6% of total food items consumed by Cobia (37.3 – 153.0 cm) in North Gulf of Mexico (Meyer & Franks, 1996). Foods of cobia was briefly reviewed (Shaffer & Nakamura, 1989) but data on the dietary ecology of this fish in Malaysia waters is lacking. This prompted the study using stomach content analyses which emphasize on the main type of food items consumed. The relationship between diet composition and the fish size was also analysed.

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MATERIALS AND METHODS

Cobia's sample for this study was obtained from fish landing centers along the northeastern coasts. Samples were taken monthly from January 2014 to March 2015. Total length (TL) and body weight (BW) of individual specimen were measured to nearest centimeter and gram, respectively. The abdomen of the fish was cut open to reveal their gender and extract their stomach. Gonadal status of the fish was examined macroscopically and classified according to Nikolsky (1963). While all stomach content was separated and identified to most exact taxonomy stage which is genus, where possible (Fischer & Bianchi 1984; Lin 1992). The total wet weight and the frequency of occurrence for every food items in the fish stomach were recorded.

Dietary importance of each food category was determined by percent number, percent weight and percent frequency of occurrence. Percent number was the number of individuals expressed as a percentage, after pooling the stomachs contents of all fish. Frequency of occurrence was the percentage of stomachs where a food category was present (Singh & Gupta, 2010; Nur-Farhana *et al.,* 2013). An index of relative importance (IRI) for all food items combined was calculated with the formula (% Number + % Weight) × % Frequency, as described by Pinkas *et al* (1971). To determine the variations in diet composition between sizes and stage, the fish were categorized into 5 groups, viz. category-I (<60 cm), category-II (60-80 cm), category-III (81-100 cm), category-IV (101-120 cm) and category-V (>120 cm), accordingly (Kulbicki *et al.,* 2005).

The degree of stomach fullness was also recorded and provides a useful index for quantifying fish diets (Phelps *et al.,* 2007). In this study, the stomach was visually classified as full, ¾ full, ½ full, ¼ full and empty depending upon the degree of fullness and the amount of food contained in them (Philip, 1994). Empty and ¼ full stomach are considered as non-active feeder, while ½ full, ¾ full and full are considered as active feeder. The Mann-Whitney U test was performed to find the significant differences at 95% confidence level in individual prey proportions of the fish diet. It is based on the small sample size of food items commonly reported for a carnivorous fish, thus a not normally distributed compositional data were assumed.

RESULTS AND DISCUSSION

General description of diet composition

A total of 82 stomach content of cobia with sizes ranged from 38 cm to 154 cm total length (TL) were analysed. Out of the total, 62 stomachs were found containing food while the other 20 with empty stomach. The result showed that *R. canadum* is a carnivorous fish with four categories of food in their stomach including fish, crab, squid and shrimp. Fish is the predominant diet composition for *R. canadum* from the study area with % IRI of 95.3%, followed by squid (3.1%), crab (1.5%), and shrimp (0.07%) The fish also recorded 80.6% frequency of occurrence while the crab, squid and shrimp were 11.3%, 12.9% and 3.2%, respectively. According to Knapp (1951), the frequency of occurrence of food in the diet of cobia caught near Aransas Bay, Texas was predominated by fishes (83%), followed by stomatopods (58%), penaeid shrimps (46%), portunid crabs (42%) and squid (17%). The relative importance (IRI) of fishes as food items was approximately three times that of shrimp and three and one-half times that of squids.

Smith (1995) reported that cobia is opportunist predator where the food is mostly at the bottom and targeting crab, prawn, and benthic fish. It is agreed by Meyer and Franks (1996) who found that crustaceans (primarily portunid crabs) occurred in 79.1% of stomachs and represented 77.6 of total food items consumed by adult cobia in the northern Gulf of Mexico. However, the present study indicated that pelagic fish such as mackerel, sardine, bream, black river, trevally and eels dominated its diet composition. The similar type of food taken was also reported by Bachok *et al* (2004) which discovered 64 percent of their foods were pelagic and demersal fishes. While Rohit and Bhat (2012) found that cobia will feed on various foods and is not selective whether it is pelagic or benthic.

