Contribution To The Study Of Reproduction Parameters Of The European Conger Eel (*Conger Conger*; Linnaeus, 1758) From The Western Algerian Coasts, Oran Bay (Algeria)

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Abstract: The demographic structure of the population of the European conger eel (*Conger conger*; Linnaeus, 1758) from the Western coast of Algeria is made up of young individuals who enlarge more quickly than they grow. The estimated parameters of growth using the equation of Von Bertalanffy are: For females: $L\infty$ = 134 mm ; K= 0,13 ; to = -0,69. For males: $L\infty$ = 108 mm ; K= 0,23 ; to = -0,67 The specimens with most advanced stage of maturation appeared from February to April 2012 for both, female and male. The size at the first sexual maturity was 78 mm in males and 88 mm in females. The sex-ratio was in favor of the females lasting almost all the year excepting during September, December (2011), and January 2012 for males.

Keywords : *Conger conger*, growth, reproduction, western Algeria coasts

1.INTRODUCTION

The European conger eel, *Conger conger* L. (Osteichthyes, Congridae) is a benthic specie living in rocky and sandy bottoms between 10 and 1000 m (Culurgioni et *al*., 2006). It is widely distributed in the Eastern Atlantic, in the Western Black Sea and it is very common in all the Mediterranean Sea (Relini et *al*., 1999). The specie constitutes an important commercial and recreational fishery resource that is caught by bottom trawl, hook and line (Figueiredo et *al*. 1996). Despite being a geographically widespread species and an important fisheries resource, little is presently known about the life history traits of this species, namely its reproductive biology, spawning area(s) and migratory patterns (Correia et *al*. 2012). In the Western Mediterranean Sea of Algeria, it is the most exploited Congridea. Mazouz et *al.* (2014) and Abi-Ayad et *al* (2011) described the histological oogenesis and spermatogenesis respectively of the *C.conger* from the Western Algerian coasts. However, no studies on growth and reproduction parameters of this important benthic species from South shore of Mediterranean Sea have been published (Mazouz et *al*. 2014., Abi-Ayad et *al*. 2011). In this paper, we provide the first observations of growth and reproduction parameters of European conger eel fishing in Western coasts of Algeria, in Oran. This fish is disembarked and sold in the hall to fish port Oran.

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2.MATERIALS AND METHODS

Sampling strategy

The sampling frequency was monthly between March 2011 and February 2012. Samples were obtained by purchasing a case of European conger eel at the fishing port of Oran and stored in a cooler with cold accumulator before returning directly to the laboratory. The sex of all individuals were determined by macroscopic examination of the gonads of mature specimens but microscopic examination was used for differentiating sex in juveniles, from a total of 770 sampled conger, 450 were females, 221 were males and 99 were sex indeterminated.

Study of growth

Length and weight

All European conger eel were measured (total length, TL, in mm) and weighed to the nearest 0.01 g. The liver (Wf) and gonad (Wg) weights were taken.

Growth parameters

The model parameters growth Von Bertalanffy equation:

$$(Lt = L\infty\ [1- \exp(-K(t-to)])$$

(Where: Lt = length at age t, L∞ = theoretical maximum length (asymptotic), K = growth coefficient, proportional to rate at which L∞ is reached, to = theoretical age at L = 0 (often negative, or zero) were estimated from the analysis of the frequency distribution of size using the LFDA program (Length Frequency Distribution Analysis). The method used is ELEFAN, based on the algorithm described by Pauly (1987).

Growth weight

It is the relationships between the length and weight in the studied species (Le Cren 1951):

$$W = aL^b$$

Where *W* is the weight of fish (g), *L* the length of the fish (mm), *a* constant and *b* the rate of allometry. Parameters *a* and *b* of the length-weight relationship was estimated by linear regression analysis based on logarithms:

$$log\ (W) = log(a) + b\ log\ (L)$$

The ratio of allometric *b* varies from 2 to 4, but it is most often close to 3. Isometry growth *b* = 3 (the specific density of the animal not changes). Positive allometry *b* > 3, the character of fish increases faster than its body size. Negative allometry *b* < 3, the fish character increases slower than its body size.

Study of reproduction

The sex ratio

The sex ratio studies provide information on the representation of male and female fish present in a population. It's the proportion states of male to female fish in a population and indicates the dominance of sex of fish species in a given population.

