JCBPS; Section B; November 2018 – January 2019, Vol. 9, No. 1; 024-033. E- ISSN: 2249 –1929

[DOI: 10.24214/jcbps.B.9.1.02433.]

Journal of Chemical, Biological and Physical Sciences

An International Peer Review E-3 Journal of Sciences

*Available online at*www.jcbsc.org

Section B: Biological Sciences

CODEN (USA): JCBPAT Research Article

Diet of *Caranx crysos* (Mitchill, 1815) catch by purse seiner in Atlantic Ocean.

N'GUESSAN Yao[2]*, AMANDE Monin Justin[1], DIAHA N'guessan Constance[1], OUSSOU Koffi Hervé[2], EDOUKOU Abekan[2], ANGUI Kouamé Jean-Paul[2], N'DA Konan[2]

[1] Département des Ressources Aquatiques Vivantes, Centre de Recherches Océanologiques, Côte d'Ivoire

[2] Laboratoire de Biologie et de Cytologie Animales, UFR des Sciences de la Nature, Université Nangui Abrogoua, Côte d'Ivoire

Received: 06 November 2018**; Revised:** 27 November 2018; **Accepted:** 04 December 2018

Abstract: The diet study included specimens of *Caranx crysos* caught by seiners in the East Atlantic Ocean. A total of 579 stomachs were examined. 501 stomachs were against 78 full. Which corresponds to the vacuity equal to 86.53%. The index of vacuity varied during the year. The highest values of this index were observed in April, June and July are 100%. The lowest was recorded in January with 16.67%. The vacuity recorded in males (59.08%) is greater than that of females (40.52%) (X^2 = 17.33, p <0.05). Indeed, the index of vacuity varied in individuals at different sexual stages. Stage VI individuals have zero, while stage III have the highest vacuity at 93.1%. Analysis of the 78 full stomachs revealed that *C. crysos* diet consisted of teleost, gastropods, cephalopods, crustaceans, annelids and phytoplankton. On the basis of the indices of relative importance (IRI), teleost constitute the preferential preys of *C. crysos* with % IRI = 59.33. The gastropods are their secondary prey (% IRI = 38.16). Cephalopods (% IRI = 0.26), crustaceans (% IRI = 2.23), annelids (% IRI = 0.003) and phytoplankton (% IRI = 0.014) are occasional prey items. The diet of males identical to that of females. However, the diet of *C. crysos* varies according to the sexual stage of the individuals. *C. crysos* is classified as a piscivore.

Key words: diet, *Caranx crysos*, purse seiner, Atlantic Ocean.

INTRODUCTION

Blue runner *Caranx crysos* (Mitchill, 1815) is widely distributed in the pelagic zone of all the tropical oceans. *Caranx crysos* is a species found in the Atlantic Ocean, particularly along the African coast, from Senegal to Angola[1]. This specie is founding from Brazil to Canada, including the Gulf of Mexico and the Caribbean in the western Atlantic, and from Angola to Great Britain, in the east Atlantic, including the Mediterranean[2]. On the Mediterranean side, landings have become increasingly important and regular [3]. However, on industrial scale, *Caranx crysos* is caught under FADs in addition with target tunas (yellowfin, skipjack and bigeye tuna) and other species (billfish, turtle, ballistae etc.) by a purse seine fishery operating in the East Atlantic Ocean. Thus the species was considering as bycatch in fisheries of purse seiner tuna[4]. And they are most often discarded or retained on board purse seiners for commercial value due to the existence of a local market[5]. Several studies have been conducted on its breeding biology in the Gulf of Mexico by Goodwin and Johnson [6] and in the Mediterranean by Sley *et al*,[3]. His diet is also studied by Keenan and Benfield [7] in the Gulf of Mexico and by Sley *et al* [8] in the Gulf of Gabès. However, very little data exists on this species at the level of East Atlantic Ocean. The purpose of the present study was to investigate the trophic behaviour of *C. crysos* caught by purse seiner fishery under artificial floating objects (drifting Fish Aggregating Devices, FADs). And examined its variability according to sex, size of first maturity and stage of sexual maturity.

