Indian J. Fish., 59(4) : 61-65, 2012

Fishery and diet composition of the cobia *Rachycentron canadum* (Linnaeus, 1766) exploited along Karnataka coast

PRATHIBHA ROHIT AND UMA S. BHAT
Mangalore Research Centre of Central Marine Fisheries Research Institute, P.B. No. 244
Bolar, Mangalore-575 001, Karnataka, India
e-mail: rohitprathi@yahoo.co.in

ABSTRACT

The fishery and food of cobia, *Rachycentron canadum* caught off Karnataka, south-west coast of India was studied during 2007-2010. An estimated 302 t was landed annually along this coast which formed 0.1% of the total fish catch of the region. Peak landings were recorded during October followed by April. Gillnets landed large sized cobia and contributed to the bulk of the catch (53%). Maximum catch by this gear was during September-October. Next dominant gear was trawl which landed fishes of all size groups with maximum catch during April-May. Trawl landings contributed 45% of the total cobia landings. The fishery was comprised of fishes of length range 26 - 125 cm TL with the mean at 58 cm. Juveniles dominated the catch. Contents of 177 non-empty stomachs were analysed for the index of relative importance (IRI) and prey specific abundance (PSA). *R. canadum* was found to be nonselective generalist carnivore feeder, foraging on micronektonic pelagic or benthic organisms (crustaceans, fish and molluscs) available in the epipelagic waters. Teleost fish (55%), crustaceans (35%) and molluscs (10%) contributed to the diet. *Decapterus russelli* (18.0%) and *Encrasicholina devisi* (10.0%) were the dominant finfish groups; *Acetes* sp. (21.1%) followed by crabs (*Charybdis* spp. and *Portunus* spp.) with an IRI of 12.9% were dominant among crustaceans and squids (*Loligo* spp.) (5.8%) and octopus (4.1%) comprised the dominant molluscans prey items.

Keywords: Cobia, Diet composition, Fishery, Index of relative importance (IRI), Predator, Prey, *Rachycentron canadum*

Introduction

Cobia (*Rachycentron canadum*) a monotypic member of the family Rachycentridae is a migratory pelagic species that occurs worldwide in tropical, subtropical and warm temperate seas except in the central and eastern Pacific Ocean (Shaffer and Nakamura, 1989 and Franks *et al*., 1996). They occupy a variety of habitats and have been reported to occur over mud, rock, sand and gravel bottoms; over coral reefs and in mangrove sloughs; inshore around pilings and buoys, and offshore around drifting and stationary objects (Springer and Bullis, 1956; Hoese and Moore, 1977; Freeman and Walford, 1976; Sonnier *et al*., 1976; Relyea, 1981; Goodson, 1985). Adult cobia inhabits coastal and continental shelf areas, occasionally entering estuaries (Ranjan *et al*., 1968; Collette, 1978; Benson, 1982; Robins and Ray, 1986). Though they are pelagic, may occur throughout the water column (Freeman and Walford, 1976), and have been taken at depths of 50 m, and over waters as deep as 1200 m (Springer and Bullis, 1956). In India the fish occurs along both the coasts forming an incidental catch in trawls, gillnets, trolls and handlines (Pillai, 1982). *R. canadum* forms a fishery throughout the year in Karnataka and contributed to 0.1% of the total marine fish catch during 2007-2010. The fish is highly preferred for its table value and fetches very good price in fresh condition. Fast growth rate and high market value both in domestic and export market has made *R. candum* an ideal candidate species for mariculture (Liao, 2003; Kaiser and Holt, 2004; 2005).