SR = F x 100 / (M+F) and *S.R = M x 100 / (M+F)*

with : S.R : sex ratio, F : females and M = males

Length at first sexual maturity

There is no exact length after which sexual maturation begins, therefore we adopted as size at first sexual maturity, that at which 50% of the individuals constituting a population have entered the gonad maturity stage (Vazzoler, 1996). To establish the percentage curve of mature females or males by length class, we counted during the reproductive cycle the number of females or males who have reached or passed the stage III compared to the total number of females or males by length class (Layachi et *al*., 2007).

Gonadosomatic index

The period for reproduction of mature congers was determined by calculating the gonadosomatic index (*G.S.I.*) which is an index of gonad size relative to fish size. It's a good indicator of gonadal development in fish (Dadzie and Wangila,1980). The gonadosomatic index was calculated according to Bougis 1952 as follows:

G.S.I. = weight of gonad x 100 / weight of fish

Hepatosomatic index

Liver weight changes, influenced by gonadic conditions was used to define the spawning periods in teleosts; Indeed, the development of sexual products is closely related to the physiological phenomena which occur in the liver (Thiam 1980) and also provides an indication on status of energy reserve in an animal. Hepatosomatic Index (*H.S.I.*) was defined as the ratio of liver weight to body weight. The hepatosomatic index was calculated according to (Htun-hun, 1978).

H.S.I. = weight of liver x 100 / weight of fish

Statistical Analysis

All data were expressed as mean ± standard deviation and were statistically compared by one-way variance analysis or ANOVA 1 (for gonadosomatic index, G.S.I.) and by non parametric variance analysis of Kruskal-Wallis and MannWithney U-test (for hepatosomatic index, H.S.I.) (d'Hainaut, 1975 a, b).

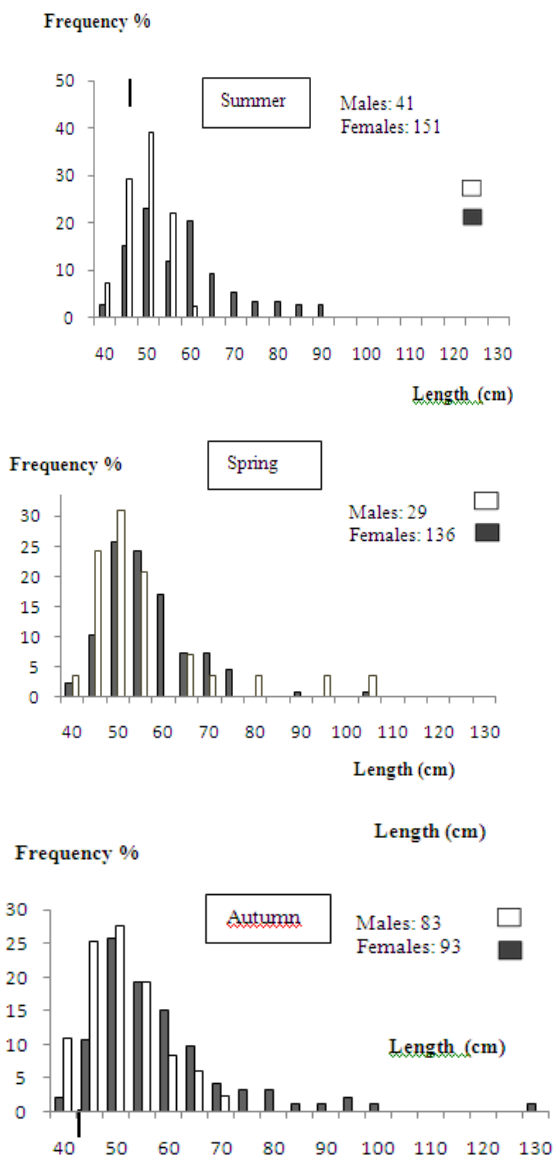
3.RESULTS

Growth

Size structure of European conger eel population

Figure 1, illustrated the frequency length (length total) in females and males of European conger (*C. conger*) at different seasons the demographic composition analysis, showed that catches focus on length was ranging for:

- Females: from 40 cm to 130 cm of length with domination from 45 cm to 70 cm in summer and spring, and 45 cm to 65 cm in winter and autumn.
- Males: from 40 cm to 115 cm of length with domination from 45 cm to 55 cm in summer, spring and winter, and 55 cm in autumn.



