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RESEARCH ARTICLE

SEX RATIO, SIZE AND WEIGHT STRUCTURE, LENGTH–WEIGHT RELATIONSHIP AND CONDITION FACTOROF THREE DEMERSAL FISH SPECIESOF SENEGALESE WATERS, WEST AFRICA

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Abstract

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This study examined size and weight structure, length-weight relationship (LWR) and condition factor (K) for three demersal species caught by small-scale fisheries: *Cephalopholistaeniops*, *Boopsboops* and *Plectorhinchusmediterraneus*on the Senegalese coast from September 2013 to August 2014.Driftnets were the most commonly used fishing gear to catch fishes, followed by longlines n° 7 to 12 and gillnets (35-40 mm mesh).Females outnumbered malesin all seasonsin the landingssites and Length-frequency distributions varied significantly between sexes for all seasons ($P<0.05$). The value of exponent "b" of length-weight relationship of combined sexesfor*B.boops*, *C.taeniops*and *P.mediterraneus*, were found to be respectively 2.8332, 3.0938 and 2.8511. Slopes of females and males LWRsdid not differ statistically within the same season, while they differed between the warm and the cold season. Analysed data showed that the condition factor (K) of *B. boobs*was less than 1, indicating that this species was not in good physiological stateKscore of 0.95±0.13), while for *C. taeniops*and *P.mediterraneus*(K score respectively of 1.46±0.20 and 1.30±0.15) the values weregreater than 1,implied that this demersal fish was in good physiologicalcondition.The data collected provided new information on the morphological and physiological characteristics of these species' populations.

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Introduction:-

Fishing plays a significant economic, social and cultural role in Senegal. Fish is also an important source of animal protein (75%) for the Senegalese people (Food and Agriculture Organization, FAO, 2012).Monitoring the size structure of fish landings is very important in the development of fisheries resource management measures (Ba, 2013). The length-weight relationship is an important parameter in evaluating the biological parameters of fishes.It helps to understand the general well being and growth patterns in a fish population.Growth is manifested by changes in weight and length, and there is also a close relationship between these two variables (Le Cren, 1951;Baijot et al.,

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1994;. Pauly and Moreau, 1997; Lévêque, 1999). Knowledge of this length-weight relationship finds applications in biology and fisheries in the assessment of fish stocks (Kochzius, 1997; Ruiz-Ramirez et al., 1997; Le Tourneur et al., 1998; Frota et al., 2004). In addition, data deriving from the length weight relationship allow the calculation of the fish weight which only the length is known and vice versa (Ba, 2013). The seasonal specific size structure of male and female fish are also important parameters in biometric studies (Ba, 2013). Finally, LWR and size structure are essential tools of comparison among different populations of the same species living in similar or different ecosystems (Odat, 2003; Thomas et al., 2003). Condition factor refers to the well-being of a certain species and its degree of fatness, which depends on the weight ofthe fish sampled (Fafioye and Oluajo, 2005; Pauly, 1983). Different values of the condition factor of a fish indicate the state of sexual maturity, the degree of food sources availability, age and sex of some species(Williams, 2000)and the system of environment(Dhakal and Subba, 2003).

The bogue, *Boopsboops*(Linnaeus, 1758), is a teleost belonging to the Sparidae family (sea breams). This species mainly inhabits the eastern Atlantic, from Norway to Angola, and the Mediterranean Sea, including the Black Sea (Froese and Pauly, 2014). It also occurs in the western Atlantic in the Gulf of Mexico and the Caribbean Sea (Bauchot andHureau, 1986).

The African hind,*Cephalopholistaeniops* (Valenciennes, 1828), is one of the main demersal fish species caught in the Senegalese coast.It is a teleost belonging to the Serranidae family and was found at Eastern Atlantic: Western Sahara to Angola, including Cape Verde and the Sao Tome and Principe islands. Also recorded from the Mediterranean (Siau, 1994),*C. taeniopsis* considered a protogynous hermaphrodite, in which mature fish function first as females and later change into males (Shapiro, 1987).

The Rubberlip grunt, *Plectorhinchusmediterraneus*(Guichenot, 1850) is a teleost belonging to theHaemulidae family. It is found in Eastern Atlantic (Spain and Portugal to Henties Bay, Namibia) (Heemstra, 1995). *P. mediterraneus* is also foundin the western Mediterranean Sea and the Canary Islands (Ben-Tuvia and McKay, 1986; Fischer et al., 1987).

