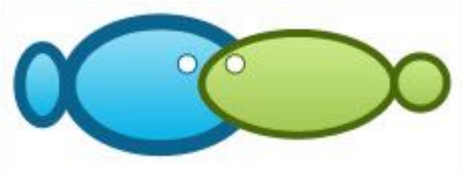

Growth, age and reproduction of *Sardinella aurita* (Valenciennes, 1847) and *Sardina pilchardus* (Walbaum, 1792) in the Algerian eastern coasts

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Abstract. The first objective of this study consists of an exhaustive description of growth, reproduction and age of 2 species of pelagic fish: the sardinella *Sardinella aurita* (N = 649) and the sardine *Sardina pilchardus* (N = 648). Samples were collected monthly from November, 2012 to October, 2013 along the Algerian eastern coasts. Concerning *S. aurita*, 7% was no identified (NI) against 22% of non-sexually differentiated (IM) individuals, 31% of males (M) and 40% of females (F). The relationship between the size and the weight revealed a majorant allometry (b = 3.13) from all material. The key size-age highlights that the majority of the IM (51) and adults (186) have a size included between: 8-11 cm at 0-1 year and 16-17 cm at 3-4 years respectively. From *S. pilchardus,* the proportions of females are slight higher than males (42%-41%) against 12% of immature individuals and 5% of no identified individuals. Length–weight relationships revealed the equation: $W = 0.005\ L^{3.15}$ (sexes combined). The most important proportion of the males and females measures 12-15 cm at 3-4 years. Finally, estimated parameters of the von Bertalanffy model of both species were characterized.
Key Words: pelagic fish, otolithometry, life-history, key size-age, Algeria.

Introduction. Most clupeiform fishes have indeterminate fecundity (the Atlantic herring *Clupea harengus* is an exception) and are characterized by a small size, high growth rates, a relatively short life span (Sinovcic 1986; Alemany & Alvarez 1993; Voulgaridou & Stergiou 2003; Silva et al 2008), and late maturity (up to the second year of life; Silva et al 2006) occurring at a large size relative to adult size such that energy is first allocated to growth and then to reproduction (Nunes at al 2011), these characteristics, in addition to important inter-annual fluctuations in population biomass and recruitment, make their stocks especially difficult to manage (Cole & McGlade 1998; Schwartzlose et al 1999; Borges et al 2003; Carrera & Porteiro 2003; Silva et al 2009).

On the other hand, knowing the age of fishes allows us to better understand the dynamics of fish stocks and how fish populations react to exploitation and environmental stresses, and thus can be used to analyze the effect of changes in relative exploitation patterns on the stocks and enables us to provide more precise management advice to the fisheries managers (Sylla at al 2012).

In the light of this information, we have choose to undertake this investigation, on two pelagic teleost along the Algerian eastern coasts: the sardinella (*Sardinella aurita*) and the sardine (*Sardina pilchardus*), that the aims is firstly, to determine the age by otolithometry- for the first time in this area- and to establish a key size-age for those specimens, secondly to study their growth and reproduction to understand the dynamic of this population.

Material and Method

Fish sampling. Sampling was carried out monthly between November 2012 and October 2013. A total of 649 *S. aurita* and 648 *S. pilchardus* were collected along the Algerian eastern coasts: El Kala 36°54'1.02''N 08°25'23.94''E, Annaba 36°54'11''N 07°47'03''E and Chetaïbi 37°04'04''N 07°83'03''E (Figure 1), they were brought back to the laboratory on ice and then weighed (total mass -Wt, with 0.1 g accuracy) and measured (total length -Lt, in mm).