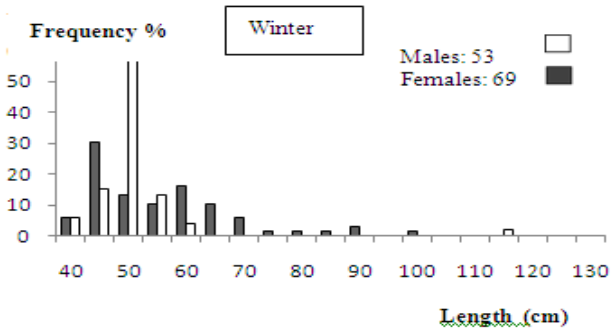


Fig 1: *Structure length in females and males European conger eel (C. conger).*

Growth

Figure 2 represented the relationships between the length and weight of the European conger. The allometric scaling of females and males of *C. conger* is higher than 3:

- Females allometric scaling: 3.35
- Males allometric scaling: 3.57

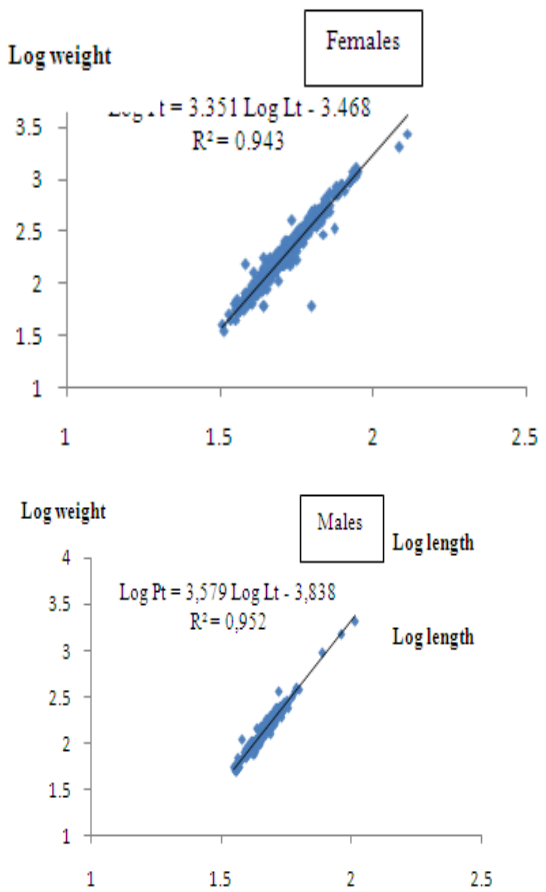


Fig 2: *Relationship between the log of weight (W) and the log of length (TL) for* C. conger.

The presence of many false rings in the *C.conger* otoliths makes their use for the growth study difficult (Correia et *al*. 2009). Using LFDA software, make us possible to estimate growths parameters of Von Bertalanffy equation (Table 1).

Table 1: *The Von Bertalanffy equation values*

	L ∞	K	t_0
Males	108	0.23	-0.67
Females	134	0.13	-0.69

Reproduction

Gonadosomatic Index (G. S. I.):

G. S. I. for males (Fig. 3) was higher in March (1.72% ± 1.4%) and April (1.86% ± 2.64%) 2011 then decreased significantly in May ($p < 0.05$). Between May 2011 and January 2012, G.S.I. value remained stable and the data revealed no significant variations ($p \geq 0.05$). In February 2012 the G.S.I. increase again ($p < 0.05$). For females (Fig. 3), G.S.I. was higher in March 2011 (1.45 % ± 0.83 %), then decreased significantly ($p < 0.05$) in April. Between April and December 2011, G.S.I. value remained stable and the data revealed no significant variations ($p \geq 0.05$). In January 2012, G.S.I. increased significantly ($p < 0.05$) again and reached to (1.15 % ± 0.66 %).