MATERIELS AND METHODS

Sampling: Our study area comprises Eastern Atlantic latitude 1°N and 21°N, longitude 0°W and 22°W (**Figure 1**). Its hydroclimatic conditions directly influence the availability of fishery resources due to the formation and recirculation of deep water. The injection of surface water into the deeper layers is responsible of the high oxygen content of the Atlantic Ocean. It also intricately linked with high surface salinity and the surface sea temperature [9-10].

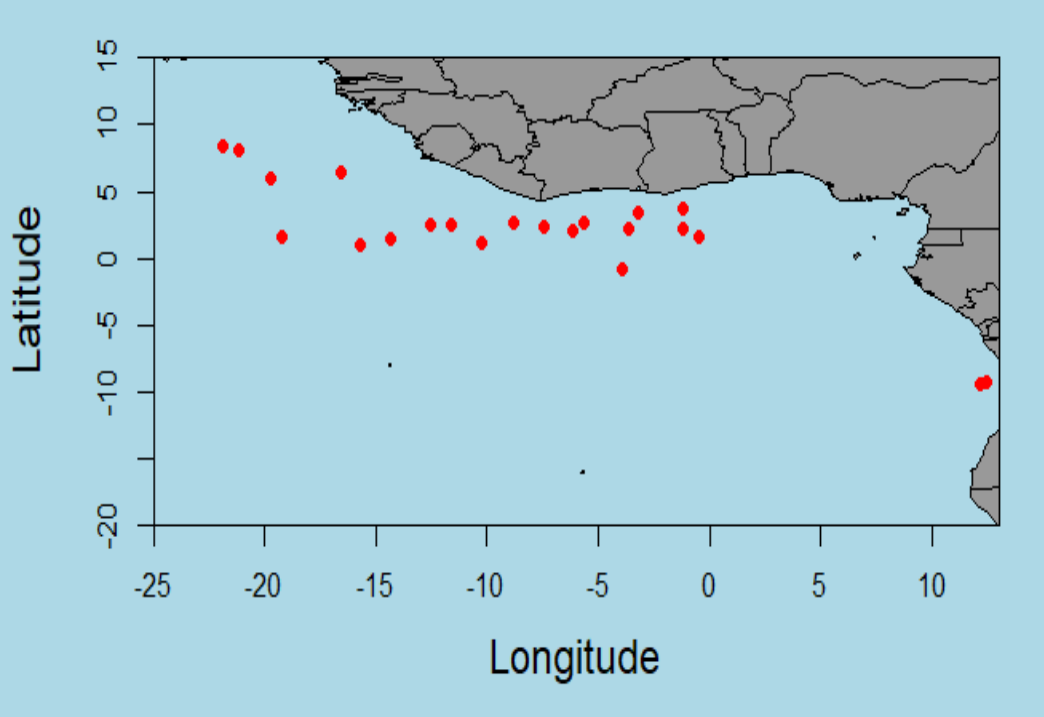

Figure 1: Fishing zone of tuna purse seine used for sampling in the Atlantic Ocean (.)

Sample of *C. crysos* came from directly on the tropical tuna purse seine fisheries operating from January to December 2016. The specimen were collected by the observer program. Fish are recovered from observers and are taken to the laboratory. A total 579 specimens were examined, ranging in size 20-45 cm fork length (LF) and 320-1499.5 g wet body weight. Each specimen, the Fork length was measured to the nearest centimeter, the weight was measured with a digital balance to the nearest 0.1 g, sex and maturity gonad stage were recorded. The stomachs contents were also recorded.

Fish gonads and stomach content analysis: The identification of the different stages of gonad development have been recorded using the classification system of Fontana [11]. The stomach contents were removed and the macroscopic food items were directly determined. Digested contents were observed under binocular microscopic or undigested to the otoliths. The different prey identified to the lowest possible taxonomic level using an identification key by FAO identification sheets for fishery needs [12] and [13]. The number of the prey in each stomach was recorded to determine the feeding pattern of *C. crysos*. Each prey item was weighed the nearest 0.01g.