Table 1. Diet composition of *R. canadum* in terms of percentage of number, weight and frequency of occurrence

No	Food items	Number (%)	Occurrence (%)	Weight (%)	IRI (%)
1	Fishes	80.3	80.6	69.9	95.3
2	Crabs	12.5	11.3	4.1	1.5
3	Squids	4.8	12.9	25.9	3.1
4	Shrimp	2.4	3.2	0.2	0.1

N = 82, number of food =208, empty stomach = 20.

Several other researches such as Daracott (1977) claimed that cobia of western Indian Ocean is known as "Crab Eater" since crab was found as its main food item. They will move to an area with abundance of food especially crustacean. However, in this study it was found that crab only contributed about 12.5% to cobia's diet. These results clearly showed the validness of geographical effects in fish diet (Arendt *et al.,* 2001) and thus their population density and distribution (Macpherson, 1989). It is also suggesting that cobia is a species that are able to use varying food resources which may diminish the generality of conclusions made previously.

Diet composition by gender

Meyer and Franks (1996) argues that there are no differences in diet composition between female and male fish for *R. canadum*. Their opinion is in-line with the finding of this study conducted where there was no qualitative difference in the overall diet composition between male and female *R. canadum*. Fish dominated the diet composition of both sexes in terms of percentage, weight as well as in the frequency of occurrence (Table 2). However, a study conducted at the northwest coast of Indian waters by Sajeevan and Kurup (2013) found that there was a difference in the composition of the food items in the stomach of male and female cobia. The major constituent of the male's gut was fish while crab was the major content in the gut of the female *R. canadum.* In this study, crab, squid and shrimp in combination was made small contribution to female diet, respectively. Shrimp was not found at all in male fish diet. Percentages of number (%N) for fish found in female stomach were 86.6% followed by crab (3.1 %), squid (5.2%) and shrimp (5.2%). While for the male *R. canadum* in this study, 74% of its total diet composition was contributed by fish, 23% of crab and 3% of squid. Fish dominated the percentage of frequency of occurrence with 77.3% for female and 87.3% for male. Studies by Franks *et al* (1996) also found that juvenile cobia in the northern Gulf of Mexico were carnivorous and fed exclusively on small fish, crustaceans and squid.

Diet composition by size classes

All categories of size classes showed the percentage of the frequency of occurrence (%IRI), weight, and numbers for fish food were the highest. The %IRI for category-II was the highest at 98%, followed by category-IV (96.5%), category-III (96.4%), category-I (95.2%) and category-V (80.7%) (Table 3). Squid was the second major contributor to the IRI for all size classes category except for category-III (IRI crab second highest). Shrimp are not found in the stomach contents of *R. canadum* in category-I and -II. While there were no shrimp and crab found in the category-V.

Frequency of occurrence of fish for *R. canadum* from northeastern waters of Peninsular Malaysia increases from category-I to category-III, but began to decline after category-IV. Weight percentage of fish has declined with increasing size classes. Statistical analysis showed that the weight has significant differences between categories ($P < 0.05$). Percentage of fish weight for size class in category-II was 88.1%, decreased to 81.1% for size class in category-III, 66.2% for size class in category-IV and 42.8% for size class in category-V. Frequency occurrence for crabs has no significant differences with fish size ($P > 0.05$). However, it tends to decrease as the fish are getting larger until none was recorded for the fish larger than 120 cm TL (category-V).

The highest frequency of occurrence for squid was found in size class category-V which is 28.6%, followed by category-I (25.0%), category-II (11.1%), category-IV (10.0%) and category-III (5.3%). However, the percentage of weight for squid increased with the size classes. The weight percentage of squid for length class in category-I was 6.9%, increased 9.7% for size class in category-II, 33.4% for category-IV and 57.2% for category-V. Shrimp only occurs in cobia stomach for size classes' category-III and category-IV, with percentage in frequency of occurrence were 5.3% and 10%, respectively.