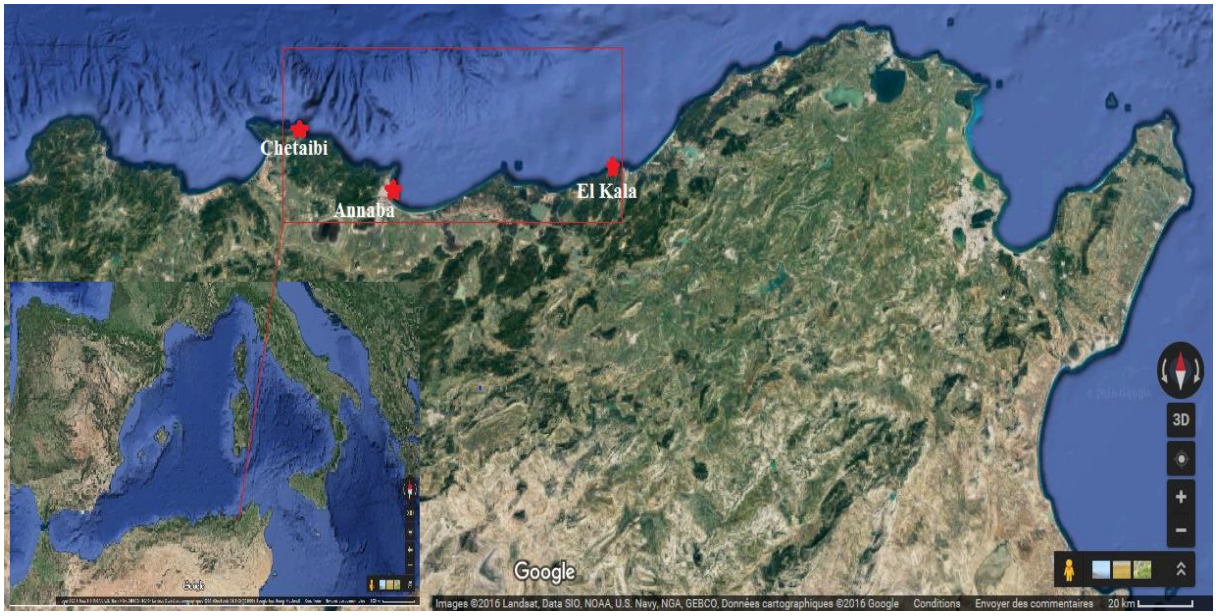

Figure 1. Northeastern of Algeria, red rectangle delimits the sampling locations.

Length-weight relationship. As fish grow in length, they increase in weight. The length–weight relationships were calculated using the equation:

$$W(t) = aLt^{b}$$

Where: a is a coefficient relative to body form;

b is an exponent indicating isometric growth when equal to 3.0, allometry marjorant when >3 and allometry minorant when <3 (Froese 2006).

Otolith analysis. The neatness of the otolith growth marks of the captured fish allowed us to interpret them directly without prior preparation using a Leica WILD M3Z microscope with reflected light against a dark background. Assessment of their age was done by counting of the winter rings (Panfili et al 2002).

Modeling of growth. For modeling of growth of the fish population in question we used the following von Bertalanffy (FCVB) equation:

$$Lt = L\infty\ (1-e^{-K(t-t0)})$$

This model is perhaps one of the most widely used models to describe age and growth relationships of fishes. The above equation describes how an individual length (Lt), is predicted as a function of its age (t) as a result of the values of the parameters k and L∞. k is the instantaneous growth rate (units of time, year-1) and L∞ is the maximum length attained by an average individual in the population.

Results

Sex-ratio. Concerning *S. aurita*, 7% was no identified (NI) against 22% of non-sexually differentiated (IM) individuals, 31% of males (M) and 40% of females (F) (Figure 2).