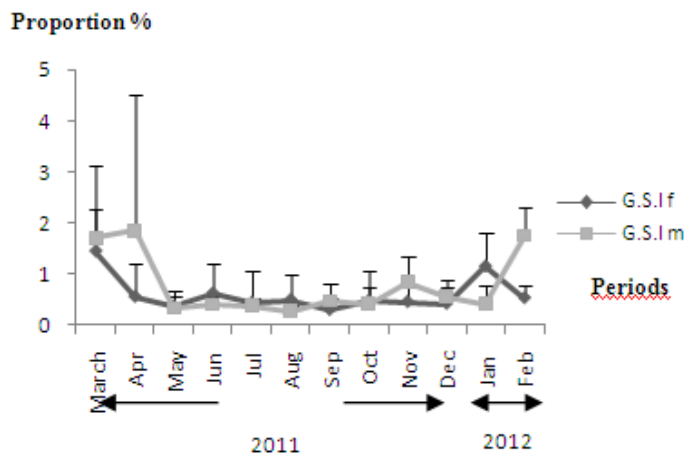


Fig 3*: Time evolution of G. S. I. (mean ± standard deviation expressed in %) in females and males European conger eel (C. conger).*

Heptosomatic Index (H. S. I.)

The Highest values of females H.S.I. (Fig 4) were observed in March (1.8% ± 0.51%), July (1.75% ± 0.61%), September (2011) (1.84% ± 0.21%) and January (2012) (1.98% ± 0.66%) ($p \geq 0.05$). Then the lowest H.S.I. was observed in April (2011). For males, the H.S.I. values are shown in Fig. 4. No significant differences among data obtained ($p \geq 0.05$), during all sampling period from March 2011 to February 2012.

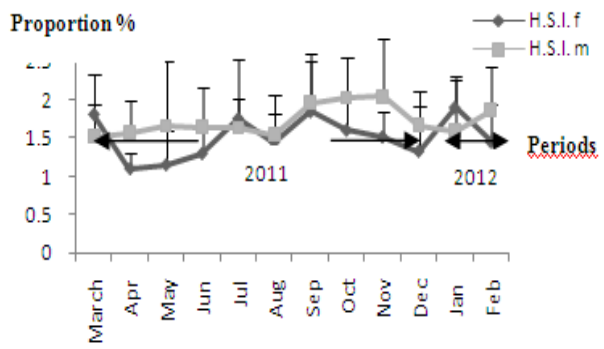


Fig 4: *Time evolution of H. S. I. (mean ± standard deviation expressed in %) in males and females European conger eel (C. conger).*

Size at first sexual maturity

The examination of sexual maturity concerned the gonads of European conger eel *(C. conger*) belonging to stage III or more, because those in stages I and II were immature. The mean size at first sexual maturity was estimated as 88 cm for females and 79 cm for males (Fig 5).

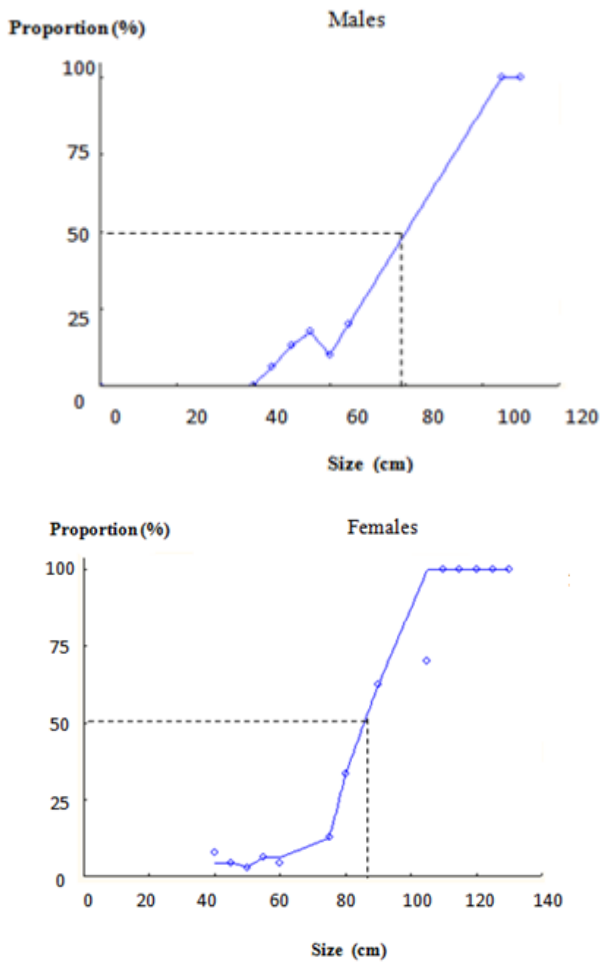


Fig 5: *Observed (dots) and estimated (lines) proportion of mature European conger eel (C. conger) of varying body lengths.*

The sex ratio temporal variations

A temporal variation in the sex ratio (Fig. 6) in *C. conger* was characterized by a predominance of females during the spring, the summer and the autumn, while males predominated during late summer and the winter period.