This present study aimed to providedata on size structure, length-weight relationship and condition factor for three major species sampled from the Senegalese coast: *B.boops*, *Cephalopholistaeniops* and *Plectorhinchusmediterraneus*. The hypothesis tested in this study is whether there is an effect of season and collection site on the biological parameters of size structure, height-weight relationship and condition factor.Based on the available data, this is the first report of size structure, length-weight relationships among fish populations for these species in the Senegalese coast. These results can thus contribute to the development of a comprehensive baseline data of marine fishes in this region.

Material and Methods:-

Study area

Systematic sampling of *B.boops*, *C.taeniops*and *P.mediterraneus* along the Senegalese coast (12°30′N – 14°45′N) was carried out monthlyfrom catches taken by the small-scale fisheries at two main landing locations (Fig 1): Dakar (Soumbédioune in the Cap Vert Peninsula) and Mbour (Centre West).

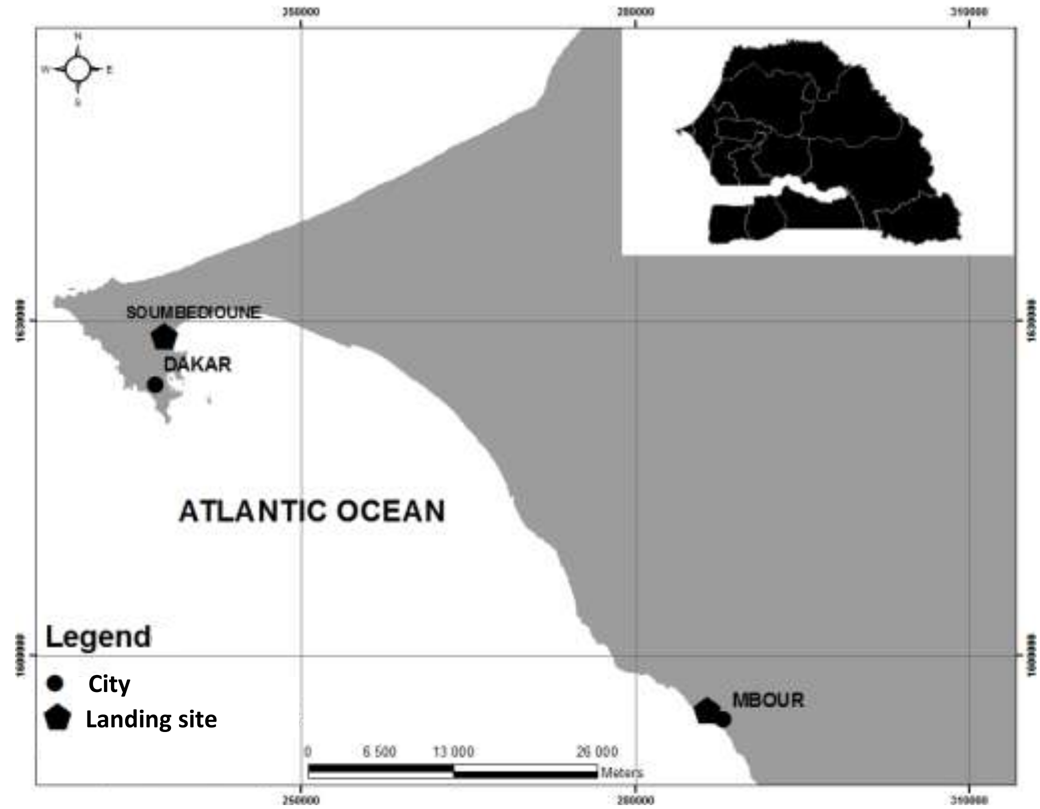

Figure 1:- Location of the two sampling sites in the Senegalese coast : Soumbédioune and Mbour.

Data collection and analysis

All specimens landed by commercial pirogues were sampled once per month at each location. The specimens were caught by several different types of fishing gear.Driftnets were the most commonly used fishing gear to catch fishes, followed by surface longlines, gillnets with mesh sizes(35-40 mm mesh) and purse-seines.A total of 569 P.mediterraneus, 569*C.taeniops* and 360B. boobswere obtained from two fish landing stations, sampled from September 2013 to August 2014 in order to calculate the length-weight relationship, the condition factor and to estimate the size and weight structures.For*P. mediterraneus*, the number of individuals collected was 277 at Mbour and 292 at Soumbédioune while for *C. taeniops*, the number of individuals collected at Mbour and Soumbédioune were respectively286 and 274. However, *B. boops*did not land at Mbour so all 360 individuals were collected at Soumbédioune.

In the laboratory, for each fishes sampled, the stretched total length (L_T) to the nearest centimeter(from the tip of the snout to the extremity of the caudal fin), the total weight (W)to the nearest grammwere measured, and the sex was determined.Individuals whose sex was not determined and hermaphrodite individuals were not considered in this study.The Length weight relationship (LWR) was estimated by using the equation:

$$W = aL_T^{\ b} \qquad (1)$$

Where W = Weight (g), L_T = total length (cm), a = Constant, b = Growth exponent and r =determination coefficient.