Table 2. Diet composition of female and male *R. canadum* in terms of percentage in number, occurrence and weight

No	Food item	Number (%)		Occurrence (%)		Weight (%)	
		F	M	F	M	F	M
1	Fishes	86.6	74.0	77.3	81.3	75.4	63.4
2	Crabs	3.1	23.0	9.1	15.6	0.5	7.5
2	Squids	5.2	3.0	13.6	9.4	23.8	29.1
4	Shrimp	5.2	0.0	9.1	0.0	0.3	0.0

F = Female, M = Male

Table 3. Diet composition and the index of relative importance (IRI) of the common food item in the diet of *R. canadum* by length classes

L. classes (cm)	Food items	(%) Occur.	(%) Weight	(%) Number	IRI	(%) IRI
Category-I	Fish	75.0	87.5	81.3	12,660.0	95.2
(< 60)	Crab	12.5	5.6	6.3	148.8	1.1
	Squid	25.0	6.9	12.5	485.0	3.6
	Shrimp	0-0	0.0	0.0	0.0	0.0
Category-II	Fish	77.8	88.1	86.7	13,599.4	98.0
(60–80)	Crab	11.1	2.2	6.7	98.8	0.7
	Squid	11.1	9.7	6.7	182.0	1.3
	Shrimp	0.0	0.0	0.0	0.0	0.0
Category-III	Fish	89.5	81.1	76.7	14,123.1	96.4
(81–100)	Crab	15.8	10.7	18.9	467.7	3.2
	Squid	5.3	7.8	0.9	46.1	0.3
	Shrimp	5.3	0.4	3.4	20.1	0.1
Category-IV	Fish	80.0	66.2	89.3	12,440.0	96.5
(101–120)	Crab	10.0	0.2	3.6	38.0	0.3
	Squid	10.0	33.4	3.6	370.0	2.9
	Shrimp	10.0	0.1	3.6	37	0.3
Category-V	Fish	71.4	42.8	82.6	8,896.4	80.7
(>120)	Crab	0.0	0.0	0.0	0.0	0.0
	Squid	28.6	57.2	17.4	2,133.6	19.3
	Shrimp	0.0	0.0	0.0	0.0	0.0

Table 4. The stomach fullness and the percentage of empty stomach by category in size classes of the *R. canadum*

Category	Size class	Stomach fullness (%)				
		Empty	¼ full	½ full	¾ full	full
I	< 60	33.3	25.0	33.3	8.3	0.0
II	61 – 80	34.6	34.6	23.1	3.8	3.8
III	81 – 100	29.5	37.0	14.8	7.4	14.8
IV	101 – 120	0.0	40.0	30.0	10.0	20.0
V	>120	0.0	28.6	28.6	42.8	0.0

The percentage number of food in cobia's diet fluctuated according to size classes. The fish percentage in cobia's diet for size class in category-I was 81.3% while for size class in category-II was 86.7%, category-III (76.7%), category-IV (89.3%) and category-V (82.6%). The crab percentage is the highest for length class in category-III which was 18.9%, followed by category-II (6.7%), category-I (6.3%) and category-IV (3.6%). Percentage of squid ranged between 0.9% (category-III) to 17.4% (category-V).

Stomach fullness

Stomach fullness according to size classes are shown in Table 4. There are 33.3% empty stomach for size class in category I, 34.6% for category-II and 29.5% for category-III. There was no empty stomach for category-IV and -V and no full stomach in category-I and -V, compared to 3.8% for category-II, 14.8% (category-III) and 20.0% (category-IV). Size class in category-V shows that most active feeder with 71.4% stomach intensities are more than ½ full (Figure 1). This followed by size class in category-IV which is 60%. However, length class in category-I, -II and -III showed higher percentage of non-active feeder than the active feeder.