Study of food item and diet: No single method of analysis of stomach contents completely describes the diet of a predator [14]. Several indices were used to quantify the importance of different prey item in diet of *Caranx crysos*. In the present study, the following formulae of these indices were used:

$$Vacuity\ index(\%VI) = \frac{number\ of\ empty\ stomach}{total\ number\ examined\ stomachs} \times 100 \quad [1]^{15}$$

$$Frequency\ of\ occurrence\ (\%F) = \frac{number\ of\ stomachs\ in\ which\ a\ food\ item\ i}{the\ total\ number\ of\ full\ stomachs} \times 100 \quad [2]^{16}.$$

$$Percentage\ of\ numerical\ abundance(\%N) = \frac{total\ number\ of\ each\ prey\ item}{total\ number\ of\ all\ prey\ in\ all\ stomachs} \times 100 \quad [3]^{14}.$$

$$Percentage\ biomass(\%W) = \frac{total\ wet\ weight\ of\ each\ prey\ item}{total\ weight\ of\ stomach\ contents} \times 100 \quad [4]\ ^{17.}$$

The diet determined using the index of relative importance (IRI) of . Pinkas *et al.*[18]. This index combines the occurrence (F), numerical (N) and weight (W) percentages.

$$IRI = \%F \times (\%N + \%W) \quad [5]$$

The index was expressed in percentage as follows:

$$\%IRI = \frac{IRI}{\sum IRI} \times 100 \quad [6]$$

Prey species were sorted in decreasing order according to IRI and the cumulative %IRI was calculated and recorded for the major prey taxa [14] and determine relationship between different maturity stage and diet profile of individual. The index value of each item is expressed as a percentage of the sum of all the indices. The food is then ordered in descending order according to the value of the percentage obtained. In this order, the index percentages of the first foods are summed up to 50% or more, these items are referred to as preferential foods; this calculation is continued until 75% or more, these items are secondary foods; the other items on the list are accidental foods.

Statistical analyses: The X^2-test was employed to compare the vacuity index (% IV) and the percentage IRI index by sex ($p<0.05$). The %IRI by sexual stage was used to compare the diet between themselves. The analyses of diet was performed on the XLSTAT software.

RESULTS AND DISCUSION

Feeding intensity: Of the 579 examined stomachs, 501 were empty (86.53%) and 78 (13.47%) containing food. The vacuity index varied with monthly, thus the highest values were observed in April, June and July (100%). The lowest was recorded in January (16.67%) (**Figure 2a**). The mean vacuity index for the male (59.08%) was significantly higher than the female (40.52%) (X^2= 17.33, p<0.05). The monthly variation of the vacuity index shows that the specimen at different maturity stages feed less and less for both sex. However, stage VI sexual maturity is the exception where only one individual has been observed with a stomach containing food. Thus, the vacuity index obtained for the stage I, II, IV and V was 86.88; 87.5; 81.88 and 78.72% respectively. The highest coefficient was recorded in stage III sexually mature individuals at 93.1% (**Figure 2b**).

These results are similar to those obtained by 8 in their study of the same species in the Gulf of Gabès in the Mediterranean. This high vacuity rate would probably be due to the stress created on the fish during their capture. Thus, regurgitation of prey contained in their stomach may have occurred, as is the case with most carangids [19]. In addition, the physiological state of the fish could also influence the food activity. Thus, the study of the reproduction of *C. crysos* has shown that the laying period, which takes place from February to March, July and October, is also the period when the emptiness coefficient reaches its maximum. In fact, the increase in gonad weight can compress the digestive tract, reduce the bolus and cause the fish to feed less [20].