The “a” and “b” and “r” values were calculated from linear regression of the fish length and weight measurements. The determination coefficient r was used as indicator of the linear regression qualities (Scherrer, 1984). Growth was regarded as isometry when the value of b=3 and allometry when less or greater than 3 (b<3 or b>3).The above equation (1) and data were transformed in to logarithms before the calculations were made. Therefore equation (1) becomes:

$$\text{LogW} = \text{loga} + \text{blogL}_T \qquad (2)$$

In order to confirm whether b-value obtained in the linear regression were significantly different from the isometric value (b= 3), a student's t-test with a confidence level at ±95 (P=0.05) was applied, expressed by the following equation (Sokal and Rohlf, 1987).

$$T_s = \frac{(b-3)}{SE} \quad (3)$$

WhereTs =student's t test, b=slope, SE=standard error of the slope, and was calculated:

$$SE = \sqrt{\frac{(sW/sL)-b^2}{(n-2)}} \quad (4)$$

WheresW=variance of body weight, sL= variance of total length, n=sample size.

The factor condition is used for comparing the condition fatness or well-being (Mir et al., 2012). The coefficient of condition was calculated using the Fulton formula (Fulton, 1904)

$$K = 100\frac{W}{{L_T}^3} \quad (5)$$

Where W is the observed total weight for each specimen, L_T is the observed standard length for each specimen and K is the condition factor.

The condition factor, K was used to compare the condition of fish between different sampling sites. The significant K's test were futher analysed using the Student's t-testto compare the well being of the species from different sampling sites at P=0.05 (Zar,1984). Chi-squared (X^2) tests were used to test the hypothesis of an equal sex ratio among seasons (Zar, 1996). There are two main climatic seasons in Senegal: the warm season, from May to October (including the rainy season between July and October); and the cold season, from November to April (Barry-Gérard, 1994). A Student'st-test for seasonal differences in length-weight parameters and condition factor for each species was performed. Difference between K values of females and males in the same season was tested using the Student's t-test. All the statistical analyses were considered at significance level of 5% (P <0.05).The XLSTAT version 2015 and Microsoft Office Excel software 2014were performed in this study.

Results:-

Sex ratio

The overall sex ratios (females (F): males (M)) were respectively estimated at 1.7:1 for *B. boops*, at5.0:1 for *C. taeniops*and at1.3:1 for *P. mediterraneus*. For the three species, the overall sex ratios were significantly different from the expected ratio 1:1. Females *B. boops* outnumbered males during the warm season (1.7:1) while males outnumbered males during the cold season (0.8:1).Females *C. taeniops*weremorenumerousin the both season season with 3.3:1 and 9.5:1 values of sex ratios for warm season cold season respectively.Females *P. mediterraneus*outnumbered in the both season season with sex ratios estimated at 1.5:1 and 1.2:1 for warm season cold season respectively. Sex ratios were differ significantly between season for B. boops (χ^2 = 95, 84, p < 0.05), for *C. taeniops* **(**χ^2 = 16.99, p < 0.05) and for *P. mediterraneus*(χ^2 = 1.38; p < 0.05).

Size and weight structure

In total, 194 females (53.89%) and 166 males (46.11%)of *Boobs boobs* were analysed (Table 1).For this species, the mean total length (L_T) for females (27.85 cm ± 3.81) was slightly greater than for males (26.78 cm± 2.42). The mean total weight for females (214.99 g ± 90.79) was greater than for males (180.93 g ± 47.39) for *B. boobs*. The size for this species in warm season ranged from 20.60 to 38.10 cm (mean = 27.67 cm±3.52) and from 21.0to 35.5 cm (mean = 26.93 cm± 2.94) in cold season. *B. boobs* specimens varied in weight from 79 to 461.0 g W (mean = 204.37 g± 83.45) in warm season and from 72 to 407 g W for in cold season (mean = 196.21 g± 63.94) (Table 2).Comparison by mean size showed significant difference between females and males (p <0.05) and between warm season and cold season (p < 0.05) while comparison by mean weight showed no significant difference between females and males (p > 0.05) and between warm season and cold season.