The food of *R. canadum* has been studied extensively from the Gulf of Mexico (Miles, 1949; Knapp, 1951; Reid, 1954; Boschung, 1957 and Christmas *et al*., 1974). Shaffer and Nakamura (1989) made a brief review on the reported diets of cobia. Smith (1995) reported on the diet of cobia collected from North Carolina. While Meyer and Franks (1996) reported on the food contents of adult cobia, Franks *et al*. (1996) reported on the stomach contents of juvenile cobia from the Gulf of Mexico. Arendt *et al*. (2001) analysed the stomach contents of cobia from lower Chesapeake Bay. In India though the fishery of cobia has been reported in general, a detailed study on the fishery and biology is lacking (Somvanshi *et al*., 2000). As is the case with other large pelagic fishes, cobia too is an apex predator preying actively on fishes, crustaceans and molluscs. The survival of these apex predators depends on their efficiency to locate prey-rich areas in the vicinity of their environment (Sund *et al*., 1981; Bertrand *et al*., 2002) and cobia is known to move to areas of high food abundance, particularly crustacean abundance (Darracott, 1977). Knowledge of the fishery and feeding habits is necessary for proper management of the fishery. Further, this species is known for its fast growth and good flesh texture. The species is harvested from the wild and farmed in several countries. In this context, knowledge on the food and feeding habits of cobia is essential to understand the role of diet in the growth of the fish and to formulate balanced artificial feed to be used in farming systems. The specific objective of this study was to ascertain the fishing status of cobia and to quantitatively analyse the diet of cobia exploited along the Karnataka coast.

Materials and methods

Catch statistics of cobia landed by different commercial fishing vessels were taken from the National Marine Fisheries Data Centre of Central Marine Fisheries Research Institute. The multi-stage stratified random sampling technique was used to obtain the monthly and annual catch figures. Weekly trips were made to the major fish landing centres of Karnataka to record length frequency distribution and collect samples for biological studies. Samples were collected only from the trawl landings as cobia was landed more frequently and on a regular basis by this gear. The total length was measured to the nearest cm from tip of snout to the tip of the caudal fin. Attempt was made to measure as many fishes as possible and random samples were collected for biological analysis. The samples were transported to the fishery biology laboratory and the total length (cm) and wet weight (g) were taken. The fishes were then cut open and the stomach was carefully removed for further detailed analysis. Stomach fullness was visually classified into six categories as full, three-fourth full, half full, one-fourth full, trace and empty based on the distension of the stomach due to the presence or absence of food. The average intensity of feeding was evaluated by point's method (Hynes, 1950; Bapal and Bal, 1958). Sex and stage of gonad maturity were also recorded for each fish. The collected stomachs were kept frozen at -20 °C till further analysis.. The total weight of the stomach contents was taken and the contents were divided into broad prey classes sorted by large categories (fish, mollusc, crustacean and others) and the weight of each category was noted. The different items constituting one category were sorted and counted. For each item, identifiable organs were used to determine the number of prey present in the stomach. Prey items if consumed just before capture could be easily identified up to species level. In case of partially digested fish, the number of mandibles, parasphenoids or the maximum number of either right or left otoliths were assumed to reflect the total number of prey. For partially digested cephalopods, the number of either upper or lower beak was taken into account. In the case of partially digested crustaceans, telsons, cephalo-thorax or claws were counted. Prey was identified up to genus level and further to species level whenever possible using keys and descriptions found in Smith and Heemstra (1986), Fischer and Whitehead (1974) and by comparison with material available in the reference collection at the Institute.

The importance of each food item in the diet was determined by index of relative importance (IRI) (Pinkas *et al*., 1971), modified to weight percentage: $IRI_i = \%FO_i (\%W_i + \%N_i)$, where $\% N_i$ = number of taxon i percentage, $\% W_i$ = weight of taxon i percentage and $\% FO_i$ = frequency of occurrence of taxon i percentage.

Results

The average annual cobia landing during 2007-2010 from the wild in Karnataka was 302.5 t. Cobia formed 0.1% of the total marine fish catch of Karnataka. Gillnets, trawls, hooks and line and the seines contributed to the cobia landings. Gillnets (53%) and trawls (45%) contributed significantly to the catch, while catch from other gears were marginal. Cobia was landed during all the months with peak landing in December followed by May (Fig. 1). Stomachs were examined from fishes in the size range, 26 - 125 cm with major mode at 40 cm and mean length 59 cm (Fig. 2).