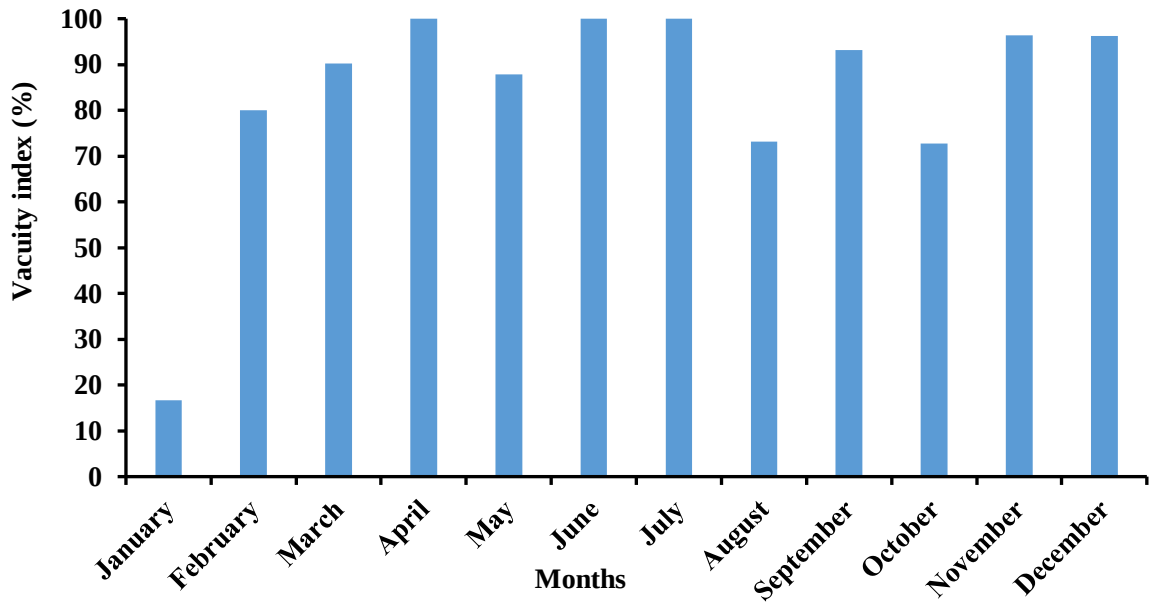

Figure 2a: Monthly variation of the vacuity index

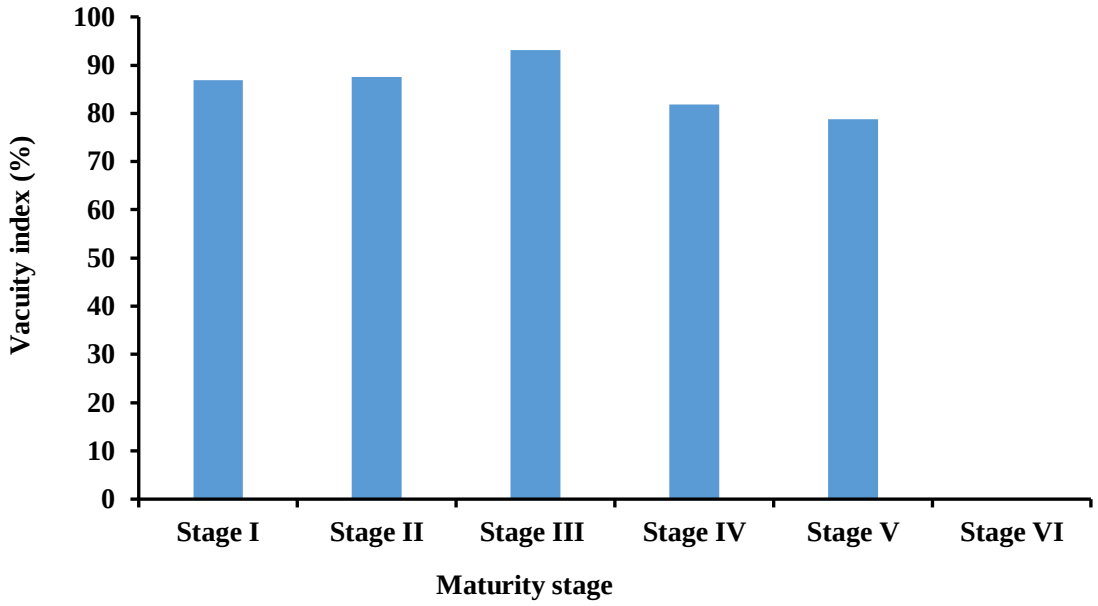

Figure 2b: Variation of the vacuity index by maturity stage

General profile of the diet: Table 1 shows the general composition of the diet in numerical percentage (% N), in percentage of weight (% P), percentage of occurrence (% F) and relative importance index (% IRI). Analysis of the 78 stomachs containing prey. Prey families were divided mainly into teleost with ten species, the group of gastropods with three species, cephalopod: one specie, the crustaceans: one specie and finally the annelids and phytoplankton. The teleost were most important prey in terms of weight (73.78%) and frequency of occurrence (79.49%); the gastropod were most numerous group (80.93%).