During the study, for *C. taeniops*, 474 females (83.60 %) and 95 males (16.75%) wereanalysed (Table 1). Themean total lengthfor females (21.77 cm L_T± 3.36) was lower than for males (25.70 cm L_T± 5.59). A similar trend was observed for the mean total weights for females and males and were estimated at 163.20 (± 83.63) and 291.17 g (± 182.18). The size of in warm season ranged from 14.5 to 35.5 cm (mean = 24.04 cm; SD = 4.09) and in cold season from 14.50 to 34.50 cm (mean = 22.42 cm; SD = 4.25). *C. taeniops* specimens varied in weight from 79 to 461.0 g W (mean = 173.66 g ; SD = 110.75) in warm season and from 72 to 407 g W for in cold season (mean = 187.36 g;

SD = 122.39) (Table 2).Comparison by mean size showed significant difference between females and males ($p < 0.05$) and between warm and cold season ($p < 0.05$) while a similar trend in comparison by mean weight was observed and showed no significant difference between females and males ($p > 0.05$) and between the booth seasons.

*Plectorhinchusmediterraneus*was consisted of 327 females (57.47%) and 242 males (42.53%) during the study ((Table 1).The mean total length (L_T) for females (29.52 cm ± 5.97) was slightly lower than for males (31.51 cm± 6.39), while the mean total weight were estimated at 214.99 g (± 90.79) and 183.92 g (± 47.31) for females and males respectively. The size of in warm season ranged from 19.50 to 57.10 cm (mean = 29.30 cm; SD = 6.85) and in cold season from 55.40 to 22.00 cm (mean = 30.90 cm; SD = 5.57). *C. taeniops* specimens varied in weight from 102.0 to 2390.0 g W (mean = 383.18 g ; SD = 344.31) in warm season and from 127.0 to 2229.0 g W for in cold season (mean = 422.64 g; SD = 288.88) (Table 2).Seasonal and sexual differencesin the comparison ofmeansize and mean weight was observed in *Plectorhinchusmediterraneus*($p < 0.05$).For these three species, the length frequency distributions were different between males and females, the latter being generally larger (Kolmogorov-Smirnov, $p < 0.05$) except for *C. taeniops* which males being larger than females (Kolmogorov-Smirnov, $p > 0.05$).

Table 1:- Distribution of number of individuals according to landing season and sex by size class for *Boopsboops*, *Cephalopholistaeniops*and*Plectorhinchusmediterraneus.*

Species/Size classes	Warm season	Cold season	N	F	M	N	F/M
Boopsboops	**203**	**157**	**360**	**194**	**166**	**296**	1,17
19-24	27	25	52	32	20	52	1,60
24-29	108	89	197	92	105	197	0,88
29-34	48	33	81	49	32	81	1,53
34-39	20	10	30	21	9	30	2,33
Cephalopholistaeniops	**314**	**277**	**591**	**474**	**95**	**569**	4,99
14-19	75	53	128	99	13	112	7,62
19-24	149	133	282	264	23	287	11,48
24-29	61	56	117	93	28	121	3,32
29-34	16	23	39	18	25	43	0,72
34-39	1	1	2		5	5	0,00
39-44	1		1		1	1	0,00
Plectorhinchusmediterraneus	**295**	**295**	**591**	**327**	**243**	**570**	1,35
19-24	69	4	73	40	18	58	2,22
24-29	84	109	193	118	70	188	1,69
29-34	93	130	224	122	101	223	1,21
34-39	19	29	48	24	24	48	1,00
39-44	19	7	26	9	17	26	0,53
44-49	2	11	13	8	5	13	1,60
49-54	5	4	9	3	6	9	0,50
54-59	4	1	5	3	2	5	1,50
Total général	**780**	**698**	**1478**	**963**	**472**	**1435**	2,04

N= sample size; F=females; M=males

Length–weight relationship and condition factor

The length–weight relationship for combined sexeswere, $W=0.016L_T^{2.8382}$ g ($r^2= 0.8659$; n = 360), $W=0.0108L_T^{3.0968}$ g ($r^2= 0.9633$; n = 569) and$W=0.0215L_T^{2.8511}$ g ($r^2= 0.9684$; n = 570) respectively for *B. boobs*(A), *C. taeniops*(B)and*P. Mediterraneus*(C) (Table 2; Fig. 1, (A, B and C). These relationships was highly correlated for both males and females for the three species.