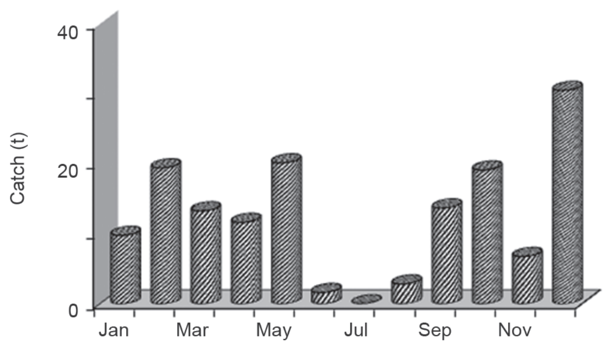

Fig. 1. Monthly variations in cobia (t) landings during 2007-2010 in Karnataka

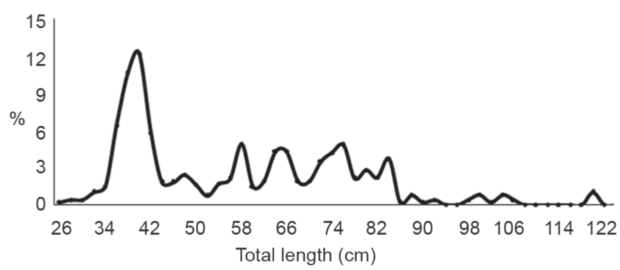

Fig. 2. Size distribution of *R. canadum* landed during 2010 in Karnataka

The diet of cobia samples collected was analysed in detail. In all the 215 cobia stomachs analysed, 33 (15.3%) were empty. Analysis was based on 182 stomachs containing prey items. Visual observation of the distension of stomach indicated that proportion of full, three-fourth full, half full, one-fourth full and trace was 37.9% 6.0%, 19.2%, 22.5% and 14.3% respectively (Fig. 3). The food contents formed 0.1% to 44.3% of the wet body weight. The prey items were grouped into fishes, crustaceans and molluscs (Fig. 4). Fishes formed bulk of the diet (76%) in wet mass.

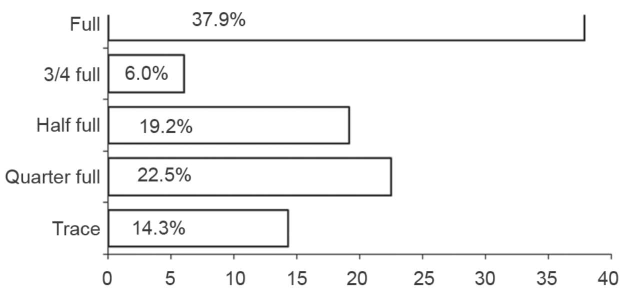

Fig. 3. Quantitative analysis of stomach contents of *R. canadum*

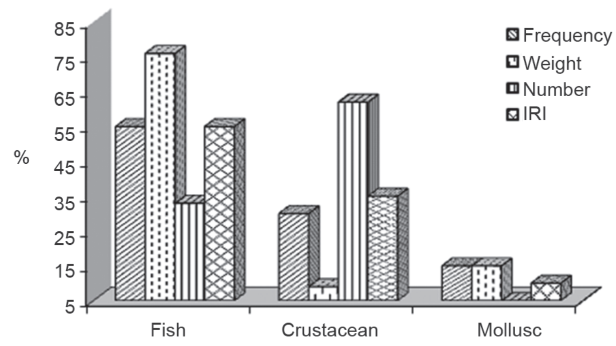

Fig. 4. Major diet components of *R. canadum*

Prey species composition

The results of the analysis of the 177 cobia stomachs are summarised in Table 1. A total of 1,295 prey items belonging to 25 families were identified. These included 16 genera of finfish, 5 genera of crustaceans and 4 genera

Table 1. Index of relative importance (IRI) estimated for *R. canadum* exploited along Karnataka coast during 2010