At the family level, Cavolinida (*Cavolinia tridentata*) were most important prey numerous (52.33%) and frequency of occurrence (42.31%). According to the percent of % IRI, the main prey were the teleost (% IRI = 59.33), the gastropod constituted the secondary prey (% IRI = 38.16). The crustaceans (% IRI = 2.23), cephalopods (% IRI = 0.26), phytoplankton (% IRI = 0.014) and annelids (% IRI = 0.003) were found occasionally. Spearman's correlation test showed that the diet of males is similar to that of females. Teleost are the most ingested prey by both sex (males is % IRI = 61.8 and females is % IRI = 56.63). Gastropods are their secondary prey (**Figure 3**).

Overall, few prey species were consumed indicating that *C. crysos* is a specialized species. Teleost were the most consumed prey although numerically snails were the most abundant group of prey. The general profile of his diet indicates that this species is a piscivore. These results corroborate those of Sley *et al.*[8]. These authors noted that *C. crysos* feeds on small pelagic fish composed mainly of Engraulidae. However, our results differ from those obtained by Keenan and Benfield [7] in the northern Gulf of Mexico. These authors indicated that *C. crysos* is a zooplanktivore. Because his diet is composed of larvae of Decapods and Stomatopods, Amphipods of Hyperidae, larvae and juveniles of fish. This observed difference implies that the diet of *C. crysos* is a function of its distribution area, but also of the availability of food in its environment. The study of the diet according to the sexes showed no difference between prey ingested by males and females.

Table 1: Prey found in the stomach of *Caranx crysos* caught by the purse seine tuna in the Atlantic Ocean

PREY	% F	% N	% P	% IRI
TELEOST	79.49	11.97	73.78	59.33
Argentina silus	1.28	0.22	0.11	0.005
Pagellus bellottii natalensis	1.28	0.22	0.11	0.005
synagrops bellus	6.41	1.77	1.1	0.2
Helicolenus dactylopterus	1.28	0.22	0.33	0.008
Climacoporus navalis	1.28	0.22	0.11	0.005
vinciguerria nimbaria	35.9	6.65	5.53	4.85
selene dorsalis	2.56	1.11	0.3	0.04
bolinichthy photothorax	1.28	0.22	0.16	0.005
Diaphus mollis	3.85	0.89	0.57	0.06
Decapterus macarellus	2.56	0.44	0.33	0.02
Fragment of fish	64.1	11.09	65.13	54.13
CRUSTACEANS	25.64	5.76	2.09	2.23
Penaeus spp	25.64	5.76	2.09	2.23
GASTEROPOD	42.31	80.93	18.6	38.16
Cavolinia tridentata	42.31	52.33	8.27	28.4
Cavolinia gibbosa	25.64	26.83	5.49	9.18
Fragment of cavolinida	7.69	1.33	3.01	0.37
Planorbella campanulata	5.13	1.77	1.83	0.2
CEPHALOPODA	3.85	0.67	5.48	0.26
Teuthida spp	3.85	0.67	5.48	0.26
ANNELIDS	1.28	0.22	0.005	0.003
PHYTOPLANKTON	2.56	0.44	0.055	0.014
TOTAL				
TELEOST	79.49	11.97	73.78	59.33
CRUSTACEANS	25.64	5.76	2.09	2.23
GASTEROPOD	42.31	80.93	18.6	38.16
CEPHALOPODA	3.85	0.67	5.48	0.26
ANNELIDS	1.28	0.22	0.005	0.003
PHYTOPLANKTON	2.56	0.44	0.055	0.014