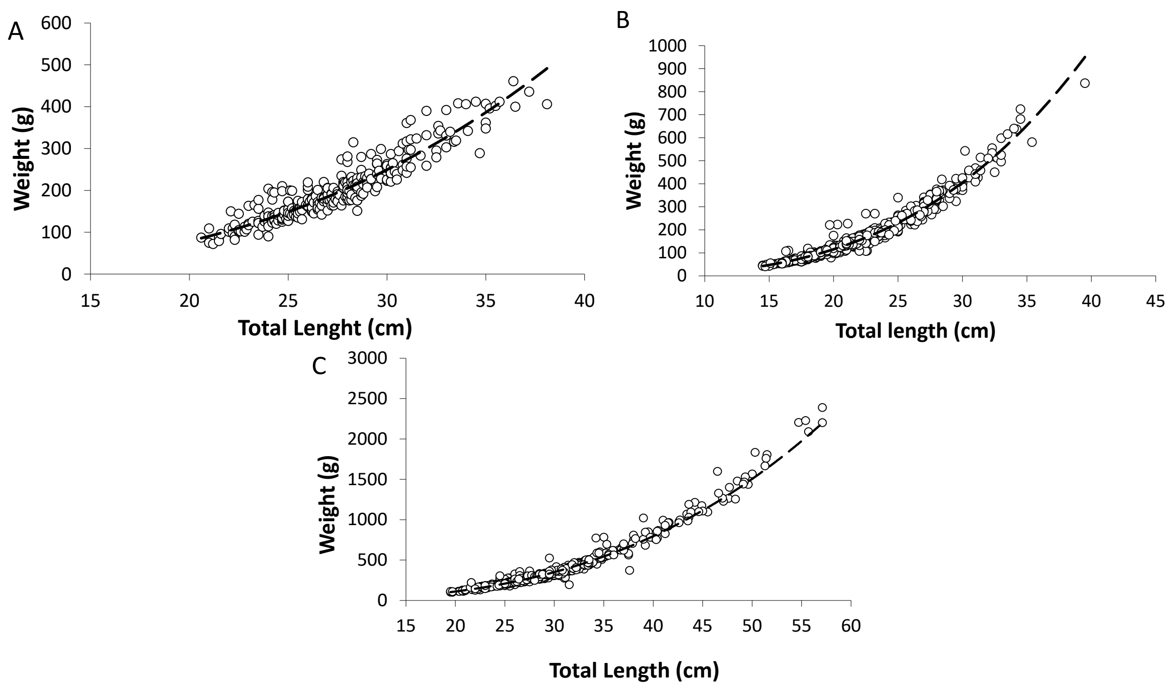

Figure 1:-Shows theLenght-weight realitionshipof the bogue *Boobs boobs* (A), the bluespotted seabass,*Cephalopholis taeniops* (B) andtherubberlip grunt*Plectorhinchusmediterraneus* (C) from the Senegalese coast.

The value of the allometric coefficient was slightly lowerthan 3, meaning that the females and males of *B. boobs*(2.9896 and 2.5775) and the males of *P. mediterraneus*(2.6083) exhibit negativeallometric growth for combined sexes (i.e. length increasedfaster than weight).However, the values of b for females of*P. mediterraneus* (3.0063) and both females (3.0613) and males (3.1480) of*C. taeniops* show positive allometric (Table 2; Figure 1, 2 and 3). The student's t-tests used to verify whether the parameter b was significantly different from the expected value of 3 showed significant difference *B. Boobs* and *P. mediterraneus* (Table 3) while no significant difference was observed for *C. taeniops*. In the present study, overall growth parameter (weight and length), r^2 values were positive and highly correlated with r >0.90between fish total length and body weight measurements except males of *P. mediterraneus.*

Table 2:- Descriptive statistics and estimated parameters of size structure, length-weight relationship for *Boopsboops*,*Cephalopholistaeniops*and*Plectorhinchusmediterraneus* from the Senegalese Coast between September 2013 and August 2014.

Species	**Sexes**	**N**	**$L_T$range (cm)**	**Wranged (g)**	**a**	**b**	**SE (b)**	**r^2**	P	**K±SD**	**K T-test**
B. boobs	F	194	20.6-38.1	72-461	0.0227	2.9896	1.8690	0.9064	-0.089	0.95±0.13	0.7401
	M	166	22.2-34.1	97-342	0.0206	2.5775	1.6722	0.8521	-0.079	0.95±0.14	
P.mediterraneus	F	327	20.3-57.1	112-2390	0.0090	3.0063	3.3082	0.9305	0.002	1.32±0.34	0.6726
	M	242	21.3-55.7	131-2229	0.0352	2.6083	3.3957	0.7687	-0.115	1.31±0.17	
C. taeniops	F	474	14.5-33.0	45-496	1. Exp-5	3.0613	1.1372	0.9457	0.054	1.46±0.19	0.0166
	M	95	14.5-39.5	43-837	7. Exp-6	3.1480	3.3631	0.9769	0.044	1.47±0.24	

* N= sample size; $L_{T=}$ total length, W = body weight; a = intercept; b = slope of length-weight relationship; SE= standard error of the slope b, r^2: coefficient of determination; P-value for t-test comparing differences for isometric growth (b = 3); K= condition factor; K T-test: t-test = P-value for t-test comparing differences for condition factor; SD: standard deviation