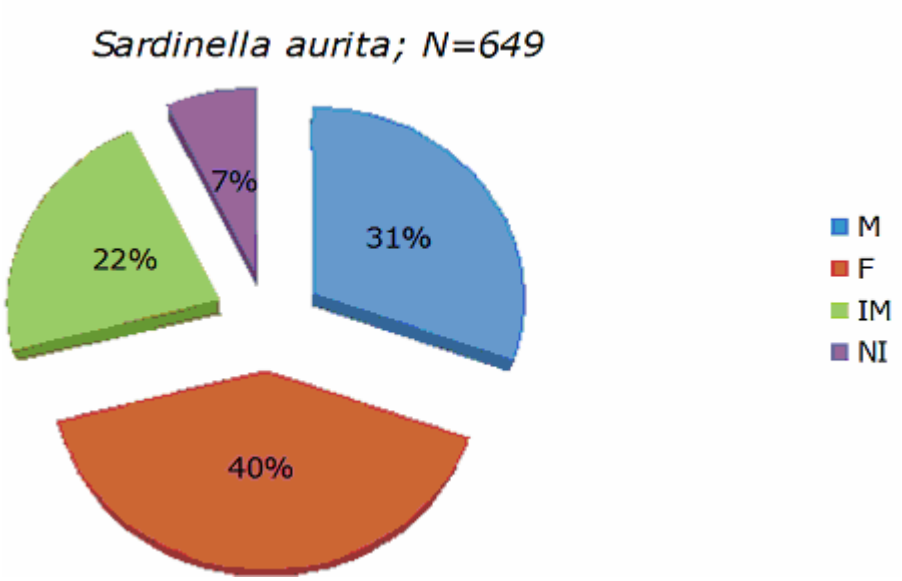

Figure 2. Proportion of different stage of *Sardinella aurita* from the Algerian eastern coasts.

Out of the total sardine specimens analyzed during the study (N = 648), 264 (41%) specimens were males, 273 (42%) were females, 76 (12%) non-sexually differentiated (IM) individuals and 35 (5%) undetermined specimens, giving an overall sex ratio of 0.97 (Figure 3).

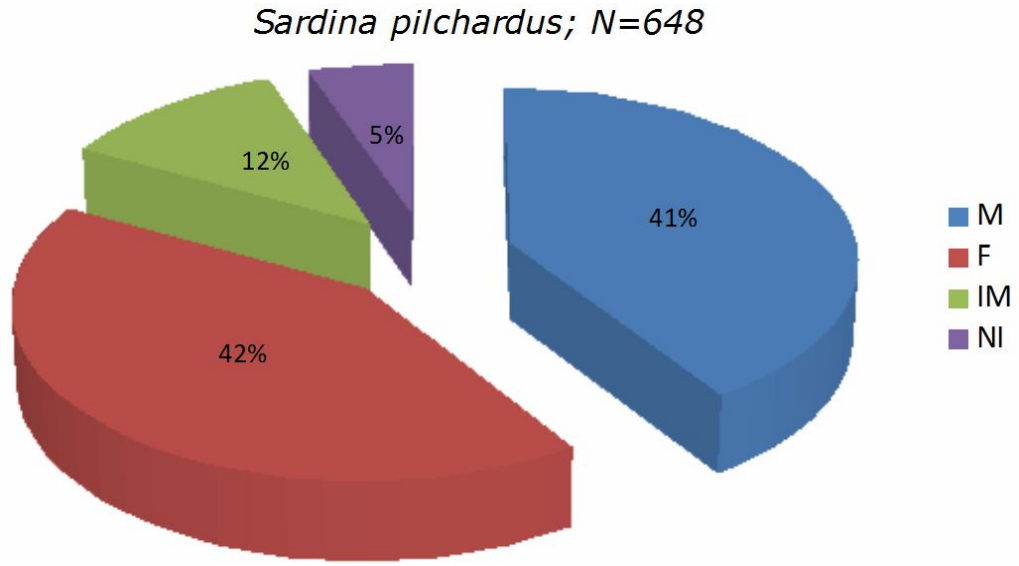

Figure 3. Proportion of different stage of *Sardina pilchardus* from the Algerian eastern coasts.

Length-weight relationship. A total of 1,297 specimens of *S. aurita* and *S. pilchardus*, ranging in total length from 8 to 25.5 cm (mean 15.74±3.26 cm) and 8.3 to 19.5 cm (mean 14.15±1.69 cm) respectively and in weights between 3.71-140.27 g (mean 32.72±20.93 g) and 3.71-54.73 g (mean 22.18±8.08 g) respectively, were sampled.

Relationships were calculated for males, females and non-sexually differentiated individuals (Table 1) of *S. aurita*. Females had a slight higher regression coefficient (b = 3.16; R^2 = 0.98) than males (b = 3.13; R^2 = 0.97). The relationship for non-sexually differentiated specimens was: W = 0.0057 $LT^{3.09}$; R^2 = 0.98. The slope of the regressions and regression coefficients indicate the majorant allometry nature of growth for all material (Table 1).