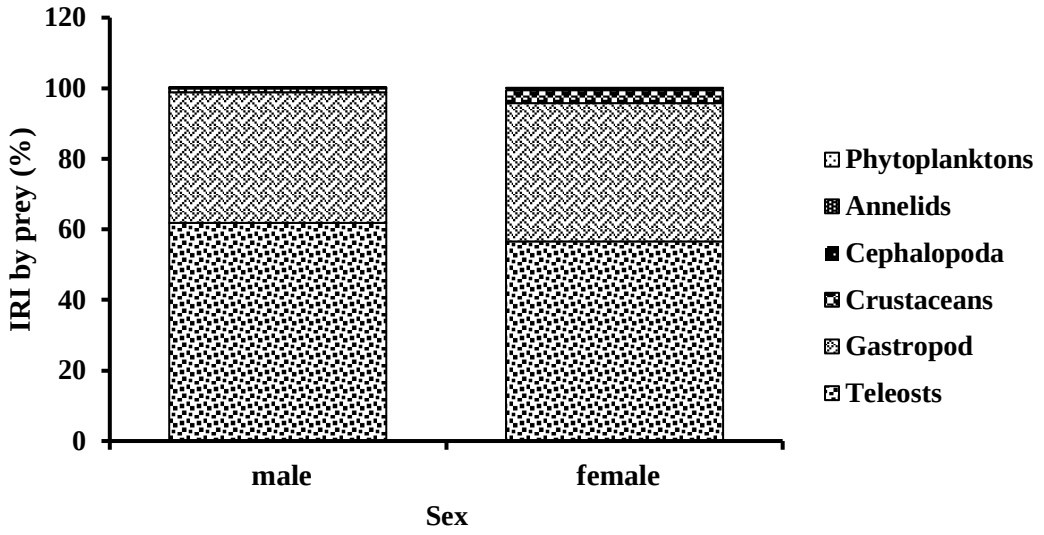

Figure 3: diet composition of *Caranx crysos* among sex based on the percentage index of relative importance values

Diet variation according to the sexual stages: The diet of specimens at different stages of maturity is very varied (**Figure 4**). However, teleost and gastropods are the staple food of these specimens. Quantitative analysis of the diet of *C. crysos* showed that in mature stage I, II, and VI, the teleost was the most ingested (% IRI = 83.47, 87.8, 100 respectively). Gastropods appear in the background for stages I (% IRI = 15.96) and stage II (% IRI = 9.92).

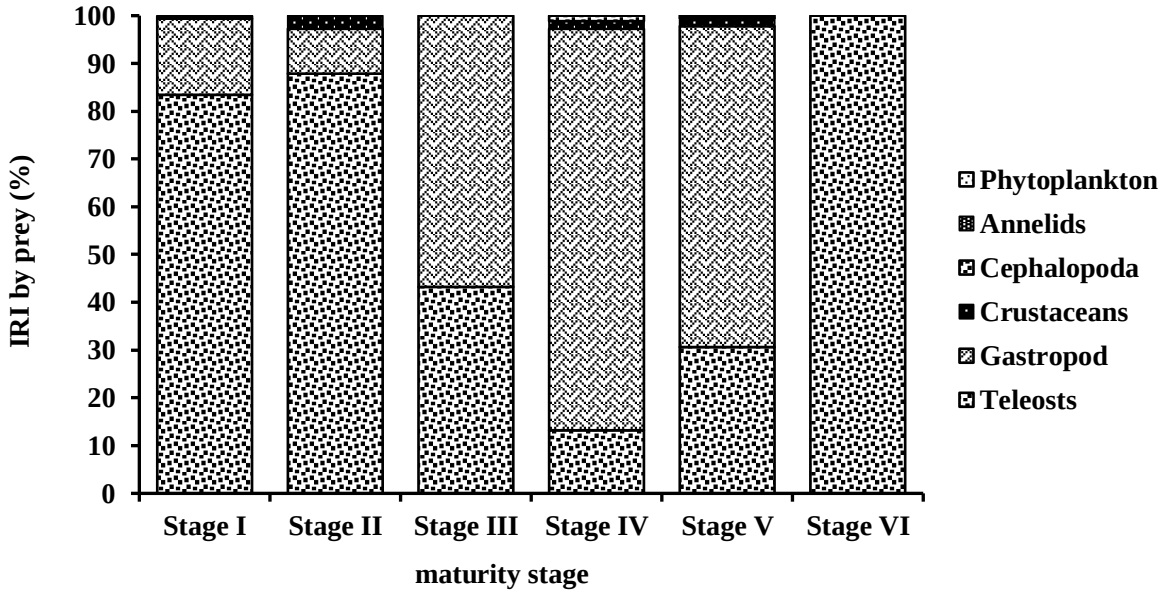

Figure 4: Diet composition of *Caranx crysos* among maturity stage based on the percentage index of relative importance values.