Both seasons showed significant differences in the condition factor for *C. taeniops* (t-test = 0.009; P<0.05) while no significant difference was observed in the condition factor for*B. Boobs*(t-test = 0.40; P >0.05) andfor*P. mediterraneus*(t-test = 0.69; P >0.05) (Table 2). K values were significantly different between females and males for *C. taeniops* but significant difference was observed betweenboth sexes for the *B. boobs* and *P. mediterraneus* (t =0.74, and 0.67 respectively;p <0.05). On the other hand, the K values of both females and males did not reflect statistical difference between sampling sites for *P. mediterraneus*(t-test =0.42; P > 0.05) but significant difference was observed in sampling sites for *C. taeniops*(t-test =0.00; P < 0.05).

Discussion:-

Sex ratio

The population of these three species showed an overall sex ratio in favour of the females. Our result are in accordance with Kara and Bayha (2015) for the bogue in Izmir Bay, Aegean Sea, Turkey. However, Bottari et al. (2014) found for this species an equally distribution among size classes between females and males. The sex-ratio data of P. mediterraneusindicated also a dominance of females in Senegal waters. A similar pattern was found for its congers as *P. flavomaculatus*(Muragi, 2002) and *P. pictum*(Grandcourt et al., 2006). Unequal sex ratios may be a consequence of sexual segregation resulting of sex-reproductive strategies, sex-specific dietary requirements or sex-specific swimming capabilities (Wearmouth and Sims, 2008). The sex ratio of *C. taeniops* is more difficult to assess. Individuals for this species whose sex could not be identified were excluded from the study. Indeed, Serranids as the *C. taeniops*are sequential hermaphrodites with natural sex reversal, expressing protogyny (Siau, 1994). The regression of the female gonad and the increased male tissue indicate the exchange of sex in *C. taeniops* individuals (Lo Nostro et al., 2004). Siau (1994) reported in Senegal that*C. taeniops* followed a sequential protogynous, hermaphrodite model with young bisexual individuals and transitional individuals (hermaphrodites). A similar result was also observed by Liu and Sadovy (2004)for *C. boenak*.

Size and weight structure

The maximal sizes recorded in the present study for B. boobs, i.e. 34.1 and 38.1cm for males and females respectively, were greater than those recorded in previous studies in the northeastern Mediterranean Sea i.e. 20.2 cm (ÖzvarolandGökoğlu, 2015) and in Izmir Bay, Aegean Sea, i.e. 27.9 cm (Kara and Bayha, 2015) (Table 3). The size of the bogue is more common between 10 and 25 cm L_T (Bauchot and Hureau, 1986; Relini et al., 1999). The size structure of fishes could be affected in response to changes in the abundance of individuals or in response to high pressure of fishing. In Izmir BayKara and Bayha (2015) stated this fact for the bogue. The maximum reported total length for *C. taeniops* is 70 cm L_T (Reiner, 1996) was clearly larger than our result. Siau (1994) reported that the most fished specimens for this species ranged from 20 to 30 cm and this finding is more consistent with that in our study. According to Pereira et al. (2012), most of fished specimens ranged from 25 to 40 cm in Cape Verde waters.

Total length ranged from 10 to 90 cm for *C. taeniops* in Ivory coast (Kouassyet al., 2010), while in this study it is from 14.5 to 33 cm for females and from 14.5 to 39.5 cm for males(Table 3). The common length is 40 cm (LT). It lives in the Eastern Atlantic (Rocha, 2018). A maximum length at 70.0 cm (TL male/unsexed) was recorded in the Cape Verdean waters (Reiner, 1996). Individuals measuring between 29.40 and 29.60 cm were observed in Libyan waters (Abdallah et al., 2007), and one individual measuring 28.5 cm (total length) and weighing 513 g was recorded in the Aegean Sea (Engin et al., 2016). Sending sizes of up to 30 cm have been recorded in the Canary Islands (Brito et al., 2011). Our study provided the first size data on the species in West Africa. Even if they are covered by the size ranges found in the Mediterranean, they will allow to better know the species and to consider further studies on the species.

P. mediterraneusis a coastal bottom fish that can reach a maximum standard length at 80 cm(Ben-Tuvia and McKay,1986). The maximum size attained by *P. mediterraneus* in this study 57.1 and 55.7 cm for males and females respectively varied slightly with those of other reported by Franqueville and Freon (1976)i.e. 53 cm. Pan et al. (2015) estimated for *P. mediterraneus* a total length ranged from 21.50 to 57.60 in the Cape Verde peninsula (Senegal) (Table 3). This total length range was evaluated by Santos et al. (2002) between 28.0 and 52.5 cm in the Southern Portugal.Changes inmaximumsizeofanareatoanotherfor these speciescould be explainedby changes inoceanfisheries, which can lead tobiologicalvariationamongpopulationsasthe maximum sizeandby changes infishing techniquesora local reductionofthe size of thisspecies due tohigh mortality (Walker and Heessen, 1996).