Prey groups	Frequency of occurrence (FO)	%FO	Weight (g) (W)	%W	Number (N)	%N	(%W+ %N)	Index of Relative Importance % FO (%W + %N)	% IRI
D. russelli	27	8.28	1149.01	21.25	53.00	4.09	25.34	209.89	18.03
E. devisi	27	8.28	416.43	7.70	89.00	6.87	14.57	120.70	10.37
Lagocephalus sp.	3	0.92	93.70	1.73	7.00	0.54	2.27	2.09	0.18
S. longiceps	2	0.61	64.55	1.19	2.00	0.15	1.35	0.83	0.07
Epinephelus spp.	2	0.61	21.50	0.40	2.00	0.15	0.55	0.34	0.03
Platycephalus sp.	7	2.15	140.97	2.61	16.00	1.24	3.84	8.25	0.71
R. kanagurta	2	0.61	170.50	3.15	3.00	0.23	3.38	2.08	0.18
Flat fish	1	0.31	4.10	0.08	1.00	0.08	0.15	0.05	0.00
N. japonicus	16	4.91	555.63	10.28	46.00	3.55	13.83	67.87	5.83
N. mesoprion	13	3.99	279.47	5.17	17.00	1.31	6.48	25.84	2.22
Apogon sp.	2	0.61	29.00	0.54	2.00	0.15	0.69	0.42	0.04
Silverbellies	8	2.45	258.22	4.78	66.00	5.10	9.87	24.23	2.08
S. tumbil	21	6.44	445.89	8.25	61.00	4.71	12.96	83.46	7.17
S. undosquamis	2	0.61	27.50	0.51	2.00	0.15	0.66	0.41	0.03
Otolithes spp.	1	0.31	8.00	0.15	1.00	0.08	0.23	0.07	0.01
Ribbonfish	1	0.31	2.38	0.04	1.00	0.08	0.12	0.04	0.00
Callionymus sp.	6	1.84	74.22	1.37	11.00	0.85	2.22	4.09	0.35
Eel	2	0.61	46.59	0.86	2.00	0.15	1.02	0.62	0.05
Acetes sp.	17	5.21	48.11	0.89	597.00	46.10	46.99	245.04	21.06
S. choprai	6	1.84	47.30	0.87	29.00	2.24	3.11	5.73	0.49
Prawn	5	1.53	20.40	0.38	12.00	0.93	1.30	2.00	0.17
Crab	27	8.28	65.22	1.21	58.00	4.48	5.68	47.08	4.05
C. hoplites	3	0.92	31.50	0.58	22.00	1.70	2.28	2.10	0.18
Charybdis smithii	32	9.82	256.44	4.74	71.00	5.48	10.23	100.37	8.62
Squilla	6	1.84	35.73	0.66	12.00	0.93	1.59	2.92	0.25
Squid	25	7.67	342.01	6.32	32.00	2.47	8.80	67.45	5.80
Cuttlefish	2	0.61	10.38	0.19	5.00	0.39	0.58	0.35	0.03
Octopus	16	4.91	430.19	7.96	23.00	1.78	9.73	47.76	4.10
Gastropod	3	0.92	3.20	0.06	3.00	0.23	0.29	0.27	0.02
Digested matter	10	3.07	20.52	0.38	0.00	0.00	0.38	1.16	0.10
Digested fish	31	9.51	308.67	5.71	49.00	3.78	9.49	90.26	7.76
Total	326	100.00	5407.33	100.00	1295.00	100.00	200.00	1163.78	100.00

of molluscs (mainly cephalopods). Fishes were the most dominant prey item by mass (weight) (75.8%) followed by molluscs (14.5%) and crustaceans (9.3%). The fully digested unrecognisable food content comprised the remaining 0.4%. On an average, 30.6 g of prey were found per stomach. Fish dominated the diet by occurrence (55%), and crustaceans by number (61.9%). However, importance of each food item in the diet determined by IRI revealed that *Acetes* was the most preyed food item of *R. canadum* with IRI (%) value of 21.1. Other significant crustacean food items were crabs (*Charybdis smithii*, *Charybdis hoplites*), prawns (*Solenocera choprai*, *Solenocera andamanensis*) and squilla (*Oratosquilla* sp.). Among finfishes, *Decapterus russelli* was the dominant species followed by *Encrasicholina devisi, Saurida tumbil* and *Nemipterus japonicus*. Occurrence of *Nemipterus mesoprion, Leiognathus* sp., *Lagocephalus inermis*, *Sardinella longiceps*, *Rastrelliger kanagurta*, *Epinephelus diacanthus*, flatheads (*Platycephalus* sp., *Callionymus* sp.), eel and *Trichiurus lepturus* as diet component was rare. Among molluscs, squid (*Loligo* spp.) was the dominant prey item followed by *Octopus* sp. and *Sepia* sp.