The food group consisting of crustaceans and cephalopods are prey occasionally consumed specimen of stage II (% IRI = 2.28) and stage I (% IRI = 0.55). No secondary or occasional prey was observed in stage VI. In contrast, in individuals of stages III, IV and V, gastropods are the preferred prey (% IRI = 56.78, 84.06 and 67.15). Teleost are consumed secondarily (% IRI = 43.22, 13.23 and 30.57). The crustacean (% IRI = 1.72), annelids (% IRI = 0.1) and phytoplankton (% IRI = 0.45) food groups are occasionally consumed by stage V individuals. IV consume occasionally cephalopods (% IRI = 1.09) and crustaceans (% IRI = 1.62). No occasional prey has been recorded in stage III. However, the study of stomach contents of *C. crysos* showed a significant difference between preys ingested by individuals at different sexual stages. This variation in diet could be explained by the fact that these individuals make choices for prey that can provide the maximum energy for the performance of migration, growth and reproduction functions. Indeed, Sánchez[21] and Ouattara *et al*. [22] have pointed out that fish dietary preference is influenced by several factors such as accessibility, abundance and energy content in the feed, that their opportunistic nature to consume only preferentially the most abundant prey in the environment. Moreover, the laying period of *C. crysos* would have been March, August and November. At these times it was found that the fish fed very little as can be deduced from the number of empty stomachs 90.21, 73 and 96.41% respectively March, August and November. Our results corroborate those of 8 in the Mediterranean in the Gulf of Gabès. These authors showed that the greatest food intensity of this species coincided with its spawning period. These results indicate that the fish would need energy during its egg-laying period with a probable selectivity of prey items. Indeed, Barreiros [23] noted that during the breeding season, females develop the protective ability against potential predators and feed only with readily catchable prey.

CONCLUSION

Study analyzed the stomach contents of *C. crysos* captured by purse seiners under FADs. The analysis revealed that the diet of this species is composed of teleost, gastropods, cephalopods, crustaceans, annelids and phytoplankton. The species is considered piscivorous because of its diet, which is dominated by teleost. The gastropods are its secondary prey. Cephalopods, crustaceans, annelids and phytoplankton are ingested incidentally. The diet of males is identical to that of females. However, ingestion of enumerated prey differs according to the sexual stages.

ACKNOWLEDGMENTS

This study was conducted with the help of Orthongel through the observer program OCUP (Observateurs Communs Uniques et Permanents). We would like to thank all the fishing masters of the CFTO and SAUPIQUET armaments vessels who allowed the collection of samples by observers on board these vessels.

REFERENCES

1. D. Herdson, *Caranx crysos*. The IUCN Red List of Threatened Species. 2010, Version 2014.3. <www.iucnredlist.org>.
2. M. Pavičić, J. Šiljić, P. Dugandžić and B. Skaramuca, New record of blue runner, *caranx crysos* (mitchill, 1815), in the Adriatic Sea. *Croatian Journal of Fisheries* 2014, **72**, 125-127. http://dx.doi.org/10.14798/72.3.743.
3. A. Sley, O. Jarboui, M. Ghorbel and A. Bouain, Annual reproductive cycle, spawning periodicity and sexual maturity of blue runner *Caranx crysos* (Pisces, Carangidae) from the

Gulf of Gabes (Tunisia, Eastern Mediterranean). 2012, doi: 10.1111/j.1439-0426.2012.02039.x. 6p.