Length–weight relationship and condition factor

Size structure, LWRs and condition factor are used to describe main life-history trait characteristicsand provided information on the physiological state of the fish in relation to its welfare(Gonçalves et al., 1997).These biological parameters made comparisons between different fish species, or between fish populations in different habitats (Andrade and Campos, 2002). Our studyhighlightedcrucial data in the fisheries biology and assessments for*B.boops*, *C.taeniops*and *P.mediterraneus*.

Parameters "b" of the relationship LWRs for the three species were henceforth available. The b value represents the body form, and it is directly related to the weight and length, affected by ecological factors (temperature, food supply, and spawning conditions) and other factors (sex, age, fishing time, area, and fishing vessels) (Ricker, 1973). Overall, the value of "b" varied from 2.70 to 3.15 in this study. This range of the value of "b" is consistent with those usually reported and accepted by the literature.This value ranged between 2.50 and 3.50 (Pauly and Moreau, 1997). Other studies haveconducted research on the LWRs of species targeted in this study in different localities (Table 3).

Table 3:-Comparison of total length range and weight-length relationships parameters for *Boopsboops*, *Cephalopholistaeniops*and*Plectorhinchusmediterraneus* from the Senegalese Coast between September 2013 and August 2014 with previously published by several authors.

Species	n	$L_T$range (cm)	b	r^2	Countries	Authors
Boobsboobs	360	22.2-38.1	2.7281	0.8115	Senegal	Presentstudy
	932	11.3-27.9	3.2370	0.956	Turkey	Bayhan and Kara, 2015
	124	10-20.2	2.0820	0.8760	Turkey	ÖzvarolandGökoğlu, 2015
	1808	8.1-33	3.1390	0.9900	Italia	Bottariet al., 2014
	929	10-25.9	2.6864	0.9500	Montenegro	Markovicet al., 2013
	243	12-26	2.9800	0.9700	Tunisia	Cherifet al., 2008
Cephalopholistaeniops	569	14.5-39.5	3.0968	0.9633	Senegal	Present study
	65	24-44	3.1470	0.9650	Cape Verde	Pereira et al., 2012
	116	34-59	3.1100	0.7300	IvoryCoast	Kouassiet al., 2010
	162	-	3.2000	0.9700	Cape Verde	Magnùsson and Magnùsson, 1987
Plectorhinchusmediterraneus	569	20.3-57.1	2.8507	0.9671	Senegal	Present study
	270	21.5–57.6	2.9400	0.9800	Senegal	Pan et al., 2015
	33	28.0-52.5	3.3300	0.9740	Portugal	Santos et al., 2002
	107	15-53	2.9480	0.9986	Senegal	FranquevilleetFréon, 1976

n= the sample size; L_T=total length; b = slope of length-weight relationship of combined sex;r^2 = the coefficient of determination.

For *B.boops*, there is a lot of data from LWR studies in the literature (about 30) but almost all of them concentrated in the Mediterranean region, covering a size range from 5 cm to 36.2 cm L_T. This study gives unique data in the area for this species. This study provides a new maximum length of 38.1 cm L_T (only 1.9 cm more). However, the estimates of parameters "a" and "b" of the equation are well within the known range for this species described elsewhere in other regions.The length-weight relationship of *B. boops*in this studyshowed a negative allometry (b<3) and it is consistent with the result reported by Anato and Ktary (1986), Zoubi (2001), Valle et al.(2003),Dulcic and Glamuzina (2006) and by ÖzvarolandGökoğlu (2015)in the northeastern Mediterranean Sea. However, a positive allometry for *B. boops*has also been reported in previous studies (Allam, 2003; Karakulak et al., 2006; Kara andBayhan, 2008). The result of this study agreed with those reported from others areas of the species according to Marcovicet al. (2013) with "b" value evaluated at 2.7443 and 2. 6864 respectively for females and males. In comparison, the value of "b" in *B.boops*in our study Senegal (2.7281) is less than that observed in Tunisia i.e. 3.086(Gaamouret al., 2003). This difference could be due to less favorable ecological conditions for the species in Senegal.