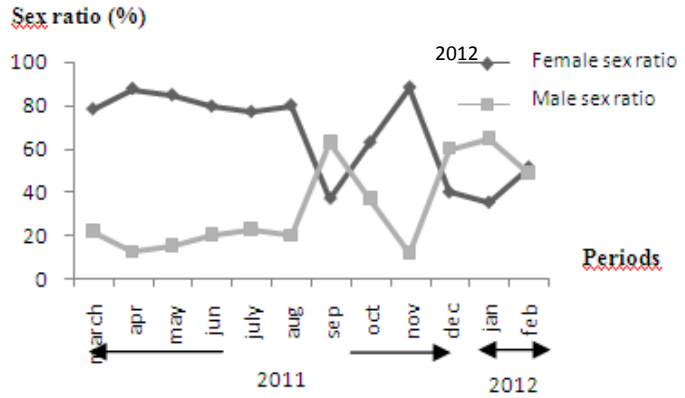


Figure 5: *Observed (dots) and estimated (lines) proportion of mature European conger eel (C. conger) of varying body lengths.*

4.DISCUSSION

Growth

The demographic structure obtained for the European conger eel characterized a population exclusively composed of young individuals. In this study, it was impossible to know the fishing gear used during the fishery. The small populations that dominate in the study area can be explained by the gradual increase in fishing effort expressed by the increase in the number of trawlers and small boats and exploitation the same areas of fishing. However, Sullivan et *al*. (2003) showed in Irish coastal waters the absence of small fish between 68 to 80 cm. This was associated with the selectivity of the fishing gear rather than indicating the absence of the small individuals. Similar results have been already reported by Correia et *al*. (2009). The allometric scaling '*b*' for both females and males of *C. conger* was greater than 3 and was consistent with other results obtained in other area (Tab 2).

Table 2: *Growth parameters results for the C. conger*

	Sex	Area	b	a	r	L∞	K	t_0
Flores-Hernandez, 1990	female	gulf of gascogne	-	-	-	228,8	0,068	-2,4
	male		-	-	-	94,8	0,27	-0,068
Fannon et *al.*, 1990	female and male	Celtic Sea	-	-	-	265	0,063	-0,38
S. Sullivan et *al.*, 2003	female	Celtic Sea	3,46	-3,65	0,95	272	0,04	-1,4
A.T. Correia et *al.*, 2009	female	Portugal	3,36	-3,39	0,98	265	0,07	-1,2
Presente study	female	Western Algerian coast	3,35	-3,46	0,97	134	0,13	-0,67
	male		3,57	-3,83	0,97	108	0,23	-0,69

Several authors reported different values from various regions of the Von Bertalanffy growth parameters (Tab 2) (Flores – Fernandez, 1990; Fannon et *al*., 1990; Sullivan et *al*., 2003; Correia et *al*., 2009;). These parameters differences in Western Algerian coasts, Oran bay and others regions might have biological reasons, but are due more likely to technical

reasons such as different sample sizes, and different gear selectivity.