4. M. J. Amandè, N. C. Diaha and K. J. Konan, Informations recueillies dans le cadre du programme observateur de la pêche thonière en côte d'ivoire. Collect. Vol. Sci. Pap. ICCAT. 2014, **70**(6): 2798-2800.
5. M. Goujon, Informations sur les captures accessoires des thoniers senneurs gérés par les armements français d'après les observations faites par les observateurs embarques pendant les plan de protection des thonidés de l'atlantique de 1997 A 2002. Col Vol Sci Pap ICCAT. 2004, **56**, 414–431.
6. J. M. Goodwin and A. G. Johnson, Age growth and mortality of blue runner *Caranx crysos* from the northern Gulf of Mexico. Northeast Gulf Science. 1986, **8**: 107–114.
7. S. F. Keenan and M. C. Benfield, Importance of zooplankton in the diets of Blue Runner (*Caranx crysos*) near offshore petroleum platforms in the Northern Gulf of Mexico. Prepared by the Coastal Fisheries Institute, Louisiana State University. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS. 2003, 029. 129 pp.
8. A. Sley, O. Jarboui, M. Ghorbel and A. Bouain, Food and feeding habits of *Caranx crysos* from the Gulf of Gabe`s (Tunisia). *J. Mar. Biol. Assoc.* 2009, U. K. 1375–1380.
9. R. Arfi, O. Pezennec, S. Cissoko & M. Mensah, Évolution spatio-temporelle d'un indice caractérisant l'intensité de la résurgence Ivoiro-Ghanéenne. *In*: environnement et ressources aquatiques de Côte d'ivoire : 1993. Le milieu marin (Le Loeuff P., Marchal e. & Amon kothias j.b. eds), 1993. 101-112 pp. Paris: ORSTOM.
10. M. Tomaczak and J. S. Godfrey, *Regional Oceanography: An Introduction*. Oxford, UK: Elsevier. 2003.
11. A. Fontana, Etude de la maturité sexuelle des sardinelles : *Sardinella eba* (Val.) et *Sardinella aurita* (C et V) de la région de Pointe-Noire. Cahiers d'ORSTOM, Séries Océanographiques. 1969, **7** : 101-114.
12. W. G. Fischer and W. B. Bianchi, Fiches FAO d'identification des espèces pour les besoins de la pêche. Atlantique Centre-est; zones de pêche 34, 47 (en partie) (éd) Fishbase ICLARM. Canada Fonds de dépôt. Ottawa, Ministère des pêcheries et Océans Canada, en accord avec l'organisation des nations unies pour l'alimentation et l'agriculture. 1981, pp: 1-7.
13. J. Malcolm, G. W. Smale and T. Hecht, Otolith atlas Southern African marine fishes. J. L. B. Smith Institute of Ichthyology Grahamstown, South African. 1995, 253p.
14. E. J. Hyslop, Stomachs contents analysis a review of methods and their application. *Journal of Fish Biology*. 1980, **17**: 411-429.
15. J. C. Hureau, Biologie comparée de quelques poissons antarctiques (Nototheniidae) Monaco. *Bulletin of the Institute of Oceanography*. 1970, **68** (1391): 1-224.
16. E. Rosecchi et Y. Nouaze, Comparaison de cinq indices utilisés dans l'analyse des contenus stomacaux. Revue des Travaux de l'Institut des Pêches Maritimes. 1987, **49**: 111123.
17. L. Lauzanne, Aspects qualitatifs et quantitatifs de l'alimentation des poissons du Tchad. Thèse d'Etat, Paris, ORSTOM. 1977, 284 p.

18. L. Pinkas, M. S. Oliphant and I. L.K. Iverson, Food habits of albacore, blue fin tuna and bonito in Californian waters. The California fish and Game. 1971, **152**: 1-105.
19. S. Sylla, B. C. Atsé and N. J. Kouassi, Régime alimentaire de *Trachinotus teraia* (Carangidae) dans la lagune Ebrié (Côte d'Ivoire). *Cybium*. 2008, **32**(1): 81-87.
20. N. C. Diaha, K. N'da, and Y. Soro, 2010, Régime alimentaire de *Scomberomorus tritor* (Cuvier, 1831) dans le Golfe de Guinée. *Int. J. Biol. Chem. Sci*. **4**(3): 669-680.
21. P. R. Sánchez, Stomach content analysis of *Mugil cephalus* and *Mugil curema* (Mugiliformes: Mugilidae) with emphasis on diatoms in the Tamiahua lagoon, México. *Rev. Biol. Trop*. 2002, **50**(1): 245-252.
22. S. Ouattara, N. Ouattara, D. Soro and A. Fantodji, Régime alimentaire d'*Engraulis encrasicolus* (Linneaus, 1758) du littoral de la Côte d'Ivoire. *Int. J. Biol. Chem. Sci.* 2014, **83** 916–924.
23. J. P. Barreiros, R. S. Santos and A. E. De Borba, Foods habits, schooling and predatory behavior of the yellowmouth barracuda, *Sphyraena viridensis* (Perciformes: Sphyraenidae) in the Azores. *Cybium.* 2002, **26**: 83-88.

*** Corresponding author: *N'GUESSAN Yao***

Département des Ressources Aquatiques Vivantes, Centre de Recherches Océanologiques, Côte d'Ivoire.

Email: yaoprosper2018@gmail.com

Online publication Date: 04 .12.2018