Table 1

Length-weight relationship of both species from the Algerian eastern coasts

Sexes	*N*		*a*		*b*		R^2		*Allometry type*	
	S. aurita	*S. pilchardus*	*S. aurita*	*S. pilchardus*	*S. aurita*	*S. pilchardus*	*S. aurita*	*S. pilchardus*	*S. aurita*	*S. pilchardus*
M	199	264	0.0052	0.0045	3.13	3.18	0.97	0.93	majorant	
F	261	273	0.0047	0.00456	3.16	3.19	0.98	0.92	majorant	
IM	143	76	0.0057	0.006	3.09	3.07	0.98	0.94	majorant	

IM - non-sexually differentiated individuals, M – males, F – females.

Concerning *S. pilchardus*, the relationship between length and weight was from males, females and non-sexually differentiated individuals: $W = 0.0045\ LT^{3.18}$, $W = 0.0046\ LT^{3.19}$ and $W = 0.006\ LT^{3.07}$ respectively. The allometry coefficient b is higher than 3 reflecting that growth is a majorant allometric (Table 1).

Key size-ages. Otolith examination based on specimens samples caught in the Algerian eastern costs gave a success rate of 90.60% (588/649) of *S. aurita*, it highlighted that the total length is ranged between 8 and 25.5 cm, and their age between 11 months and 7 years. Males ranged in size from 12.7 to 24.4 cm (from 1.16-6 years) and females from 12.7 to 25.5 cm (from 1.16-6 years). Non-sexually differentiated individuals were between 8 and 14.7 cm long (from 11 months-3.9 years). The age 3-4 years is the most dominant for males (86) and females (100) (Table 2).

Table 2

Key size-ages (cm-years) for *Sardinella aurita* from the Algerian eastern coasts

Size (cm)	*Age class*															
	0-1	*1-2*			*2-3*			*3-4*			*4-5*		*5-6*		*6-7*	
	IM	*IM*	*M*	*F*	*IM*	*M*	*F*	*IM*	*M*	*F*	*M*	*F*	*M*	*F*	*M*	*F*
8-9	36															
10-11	15	32			4											
12-13		11	5	5	26	4	5	5		1						
14-15			1	5	5	28	51	5	22	31	1	1				
16-17						5	8		48	55	15	13	3	4		
18-19									14	11	24	22	4	8		
20-21								2	1	5	13	6	4	1		
22-23										1	1	5		5	2	3
24-25.5												1	1	3		1

IM - non-sexually differentiated individuals, M – males, F – females.

Concerning *S. pilchardus,* otolith readings gave a success rate of 87.96% (570/648), age range of the sampled fish was 10.8 months – 6.75 years, with a predominance of age classes of 3–4 years in the catch (51.22% individuals). Females predominated in almost all age classes, except in 4-5 years (predomination of males). Finally, in age class 3-4 years, both sexes were equally presented (Table 3).

Table 3

Key size-ages (cm-years) for *Sardina pilchardus* from the Algerian eastern coasts

Size (cm)	*Age class*														
	0-1	*1-2*			*2-3*			*3-4*			*4-5*		*5-6*		*6.75*
	IM	*IM*	*M*	*F*	*IM*	*M*	*F*	*IM*	*M*	*F*	*M*	*F*	*M*	*F*	*M*
8-9	2	6			3										
10-11	2	5	2	2	15	7	4	1	2	1					
12-13			1	2	21	21	30	6	60	37	2	1			
14-15						6	7		80	102	34	31		1	
16-17									1	2	28	26	4	10	
18-19											1	1	1	1	1

Modeling of growth. Estimated parameters by the direct method of von Bertalanffy were resumed in the following Table 4. It shows that the males and the non-sexually differentiated individuals of *S. aurita* have a slight high growth rate (k = 0.18 and 0.19

year^{-1} respectively) than females k = 0.13 (year^{-1}) and that these, therefore, reach a final size (asymptotic length) L∞ = 32.26 cm higher than males L∞ = 27.3 cm (Table 4).