Discussion

The distribution and availability of cobia along the Indian coast is well documented (CMFRI, 2009; Wagmare *et al*., 2009) and its representation in marine fish catch more as an incidental catch by all gears is agreeable to the basic nature of cobia occurring singularly or as occurring in small pods (Hammond *et al*., 1977; Shaffer and Nakamura, 1989). Exploitation of cobia by different gears also suggested that they have a wide distribution from the shallow continental shelf area to deeper waters in the continental slope region. Cobia popularly known as 'crab eaters' due to their assumed fondness for crabs as its major diet, moves to areas of high food abundance, particularly crustacean abundance (Daracott, 1977). However, diet of cobia in the present study has not shown any such specific preference for crabs, though crabs do form an important component of the diet. The only earlier report on the food of cobia exploited from Indian EEZ by Somvanshi *et al*. (2000) recorded the dominance of puffer fishes and occasionally other items like scads, barracudas and squids. Smith (1995) reported that cobia's are opportunistic feeders conducting most of their feeding near the bottom targeting crabs, shrimp, squid and benthic fish. The present study has indicated that cobia feed on a wide variety of food items and are nonselective feeders foraging on whatever pelagic or benthic organisms that are locally available. Franks *et al*. (1996) found that juvenile cobia captured by trawl in the northern Gulf of Mexico were carnivores and fed exclusively on small fish, crustaceans and squid. Fish, crustaceans and cephalopods also comprised the diet of adult cobia collected in the north central Gulf of Mexico (Meyer and Franks, 1996) and Aransas Bay, Texas (Knapp, 1951). A similar trend was observed in the present study with dominance of fishes in the diet. Fish component was dominant in frequency of occurrence (55.1%), by weight (76.0%) and IRI (55.2%). Numerically the crustaceans formed the dominant group (61.9%) of which *Acetes* formed the most dominant crustacean diet component numerically (46%) as well by IRI (21.1%). *C. smithii* had the maximum frequency of occurrence (9.8%) followed by other crabs, and finfishes *viz*., *E. devisi* and *D. russelli* with similar frequency of occurrence (8.3%).

The diversity observed in the diet component of cobia in the present study showed that cobia exhibits opportunistic feeding behaviour, are strong swimmers capable of capturing fast moving fishes, squids and decapod crustaceans which are open nektonic, benthic and demersal.

Reference

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

Bapal, S. V. and Bal, D. V. 1958. Food of some young fishes from Bombay waters. *Proc. Ind. Acad. Sci*., 35: 78-92.

Benson, N. G. 1982. Life history requirements of selected finfish and shellfish in the Missippi Sound and adjacent areas. *U.S. Fish.Wild.Serv. FWS/OBS*-81151: 49-50.

Bertrand, A., Bard, F-X and Josse, E. 2002. Tuna food habits related to the micronekton, distribution in French Polynesia. *Mar. Biol*., 140: 1023-1037.

Boschung, H.T., Jr. 1957. *The fishes of Mobile Bay and the Gulf coast of Alabama*. Ph. D.Dissertation, University of Alabama, Tuscaloosa, AL, 633 pp.

Briggs, J. C. 1958. A list of Florida fishes and their distribution. *Bull. Fla. State Mus., Biol. Sci*., 2: 221-318.

Christmas, J. Y., Perry, A. and Waller, R. S. 1974. *Investigations of coastal pelagic fishes.* Completion Report, proj.2-128-R, Gulf Coast Research Lab., Ocean Springs, MS 39564, 105 pp.

CMFRI 2009. *Annual Report*, Central Marine Fisheries Research Institute, Kochi.

Collette, B. B.1978. Rachycentridae. In: Fisher, W. (Ed.), *FAO species identification sheets for fishery purposes,* Western Central Atlantic (Fishing Area 31), Vol.IV. FAO, Rome, Unpaginated.

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

Fischer, W. and Whitehead, P. J. P. 1974. *FAO species identification sheets for fishery purposes*. Eastern Indian Ocean (Fishing area 57) and Western Central Pacific (Fishing area 71), Vol. 1-4.

Franks, J. S., Garber, N. M. and Warren, J. R. 1996. Stomach contents of juvenile cobia, *Rachycentron canadum*, from the northern Gulf of Mexico. *Fish. Bull*., 94(2): 374-380.

Freeman, B. L. and Walford, L. A. 1976. *Anglers guide to the United States Atlantic coast: Fish, fishing grounds and fishing facilities.* Sect. VII: Altamaha Sound, Georgia to Fort Pierce Inlet, Florida. Natl. Mar. Serv., NOAA, Seattle, WA 98115-0070, 21 pp.

Goodson, G. 1985. *Fishes of the Atlantic Coast.* Stanford Univ.Press, Stanford, CA, 204 pp.

Hammond, D. L., Myatt, D. O. and Cupka, D. M. 1977. Evaluation of midwater structures as a potential tool in the management of fisheries resources on South Carolina's artificial reefs. *SC Mar. Res. Tech. Rep*., 15: 19 pp.