Length-weight relationships study for *Cephalopholis* species **(Serranidae) landed on the south coast of Kenya revealed some b values comprising beween 2.89 and 3.22** (Agembeet al., 2010). These results were very far to those found in our study for C. taeniops.The b-value reported for this specieswas consistent with that reported for this species in other regions; i.e.3.11 in Ivory Coast (Kouassiet al.,2010), 3.20 in Cap Verde (Magnússon and Magnússon, 1987; Pastor, 2002).

For*P mediterraneus*, our study corroborated with the value found for its congeners i.e. *P. pictus*,*P. gibbosus*,*P. goldmnnni*,*P. obscurus* and*P. Picus*(Kulbickiet al., 1993).When b> 3, the fish grows faster in weight than in length such as observed for *C. taeniops* in both locations in this study. When the value of b < 3.0, the fish experiences a negative allometric growth such as observed for*B. boobs*and *P. mediterreanus*(Pervin and Mortuza, 2008). The differences between the "b" values could be explained by the Changes in "b" responded mostly to differences in the sample size and in the covered length range,but also to species morphology and environmental factors such as: temperature, salinity, food (quantity, quality and size), sex, health and developmental stage)(Sparre, 1992). For *Plectorhinchusmediterraneus*(Guichenot, 1850), we have several estimates of LWR in the literature. The fish reaches a SL max of 80 cm (=$L_T$max of about 86 cm) with a common size range between 20 and 55 cm (Franqueville andFréon 1976; Santos et al., 2002; Pan et al., 2015). Such a size range seems very far from the sizes observed in landings in our study in Senegal. This study covers only a size between 14.5 and 39 cm L_T, and thus less than the size range previously known in the area. Could this be a reduction in the size of the species in response to high fishing pressure, or a sign of the beginning of a decline of the species or insufficient size coverage of this species? Sampling in a broader spatio-temporal framework could certainly give more reliable answers. Therefore, the estimate of LWR in this study is only of local or sub-regional interest and is probably not very species-specific on a global scale, as the upper size classes are missing. Although the new LWR data in this document are consistent with those previously published in the study area (FranquevilleandFréon 1976; Santos et al., 2002; Pan et al., 2015) they are of great value for fisheries management at the local and sub-regional level.

This information releated to LWRsis necessary for the purpose of fisheries management in the Senegalese waters as well as for the estimation of the biomass of these species and encourage further length-weight relationships studies for others species. The high correlation coefficient "r^2" = 0.9 obtained in this study showed that there was strong association between fish total length and body total weight measurements. This means that as the length of the fish increases, the weight also increases proportionnaly. This was in agreement with previous studies on different fish species from various water bodies (Tahet al., 2012; Koffi et al., 2014).This means that there is a positive correlation between length and weight of *B. boops*,*C. taeniops* and *P. mediterraneus*from the Senegalese coasts.

The condition factor of a fish reflects physical and biological circumstances and fluctuations by interaction among feeding conditions, parasitic infections and physiological factors (Le Cren, 1951). This study revealed that the female and male individuals for B. Boobs and P. mediterraneushad the same condition factor in the same seasons (no significant difference was found in condition factor of females and males within seasons). There was also no significant difference in K between sexes (t-test, P > 0.05) for *B. Boobs* and *P. mediterraneus*. However, condition factordiffered between seasons for of females and males *C. taeniops*(t-test, P < 0.05). This study revealed that for female and male individuals, significant difference was found in condition factor for *C. taeniops* while the contrary was recorded for *P. mediterraneus*between the both locations, Soumbédioune and Mbour.In these sampling sites,for*C. taeniops*and *P. mediterraneus*the condition factors indicated that fish were doing well in the Senegalese coasts. However, Sarkar et al.(2013) noted also that condition factor is not constant for a species or population.

In studies of population dynamics high condition factor values indicates favourable environmental conditions (such as: habitat and prey availability) and low values indicate less favorable environmental conditions (Blackwell et al., 2000).It reflects the well-being of the fish (Aboweiand Davies, 2010) and is an index to access the status of the aquatic ecosystem (Edah et al., 2010). Braga (1986)showed that values of the condition factor vary according to seasons and are influenced by environmental conditions. The condition factors for both *B. boobs*in soumbediounesampling site was less than 1 and indicated that this species fish was not doing well in the Senegalese coasts. This result was consistent with those found by Markivicet al. (2013). The K value obtained for *C. taeniops*and *P.mediterraneus* in sampling sites was greater than that of *B. boobs* and suggested that the fish was in good condition.

Conclusion:-

An important outcome from this study is information on the sizestrucure, the WLRs and K values in different seasonsand sites sampling for *B. Boobs*, *C. taeniops*and *P. mediterraneus*from Senegalese coast as a basis for stock assessment and management.The results will be not only useful for fishery research, but also for the fishery management of these fishes in natural waters.

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