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# Growth and Mortalties of *B. boops* (Walbaum, 1792) in the Western Region of Algeria

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**Abstract:** *Boops boops* is one of the main target species of the commercial fishery; it is widely distributed along the Algerian coasts. A subsample of 2068 specimen ranging from 9.7-27.4 cm was obtained from commercial catches on western Algerian coast. Age and growth were determined of *Boops boops* by otolith interpretation with TNPC Software. Data for length-weight relationship, age, growth and mortality were analyzed for *Boops boops*. The parameters of the von Bertalanffy growth equation were: $L\infty = 30.045$ cm, $K = 0.117$ per year, $t_0 = -2.919$ year. The instantaneous rates of total mortality (Z) and natural mortality (M) were 0.418 and 0.24 per year, respectively. Rates of fishing mortality F and exploitation E were 0.178 and 0.43 per year, respectively.

## INTRODUCTION

*Boops boops* is one of the main fishing activities that contributes significantly to the fishing economy of the western region of the Algerian basin, given its yield in terms of catches and the economic interest it generates. In order to better understand the stock status of the species in question, and in order to collect data necessary for the establishment of a management plan, stock assessment studies must be undertaken. These studies are based on the determination of some characteristic parameters of the population, including data on age, growth parameters and mortality rates.

This study investigates the estimation of the age of the bogue in the western region of the algerian coast by direct reading of whole otoliths in order to estimate the biological parameters related to the growth of this species according to the Model of Von Bertalanffy. Then to the estimation of natural mortality, total mortality and fishing mortality.

## MATERIALS AND METHODS

**Collection of data:** From July, 2014 to May, 2016, 2068 individuals from both sexes were collected monthly, along the western coast of Algeria, between Tenes and Tlemcen, from commercial fishing landings. Their size ranged from 9.7-27.4 cm.

They were regularly measured with great accuracy (millimeters), using a caliper and then weighed. About 326 Sagittal otoliths were removed and kept dry in Eppendorfs. Age was read from the whole otoliths (Mahe *et al.*, 2007). Although the difficulties of age reading due to the convex and thick aspect of the otolith, the age determination was carried out using the TNPC software. Lengths at different ages (age-length key) were modeled using the growth model:

$$Lt = L_{\infty}\left(1\text{-}\exp\left[-k\left\{t\text{-}t_0\right\}\right]\right)$$

Where:
Lt = The length (cm) at age (t)
L∞ = Asymptotic length
K = Curvature parameter
$t_0$ = Theoretical age where Lt = 0

The study of length–weight relation involved 610 pairs of Total Length (TL)-total Weight (W) values. Sizes that moved from 9.5-27.4 cm were adjusted by the equation. The regression coefficient is generally between 2.5 and 3.5. The relation is said to be isometric when it is equal to 3 (Ecoutin *et al*., 2005). Linear growth parameters of Von Bertalanffy equation was carried out using the fish methods package of the open source code of the statistical software R (R 3.1.2 Language Environment, 2013).

Total mortality rate (Z) was estimated using the FISAT II 1.2.0 program. Based on the following equation $\ln(C_{Li,¥}) = a+b\cdot \ln (L_¥-L_i)$ (Jones/van Zalinge method) Where $\ln(C_{Li,¥})$ is the cumulative catch (computed from the highest length class with non-zero catch) corresponding to length class i, and $L_i$ is the lower limit of length class i. The slope b, is an estimate of Z/K.

According to Bouaziz *et al*. (2014), the natural mortality coefficient is one of the most difficult parameters to estimate. However, a value, as accurate as possible of M is necessary to implement the most usual models of stocks management (Pauly, 1984). For its evaluation, we found the equation of Djabali *et al*. (1994) useful: log10 M = 0.0278-0.1172×log10 L∞+0.5092×log10 K.

## RESULTS

**Length frequency distribution:** The total length of all individuals (n = 2068) ranged from 9.7-27.4 cm (Fig. 1 and 2). 17.75 cm is considered as the modal value of the distribution.

**Age:** Using otoliths (Fig. 2), nine age classes were determined for both sexes. Means length-at-age direct otoliths reading are represented in Table 1.

**Growth estimation:** The otoliths reading performed without distinction between the sexes by TNPC Software indicates that bogues can live up to nine years. The von Bertalanffy growth equations are as follows (Fig. 3):

$$Lt = 30.045\left(1-\exp\left[-0.117\left\{t+2.919\right\}\right]\right)$$

**Length-weight relationships:** The total length-weight relationships were evaluated separately for both sexes (Fig. 3). The calculated length-weight equation for females was: $W = 0.0039L^{3.2658}$ ($r^2 = 0.9234$).