REPRODUCTION

The females G.S.I. presents two peak, the first in early winter, in January 2012, (1.15 % ± 0.66 %) and the second in the late winter, in March 2011, (1.45 % ± 0.83 %), and reached the lowest value in autumn. However, the higher values of males G.S.I. were observed in winter, in February 2012 (1.77 % ± 0.52 %), and in spring in March 2011(1.72 % ± 1.4 %) and April 2011 (1.86 % ± 0.88 %) and reached the lowest value in autumn and summer. Similar findings have been reported by Hood and *al*., (1988) and Sullivan et *al*., (2003) on *Conger. oceanicus* and *C.conger*, respectively. Nevertheless, Correia et *al*., (2009), showed that the G. S. I. was lowest in autumn and high during winter and spring seasons. This was probably due to mobilization of somatic energy for the development of ovaries. The decline of G.S.I. from April to December 2011in female and from May 2011 to January 2012 in male may be due to the migration of the broodstock. Indeed, the reproduction is carried out in deep water, south-east of Sardinia in the Mediterranean Sea. A spawning ground exists in the Sardinia channel at depths between 600 and, at least, 800 m in the Mediterranean Sea (Cau and Manconi, 1983). The females H.S.I. showed two pairs of peak, first in winter, in January 2012 (1.89 % ± 0.36 %) and March 2011 (1.80 % ± 0.51 %), and the second in summer, in July 2011 (1.75 % ± 0.78 %) and September 2011 (1.84 % ± 0.66 %). The summer peaks coincided with hepatic fats deposits due to intense feeding activity, probably because of the abundant food, useful for fish gonad maturation (Abi-Ayad et *al*., 2011). The peaks measured in January and March was correlated with the dynamic of G. S. I. these can be explained either by the action of liver (precursor synthesis products involved in oocyte growth) or by increasing enzyme activity necessary for vitellogenesis (Medford and Mac kay, 1978). However, the males H.S.I. in this study, were stable during all the sampling period, this probably indicates that males of *C. conger* do not used the liver reserves for maturation before migration because of abundance prey in these periods (Abi-Ayad et *al*., 2011). In the Mediterranean Sea, males conger eel are reported to be smaller than females, and rarely exceeding 100 cm in length and females reaching over 200 cm (Cau and Manconi, 1983). In fact, 50 % of males become sexually mature earlier than 50 % of females in all samples analyzed in this study. However, the present study is the first attempt to determine the size at first maturity for this species. There were no references dealing with the size at maturity for *C.conger*, reported from other regions. The sex ratio of the European conger eel population in the western coast of Algeria was strongly skewed towards females in summer and spring seasons, which represent 86 % of the population. In winter and autumn the percentage between males and female in quite equal. Different findings have been reported by Sbaihi et *al*., 2001, Sullivan et *al*., 2003, and Correia et *al*., 2009. This may be caused by different gear used in summer and spring and in winter and autumn. In fact, the European conger eel present a spatial displacement of sexes, females were found in the inshore waters but males were only found at much greater depths (Cau and Manconi, 1983). The conclusion of that contribution, the inshore fishery of the European conger eel (*Conger conger*) target mainly young individuals with sizes between 50 cm and 60 cm. The study of the biology of *C. conger*, growth and reproduction, lets understand a situation of over-exploitation of the species in the study area. The increase in fishing effort and motor ability trawlers make the situation worse of this resource. Thus, the partial transfer of the fishery seaward beyond 3 nautical miles is recommended to reduce the fishing effort for coastal resource. This measure will allow certainly an increasing biomass, an improvement the level of recruitment and growth in resource productivity.

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6.REFERENCES

[1] Abi-Ayad, S.-M. E.-A., Bensahla, T. A., Ali Mehidi, S., Dalouche, F. and Meliani, F. M., 2011 - Some aspects on the reproductive cycle of European conger eel, Conger conger (Linnaeus, 1758) (Osteichthyes, Anguilliformes, Congridae) captured from Western Algerian coasts: a histological description of spermatogenesis. Biodiversity Journal, 2 (3): 107-114.

[2] Bougis P., 1952 - Recherches biométriques sur le rouget (Mullus barbatus L. et Mullus surmuletus L.). Arch. Zool. Exp. Gen, 89, 59-174.

[3] Cau A., and Manconi, P., 1983 - Sex ratio and spatial displacement of Conger conger. Rapp. Comm. Int. Mer. Medit., 28: 93–96.

[4] Correia, A.T., Ramos, A. A., Barros F., Silva, G.A., Hamer, P., Morais, P., Cunha, R. L. and Castilho, R., 2012 - Population structure and connectivity of the European conger eel (Conger conger) across the north-eastern Atlantic and western Mediterranean: integrating molecular and otolith elemental approaches. Mar Biol, 159 :1509–1525.

[5] Correia, A.T., Manso, S. and Coimbra, J., 2009 - Age, growth and reproductive biology of the European conger eel (Conger conger) from the Atlantic Iberian waters. Fish Res. 99: 196 –202.

[6] Culurgioni, J., D'Amico, V., Coluccia, E., Mulas, A. and Figus, V., 2006 - Metazoan parasite fauna of conger eel Conger conger L. from Sardinian waters (Italy): ITTIOPATOLOGIA, 3: 253-261.

[7] Dadzie, S., and Wangila, B. C. C., 1980 - Reproductive biology, length –weight relationship and relative condition of pond raised Tilapia zilli (Gervais). J. Fish Biol., 17: 243-253.

[8] D'hainaut, L., 1975a - Concepts et méthodes de la statistique (Vol. 1). Education 200, Edition Labor (Bruxelles) et Fernand Nathan (Paris). 369.