It is found that their feeding intensity increases according to size. The similar trend was reported for cobia of northwest India Ocean (Sajeevan & Kurup, 2014). It is clear that empty stomachs were absent in the case of large sized or adult cobia (category-IV and -V). According to Purusothaman *et al* (2014), the most active feeding period was during gonad maturing and ripening stages. This suggests that

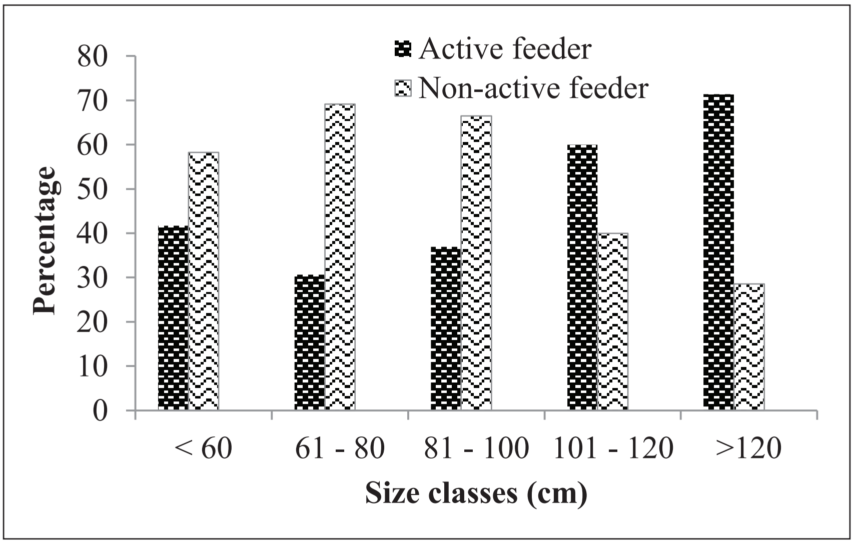

Fig. 1. Percentage of active and non-active feeder recorded for the *R. canadum* based on size classes.

during development stage, food intake increase because a lot of energy is needed for gonad development.

The present study indicated that cobia, *R. canadum* are opportunist predator with four categories of food in their stomach that are fish, crab, squid and shrimp. Fish is the major component of cobia diet. Variation in the availability of food items or the stomach content for the *R. canadum* could be associated with the geographic differences.

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REFERENCES

Arendt, M.D., Olney, J.E. & Lucy, J.A. 2001. Stomach content analysis of cobia, *Rachycentron canadum* from lower Chesapeake Bay. *Fishery Bulletin,* **99(4)**: 665-670.

Bachok, Z., Mansor, M.I. & Noordin, M. 2004. Diet composition and food habits of demersal and pelagic marine shes from Terengganu waters, east coast of Peninsular Malaysia. *NAGA, World Fish Center Quarterly,* **27(3 & 4)**: 41-47.

Bal, D.V. & Rao, K.V. 1984. *Marine Fisheries*. Tata McGraw-Hill Publishing Company Limited, New Delhi. 250 pp.

Benetti, D.D., Alarcon, J.F., Stevens, O.M., O'Hanlon, B., Rivera, J.A., Banner-Stevens, G. & Rotman, F.J. 2003. Advances in hatchery and grow out technology of marine finfish candidate species for offshore aquaculture in the Caribbean. *Proceedings of the Gulf and Caribbean Fisheries Institute,* **54**: 475-487.

Chu, Y.Y., Nega, M., Wölfle, M., Plener, L., Grond, S., Jung, K. & Friedrich Götz. 2013. A new class of quorum quenching molecules from *Staphylococcus* species affects communication and growth of gram-negative bacteria. *PLOS Pathogens*.

Darracott, A. 1977. Availability, morphometrics, feeding and breeding activity of a multi-species, demersal fish stock of the western Indian Ocean. *Journal of Fish Biology,* **10(1)**: 1-16.

Fischer, W. & Bianchi, G. 1984. FAO species identification sheets for fishery purposes. Western Indian Ocean (Fishing Area 51). Food and Agriculture Organisation of the United Nations, Rome. 1-5.

Franks, J.S., Garber, N.K. & Warren, J.R. 1996. Stomach contents of juvenile cobia, *Rachycentron canadum*, from the northern Gulf of Mexico. *Fishery Bulletin,* **94(2)**: 374-380.