Concerning *S. pilchardus,* juvenile exhibit an extremely fast growth (k = 0.8) but the rate of growth (k = 0.2) and the asymptotic length (L∞ = 21.04 cm) are the same in both sexes (Table 4).

Table 4

Growth parameters of both species from the Algerian eastern coasts

Sexes	*L∞(cm)*		*K(year^{-1})*		*t_0(year)*	
	S. aurita	*S. pilchardus*	*S. aurita*	*S. pilchardus*	*S. aurita*	*S. pilchardus*
M	27.3	21.04	0.18	0.2	-1.9	-2.4
F	32.26	21.04	0.13	0.2	-1.99	-2.4
IM	18.41	11.99	0.19	0.8	-3.01	-1.11

Discussion. The sex-ratio in the population of *S. aurita* and *S. pilchardus* along the Algerian eastern coasts is in favor of females (40% and 42% respectively). The dominance of the females seems to be a general rule to Clupéidae (Boëly 1980) because it was noticed at other species: *Sardinella maderensis* (Boëly 1979) and anchovy *Engraulis mordax* (Parrish et al 1986). The numerical superiority of the females can be the result of several factors among whom the most credible would be a bigger longevity and a fast growth of the females (precocious development of the ovaries), a more important vulnerability in relation to the devices of gear of fishing or else of the migratory movements different from those of the males (Khemiri & Gaamour 2009). Furthermore, variations of the sex ratio at different sizes are related to unequal rates of growth and mortality (Turner et al 1983).

Our results regarding sex-ratio is in agreement with the results of several authors in different area: in Morocco (Baali et al 2015), Balearic Islands (Andreu & Rodriguez-Roda 1952), Senegalese coast (Conand 1977; Boëly 1979), EEZ Mauritanian (Cheibany 1990). According to Diouf et al (2010), there is a predominance of males among the first individuals arrived, followed by a numerical inequality of females and males, and a female predominance in late migration.

Analysis of length-weight relationship showed that female had a slight higher regression coefficient from both species and that the slope of the regressions indicates the majorant allometry nature of growth for all material.

Our age and growth estimates from *S. pilchardus* are similar to those calculated on the age–length data reported by: Brahmi et al in Algiers (1998) (a = 0.00385; b = 3.20), Bouchereau (1981) (a = 0.0096; b = 3.48) in the Bay of Oran, Guerault & Avrilla (1978) in the gulf of Gascogne (a = 0.00395; b = 3.24); and from *S. aurita* by: Baali et al (2015) in Morrocco, Camarena (1986) and Boëly (1979) in Senegal, Ghéno & Fontana (1981) in Congo and Holzlöhner el al (1983), Wagué & Mbobj (2002), Diouf et al (2010), Samba (2011) in Mauritania. On the contrary, in the same region Bedairia & Djebar (2009) and Kartas (1981) in Tunisia found from *S. pilchardus* an isometric growth results (a = 0.00488; b = 3.055). A number of factors such as growth phase, season, degree of stomach fullness, gonad maturity, sex, size range, health and general fish condition, and preservation techniques are known to influence the length-weight relationship in fishes (Bedairia & Djebar 2009).

Our study on the growth of *S. aurita* showed that this species has a slow growth, with a maximum age observed in 7 years. In Morocco, Baali et al (2015) show that this species has a rapid growth, with a maximum age observed in 5 years, reaching average 19 cm after one year. Other studies showed that the growth of *S. aurita* is fast, reaching an average of 18 cm after one year (Camarena 1986; Cury & Fontana 1988). In the Senegalese coast, the size is growing rapidly, reaching its maximum after 3 years of life. The recent study of the growth of Sardinella from peninsula of Cape Verde, performed by Samba (2011), also shows very rapid growth of *S. aurita* with maximum observed

morphological trait at 4 years. The interpretation of the results is complicated by the existence of two relatively long breeding seasons and migrations carried out by this fish. The difference concerning, in particular, the growth rate may be fast for some, or relatively slow for others (Baali et al 2015).