Hoese, H. D. and Moore, R. J. 1977. Fishes of the Gulf of Mexico; Texas, Louisiana and adjacent waters. Texas A&M Univ. Press, College Station, TX, 327 pp.

Hynes, H. B. N. 1950. The food of fresh-water sticklebacks (*Gasterosteus aculeatus* and *Pygosteus pungitius*) with a review of methods used in studies of the food of fishes. *J. Anim. Ecol*., 19: 26-58.

Kaiser, J. B. and Holt, G. J. 2004. Cobia: a new species for aquaculture in the US. *World Aquacult.*, 35: 12-14.

Kaiser, J. B. and Holt, G. J. 2005. Cobia aquaculture. In: Kelly, A.M. and Silverstein, J. T. (Eds.), *Aquaculture in the 21st Century*. American Fisheries Society. Bethesda, Maryland, USA, p. 465-469,

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

Liao, I. C. 2003. Candidate species for open ocean aquaculture: the successful case of cobia *Rachycentron canadum* in Taiwan. In: Bridger, C. J. and Costa-Pierce, B. A. (Eds.), *Open ocean aquaculture: from research to commercial reality*. World Aquaculture Society, Baton Rouge, Louisiana, USA, p. 205-213,

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

Miles, D. W. 1949. *A study of the food habits of the fishes of the Aransas Bay area*. M. S. thesis, University of Houston, Houston, TX, 70 pp.

Pillai, P. K. M. 1982. Black kingfishes. *Mar. Fish. Infor. Serv. T & E Ser*., 39: 12.

Pinkas, L., Oliphant, M. S. and Iverson, I. L. K. 1971. Food habits of albacore, bluefin tuna and bonito in Californian waters. *Calif. Dep. Fish. Game Fish. Bull*., 152: 105 pp.

Rajan, S., Patnaik, S. and Basu, N. C.1968. New records of fishes from the Chilka. *J. Zool. Soc. India,* 20(1/2): 80-93.

Reid, G. K., Jr. 1954. An ecological study of the Gulf of Mexico fishes, in the vicinity of Cedar Key, Florida. *Bull. Mar. Sci. Gulf Caribb*., 4: 1-94.

Relyea, K. 1981. *Inshore fishes of the Arabian Gulf*. George allen & Unwin, London, 149 pp.

Robins, C. R. and Ray, G. C. 1986. *Field guide to Atlantic Coast fishes of North America.* Houghton Mifflin Co., Boston, MA, 354 pp.

Shaffer, R.V and Nakamura, E. L. 1989. Synopysis of biological data on the cobia, *Rachycentron canadum*. (Pisces:Rachycentridae). *FAO Fisheries Synop*., 153 (NMFS/S 153). U.S. Dep. Commer., *NOAA Tech. Rep. NMFS,* 82: 21 pp.

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

Smith, M. M. and Heemstra, P. C. 1986. *Smiths' sea fishes.* Southern Book Pub., Johanesburg.

Somvanshi, V. S., Varghese, S., Gulati, D. K. and Bhargava, A. K.. 2000. Some biological aspects of kingfish *Rachycentron canadum* (Linneaus, 1766) from the north-west Indian EEZ. *Occasional Paper of Fishery Survey of India*, No.10: 33 pp.

Sonnier, F. J. Teerling and Hoese, H. D. 1976. Observations on the offshore reef and platform fish fauna of Louisiana. *Copeia*, (1): 105-111.

Springer, S. and Bullis, H. R. Jr. 1956. Collections by the Oregon in the Gulf of Mexico. *U. S. Dept. Inter. Bur. Commer. Fish., Spec. Sci. Rep. Fish*., 196: 134 pp.

Sund, P. N., Blackburn, M. and Williams, F. 1981. Tunas and their environment in the Pacific Ocean: a review. *Oceanogr. Mar. Bio. Ann. Rev*., 19: 443-512.

Wagmare, K. B., Sundaram, S. and Mestry, A.Y. 2009. An emerging commercial fishery of *Rachycentron canadum* (Linnaeus, 1766) at New Ferry Wharf, Mumbai. *Mar. Fish. Infor. Serv., T&E Ser.,* 201: 10-11.

Date of Receipt : 18.01.2012
Date of Acceptance : 23.07.2012