Hammond, D.E., Simpson, H.J. & Mathieu, G. 1977. Radon 222 distribution and transport across the sediment-water interface in the Hudson River estuary. *Journal of Geophysical Research,* **82**: 23-30.

Knapp, F.T. 1951. Food habits of the sergeant fish, *Rachycentron canadum*. *Copeia,* **1951**: 101-102

Kulbicki, M., Guillemot, N. & Amand, M. 2005. A general approach to length-weight relationships for pacific lagoon fishes. *Cybium,* **29**: 235-252.

Macpherson, E. 1989. Influence of geographical distribution, body size and diet on population density of benthic fishes off Namibia (South West Africa). *Marine Ecology Progress Series,* **50**: 295-299.

Mazlan, A.G., Samat, A., Amirrudin, A. & Anita, T. 2007. Aspects on the biology of *Garra cambodgiensis* and *Mystacoleucus marginatus* (Cyprinidae) from Ulu Dungun, Terengganu. *Malaysian Applied Biology,* **36(1)**: 67-72.

Meyer, G.H. & Franks, J.S. 1996. Food of cobia, *Rachycentron canadum*, from the north-central Gulf of Mexico. *Gulf Research Reports,* **9(3)**: 161-167.

Nikolsky, G.V. 1963. *The Ecology of Fishes*. 1st ed. Academy Press, London. 123-134pp.

Nur-Farhana, A., Samat, A., Zaidi, C.C. & Mazlan, A.G. 2013. Stomach content and trophic level position of two bamboo shark species *Chiloscyllium indicum* and *C. hasseltii* (Hemiscylliidae) from South Eastern Waters of Peninsular Malaysia. *Journal of Sustainability Science & Management,* **8(1)**: 113-120.

Phelps, Q.E., Powell, K.A., Chipps, S.R. & Willis, D.W. 2007. A method for determining stomach fullness for planktivorous fishes. *North American Journal of Fisheries Management,* **27**: 932-935.

Philip, K.P. 1994. Studies on the biology and fishery of the fishes of the family Priacanthidae (Pisces: Perciformes) of Indian waters. Ph.D. Thesis, Cochin University of Science and Technology, Kochi. 169 pp.

Pinkas, L., Olipham, M.S. & Iverson, I.L.K. 1971. Food habits of albacore, bluefin tuna and bonito in Californian waters. *California Fish Game,* **152**: 1-105.

Pinkas, L. 1971. Bluefin tuna habits. *In* L. Pinkas, M.S. Oliphant & I.K. Iverson (eds.). Food habits of albacore, bluefin tuna and bonito in California waters. *California Fish Game,* **152**: 47-63.

Purusothaman, S., Jayaprabha, N., Silambarasan, A. & Murugesan, P. 2014. Fishery resources in the trawl bycatches of Cuddalore and Parangipettai, Southeast Coast of India. *Journal of Marine Biology and Oceanography,* **3**: 3.

Robins, C.R. & Ray, G.C. 1986. *A Field Guide to Atlantic Coast Fishes of North America.* Houghton Mifflin Company, Boston, U.S.A. 354 pp.

Rohit, P. & Bhat, S.U. 2012. Fishery and diet composition of the cobia *Rachycentron canadum* (Linnaeus, 1766) exploited along Karnataka coast. *Indian Journal of Fisheries,* **59 (4)**: 61-65.

Sajeevan, M.K. & Kurup, B.M. 2013. Evaluation of feeding indices of cobia *Rachycentron canadum* (Linnaeus. 1766) from northwest coast of India. *Journal of the Marine Biological Association of India,* **55(2)**: 16-21.

Shaffer, R.V. & Nakamura, E.L. 1989. Synopsis of biological data on the cobia, *Rachycentron canadum* (Pisces: Rachycentridae). NOAA. Tech. Rep. NMFS. 82. Food and Agriculture Organisation of the United Nations Fisheries Synopsis 153, U.S. Department of Commerce, Springfield, Virginia, 21 pp.

Smith, J.W. 1995. Life history of cobia, *Rachycentron canadum* (Osteichthyes: Rachycentridae), in North Carolina waters. *Brimleyana,* **23**: 1-23.