The analysis of the growth performed without discrimination between sexes point out that the sardine can live until 6.25 years, juvenile exhibit an extremely fast rate of growth (k = 0.8) notably in the course of first 3 years of life, however, and from the third year, the growth in length becomes of more in slower, and is possible to be estimated in some millimeters/year. Sardine populations across the Atlantic and Mediterranean waters show large variation in Von Bertalanffy growth parameters and maximum age and the longevity of sardine in the Atlantic is higher than in the Mediterranean; indeed, in the Mediterranean, the ages recorded show a maximum of 6 years and correspond to values of L∞ of 22.56 cm, 19.44 cm and 22.58 cm, respectively from Gulf of Annaba-Algeria (Bedairia & Djebar 2009), Bou–Ismail-Algeria (Mouhoub 1986) and Galicia-Spain (Álvarez 1980). In the Atlantic, however, longevity is 8 years, which corresponds to asymptotic lengths of 25.5 cm in the Bay of Biscay (Guerault 1980) and 24 cm in the east Atlantic (Copace 1978). It is extremely difficult to assess the possible influence on growth rates that is directly ascribable to the different environmental and biological factors in the regions considered, the most likely candidates, i.e., temperature, food availability, competition, and predation, have mainly been determined for larvae or in laboratory studies (Morales-Nin & Pertierra 1990).

Conclusions. This study highlights the following points:
* The sex-ratio in the population of *S. aurita* and *S. pilchardus* is in favor of females (40% and 42% respectively);
* The relationship between the size and the weight revealed a majorant allometry for both species;
* The growth of both species is relatively slow but juvenile of *S. pilchardus* exhibit an extremely fast rate of growth (k = 0.8).

References

Alemany F., Alvarez F., 1993 Growth differences among sardine (*Sardina pilchardus* Walb.) populations in western Mediterranean. Scientia Marina 57:229–234.

Álvarez F., 1980 Growth studies of *Sardina pilchardus* (Walb) in Galicia waters (N. W. Spain). International Council for the Exploration of the Sea, Pelagic Fish Committee, C.M. 1981/H, 29:1–11.

Andreu B., Rodriguez-Roda J., 1952 Considération sur la proportion des sexes dans la pêche de poissons pélagiques dans la Méditerranée et leur signification statistique. Vie et Milieu Suppl 2:271–281.

Baali A., Yahyaoui A., Amenzoui K., Manchih K., Abderrazik W., 2015 A preliminary study of reproduction, age and growth of *Sardinella aurita* (Valenciennes, 1847) in the southern of Atlantic Moroccan area. AACL Bioflux 8(6):960-974.

Bedairia A., Djebar A. B., 2009 A preliminary analysis of the state of exploitation of the sardine, *Sardina pilchardus* (Walbaum, 1792), in the gulf of Annaba, East Algerian. Animal Biodiversity and Conservation 32(2):89–99.

Boëly T., 1979 Biologie des deux espèces de sardinelles: *Sardinella aurita* Valenciennes 1847 et *Sardinella maderensis* (Lowe 1841) des côtes sénégalaises. Thèse Doctorale d'état, Université de Paris VI:286.

Boëly T., 1980 Étude du cycle sexuel de la sardinelle plate: *Sardinella maderensis* (Lowe, 1841) des côtes sénégalaise. Cybium 3e sér 8:77-88.

Borges M. F., Santos A. M. P., Crato N., Mendes H., Mota B., 2003 Sardine regime shifts off Portugal: a time series analysis of catches and wind conditions. Scientia Marina 67(Supplement 1):235–244.

Bouchereau J. L., 1981 Contribution à l'étude de la biologie et de la dynamique exploitée de *Sardina pilchardus* (Walbaum, 1792) dans la baie d'Oran (Algérie). Thèse Doctorale 3ème cycle, Université Aix– Marseille II.