[9] D'hainaut, L., 1975b - Concepts et méthodes de la statistique (Vol. 2). Education 200, Edition Labor (Bruxelles) et Fernand Nathan (Paris). 384.

[10] Fannon, E., Fahy, E. and O'Reilly, R., 1990 - Maturation in female Conger eel,Conger conger (L.). J Fish Biol 36:275–276.

[11] Figueiredo, M. J., Figueiredo, I. and Correia, J., 1996 - Caracterizacao geral dos recursos de profundidade em estudo no IPIMAR. Relat. Cient. Tec. Inst. Invest. Marit. 21: 50.

[12] Flores-Hernandez, D., 1990 - Les pêcheries de congre (Conger conger L.) dans le Mor Braz,Bretagne Sud. (Eléments de la biologie et de gestion de la ressource). Thèse 3ème cycle. Université de Marseille. France. 150p.

[13] Hood, P.B., Able, K.W. and Grimes, C.B., 1988 - Biology of the conger eel Conger oceanicus in the Mid-Atlantic Bight. Mar. Biol. 98: 587–596.

[14] Htun-hun., 1978 - The reproductive biology of the dab Limanda limanda (L) in the North Sea; gonadosomatic Index; Hepatosomatic Index and condition factor. J. Fish Biol., 13: 369-378.

[15] Layachi, M., Melhaoui, M., Srour, A. and Ramdani, M., 2007- Contribution à l'étude de la reproduction et de la croissance du Rouget-barbet de vase (Mullus barbatusL., 1758) de la zone littorale méditerranéenne de Nador (Maroc). Bulletin de l'Institut Scientifique, Rabat, section Sciences de la Vie no 29.

[16] Le Cren, E.D., 1951- The lenght weight relationship and seasonal cycle in gonad weight and condition in the Perch (P. fluviatilis). J. Anim. Ecol, 20, 201-219.

[17] Mazouz, M., Seddikoui, L., Bensahla, Talet A. and Abi-Ayad, S.-M. E.A., 2014 - Some aspects of the reproductive cycle of the European conger eel, Conger conger (Linnaeus, 1758) (Osteichthyes, Anguilliformes, Congridae) captured from Western Algerian coasts: a histological description of oogenesis. SYLWAN journal, Vol. 158, Issue. 7.

[18] Medford, B. A. and Mackay, W. C., 1978 – Protein and lipid content of gonads, liver, and muscle of northern pike (Esox lucius) in relation to gonad growth. J. Fish. Res. Bd. Canada, 35: 213-219.

[19] Pauly, D., 1987- A review of the ELEFAN system for analysis of lenght-frequency data in fishand aquatic vertebrates. In : Pauly D. & Morgan G. (eds) - Length-based methods in fisheries research. ICLARM, Manila, Philippines and Kisr, Safat, Kuwait, 7-34.

[20] Relini, G., Bertrand, J. and Zamboni, A., 1999 – Sintesi delle conoscenze sulle risorse da pesca dei fondi del Mediterraneo Central (Italia e Corsica). Biol Marina Meditérranea, 6: 174-179.

[21] Samsun, O., Samsun, N., Bilgin, S. and Kalayci, F., 2006 - Population biology and status of exploitation of introduced garfish Belone belone euxini (Günther, 1866) in the Black Sea. J. of Applied Ichthyology ; 22:353-356.

[22] Sbaihi, M., Fouchereau-Peron, M., Meunier, F., Elie, P., Mayer, I., Burzawa-Gerard, E., Vidal, B. and Dufour, S., 2001 - Reproductive biology of conger eel from the south coast of Brittany, France and comparison with the European eel. J. Fish Biol. 59: 302–318.

[23] Sullivan, S.O., Moriarty, C., Fitsgerard, R.D., Davenport, J. and Mulcahy, M.F., 2003 -Age, growth and reproductive status of the European conger eel. Conger conger (L.) in Irish coastal waters. Fish Res. 64: 55–69.

[24] Thiam, M., 1980 - Biologie, écologie et dynamique des cynoglosses du plateau continental sénégambien. Reproduction, biométrie et croissance de Cynoglosses canariensis (Steind.1882). Doc. Scient. CRODJ, ISRA, 65-58.

[25] Vazzoler, 1996 - Biologia da reprodução de peixes Teleósteos: Teoria e prática. Ed. EDUEM, Maringá, 169.