Brahmi B., Bennoui A., Oualiken A., 1998 Estimation de la croissance de la sardine (*Sardina pilchardus*, Walbaum, 1792) dans la région centre de la côte Algérienne. Marine Populations Dynamics 35:57-64.
Camarena T. L., 1986 Les principales espèces de poissons pélagiques côtiers au Sénégal: biologie et évaluation des ressources. Thèse de Doctorat Université Bretagne Occidentale, France, 187 pp.
Carrera P., Porteiro C., 2003 Stock dynamic of the Iberian sardine (*Sardina pilchardus*, W.) and its implication on the fishery off Galicia (NW Spain). Scientia Marina 67(Supplement 1):245–258.
Cheibany A., 1990 Méthodes d'étude des paramètres biologiques. Rapp. Stage fin d'études CNROP. Nouadhibou.
Cole J., McGlade J., 1998 Clupeoid population variability, the environment and satellite imagery in coastal upwelling systems. Reviews in Fish Biology and Fisheries 8:445–471.
Conand C., 1977 Contribution à l'étude du cycle sexuel et de la fécondité de la sardinelle ronde, *Sardinella aurita*: pêche sardinière dakaroise en 1975 et premier semestre 1976. Cahiers Orstom Série Océanographie 15(4):301-312.
Cury M. P., Fontana A., 1988 Compétition et stratégies démographiques comparées de deux espèces de sardinelles (*Sardinella aurita* et *Sardinella maderensis*) des côtes ouest africaines. Aquatic Living Resources 1:165–180.
Diouf K., Samb B., Sylla M., 2010 Contribution à la connaissance de la biologie des sardinelles (*Sardinella aurita* et *Sardinella maderensis*) du littoral sénégalais. Dans: Science et aménagement des petits pélagiques. Symposium sur la science et le défi de l'aménagement des pêcheries de petits pélagiques sur les stocks partagés en Afrique nord-occidentale. S. Garcia, M. Tandstad, Caramelo A. M. (eds), pp. 39–56, 11-14 mars 2008, Casablanca, Maroc. FAO Comptes rendus des pêches et de l'aquaculture, No. 18, Rome, FAO.
Froese R., 2006 Cube law, condition factor and weight–length relationships: history, meta-analysis and recommendations. Journal of Applied Ichthyology 22:241-253.
Ghéno Y., Fontana A., 1981 Les stocks de petits pélagiques côtiers les sardinelles. In: Milieu marin et ressources halieutiques de la république de la république populaire du Congo, A. Document. Orstom, Paris, 138:213-257.
Guerault D., Avrilla J. L., 1978 La sardine de la côte des landres. Pêche et biologie. CIEM.C. M./H., 23:1–18.
Guerault D., 1980 La croissance linéaire de la sardine du golfe de Gascogne. Ses variations à long terme. CIEM.C. M./H., 40:1–9.
Holzlöhner S., Kloxin C., Pingel C., Hoffmann U., 1983 On the species composition and length-age structure of the most important pelagic fishes off Mauritania in 1982. International Council for the Exploration of the Sea, Pelagic Fish Committee, 44 pp.
Kartas F., 1981 Les clupéidés de Tunisie. Caractéristiques biométriques et biologiques. Étude comparée des populations de l'Atlantique est et de la Méditerranée. Thèse de Doctorat d'Etat, Université de Tunis, Faculté des sciences, 608 pp.
Khemiri S., Gaamour A., 2009 Relation taille –masse, condition relative et cycle sexuel des anchois et des sardines des côtes tunisiennes. Bulletin de l'Institut National des Sciences et Technologies de la Mer de Salammbô 36:45-57.
Morales-Nin B., Pertierra J. P., 1990 Growth rates of the anchovy *Engraulis encrasicolus* and the sardine *Sardina pilchardus* in the Northwestern Mediterranean Sea. Marine Biology 107:349-356.
Mouhoub R., 1986 Contribution à l'étude de la biologie et de la dynamique de la population exploitée de la sardine *Sardina pilchardus* (Walbaum, 1792) des côtes algéroises. Thèse de Magistère, U.S.T.H.B.
Nunes C., Silva A., Soares E., Ganias K., 2011 The Use of Hepatic and Somatic Indices and Histological Information to Characterize the Reproductive Dynamics of Atlantic *Sardine Sardina pilchardus* from the Portuguese Coast. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 3(1):127-144.

Panfili J., (de) Pomuai H., Troadec H., Wright P. J. (eds), 2002 Manuel de sclérochronologie des poissons Coédition Ifremer-IRD, pp. 464.
Parrish R. H., Mallicoate D. L., Klingbeil R. A., 1986 Age dependent fecundity, number of spawning per year sex ratio, and maturation stages in northern anchovy *Engraulis mordax*. Fisheries Bulletin 84:503-517.
Samba O., 2011 Nouvelle évaluation des caractéristiques biologiques de *Sardinella aurita* (Valenciennes, 1847) et *Sardinella maderensis* (Lowe, 1841). Mémoire de DEA, IUPA/UCAD, 45 pp.
Schwartzlose R. A., Alheit J., Bakun A., Baumgartner T. R., Cloete R., Crawford J. M., Fletcher W. J., Green-Ruiz Y., Hagen E., Kawasaki T., Lluch-Belda D., Lluch-Cota S. E., MacCall A. D., Matsuura Y., Nervaez-Martinez M. O., Parrish R. H., Roy C., Serra R., Shust K. V., Ward M. N., Zuzunaga J. Z., 1999 Worldwide large-scale fluctuations of sardine and anchovy populations. South African Journal of Marine Science 21:289–347.
Silva A., Santos M. B., Caneco B., Pestana G., Porteiro C., Carrera P., Stratoudakis Y., 2006 Temporal and geographic variability of sardine maturity at length in the north-eastern Atlantic and the western Mediterranean. ICES Journal of Marine Science 63:663–676.
Silva A., Carrera P., Massé J., Uriarte A. D., Santos M. B., Oliveira P. B., Soares E., Porteiro C., Stratoudakis Y., 2008 Geographic variability of sardine growth across the northeastern Atlantic and the Mediterranean Sea. Fisheries Research 90:56–69.
Silva A., Skagen D. W., Uriarte A., Massé J., Santos M. B., Marques V., Carrera P., Beillois P., Pestana G., Porteiro C., Stratoudakis Y., 2009 Geographic variability of sardine dynamics in the Iberian Biscay region. ICES Journal of Marine Science 66:495–508.
Sinovcic G., 1986 Estimation of growth, mortality, production and stock size of sardine, *Sardina pilchardus* (Walb.), from the middle Adriatic. Acta Adriatica 27:67–74.
Sylla M., Wagué A., El Youssoufi A., Mendy A., Diagne A., Amenzoui K., Darboe F., Santamaria M. T. G., Timoshenko N., Morgado C., Caramelo A. M., Tandstad M., 2012 Age estimation of sardine (*Sardina pilchardus*) and round sardinella (*Sardinella aurita*) in Northwest Africa. In: Science and management of small pelagics. Garcia S., Tandstad M., Caramelo A. M. (eds), Symposium on Science and the Challenge of Managing Small Pelagic Fisheries on Shared Stocks in Northwest Africa, 11–14 March 2008, Casablanca, Morocco.
Turner S. C., Grimes C. B., Able K. W., 1983 Growth, mortality, and age/size structure of the fisheries for the tilefish, Lopholatilus chaemaelonticeps, in the middle Atlantic-Southern New England region. Fisheries Bulletin 81:751-763.
Voulgaridou P., Stergiou K. I., 2003 Trends in various biological parameters of the European sardine, *Sardina pilchardus* (Walbaum, 1792), in the eastern Mediterranean Sea. Scientia Marina 67(Supplement 1):269–280.
Wagué A., M'bodj O. B., 2002 Étude de quelques aspects de la reproduction chez la sardinelle ronde *Sardinella aurita* (Valencienne, 1847) pêchée le long des côtes mauritaniennes. Bulletin Scientifique de l'Institut Mauritanien de Recherches Océanographiques et des Pêches 29:13-18.
*** Copace FAO, 1978 Rapport du groupe de travail sur l'unification de détermination de l'âge de la sardine (*Sardina pilchardus,* WALB). COPACE/TECH/78/8/Dakar (Fr): 1–9.

Received: 22 September 2015. Accepted: 27 October 2016. Published online: 30 October 2016
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How to cite this article:
Dahel A., Tahri M., Bensouilah M., Amara R., Djebar B., 2016 Growth, age and reproduction of *Sardinella aurita* (Valenciennes, 1847) and *Sardina pilchardus* (Walbaum, 1792) in the Algerian eastern coasts. AACL Bioflux 9(5):1172-1181.