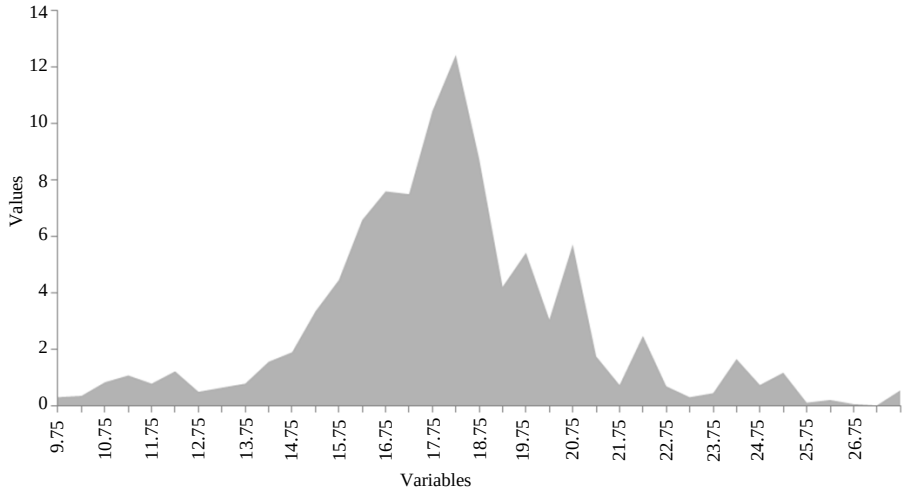


Fig. 1: Total length and weight frequency distribution of *Boops boops*

Table 1: Age-length key of *S. pilchardus* from the western region of Algeria based on otoliths readings.). Average length plus standard deviation (SD) per age

| | Values | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Age | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Mean length | 10.77 | 13.70 | 15.27 | 16.39 | 17.76 | 19.31 | 21.05 | 22.13 | 22.40 |
| SD | 0.48 | 0.68 | 0.58 | 0.63 | 0.68 | 0.45 | 1.30 | 1.55 | 0.45 |

Kooijman and Kooijman (2010) and Pecquerie (2007) may affect variability in growth parameters

Fig. 2: An otolith picture of a specimen of 14.3 cm in total length obtained with a scanner

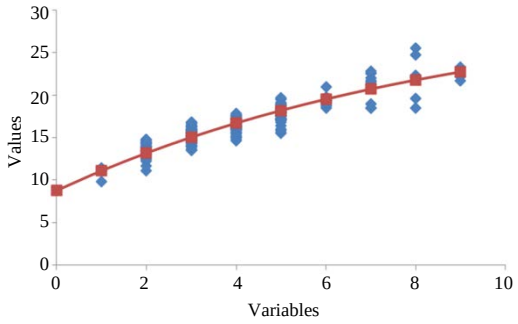


Fig. 3: Von Bertalanffy growth curve of Boops boops in the western coast of Algeria

Weight increased positive allometrically with size since the value of $^{3.2658}$ had not a significant difference from the value 3.0 Using the t–test indicated isometric growth in both sexes based on the comparison of two slopes <1.96 for α = 5%. (t-test , p<0.05) (Fig. 4). The combination of the linear growth equation of Von Bertalanffy with the size-weight relationship allows to establish the weight growth equation:

$$Wt = 261.315\left(1\text{-}\exp\left[-0.117\left\{t+2.919\right\}\right]\right)^{3.2658}$$

**Natural mortality:** The natural mortality coefficient was estimated at 0.24 year$^{-1}$ by the equation of Djabali *et al.* (1994). Total mortality for combined sexes was Z = 0.418 year 1. The calculation of fishing mortality gave F = 0.178 year 1. So, the exploitation rate was computed as E = 0.43.

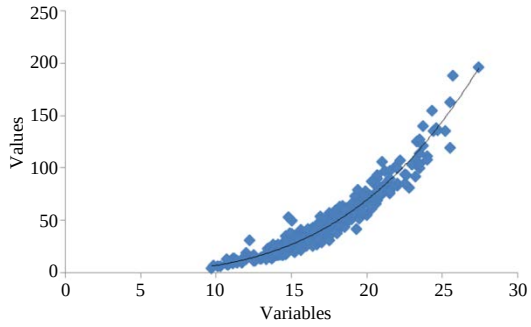


Fig. 4: Length-weight relationships of *B. boops*

## DISCUSSION

The demographic structure obtained for the bogue characterized the population as consisting mainly of medium-sized individuals from 15-19 cm with a sharp peak in the range of 17.75 to of 18.75. These results are similar with those of Kherraz *et al.* (2011) who reported that the structure sizes of *B. boops* from western coasts of Algeria are represented by medium-size individuals (140-160 mm).

Growth analysis performed without distinction between the sexes indicates that bogue can live up to nine years. However, as reported by Lamrini (1988), Von Bertalanffy equation is very sensitive to the number of age groups used for its calculation. The larger and younger people are generally poorly represented in the samples which can affect the fit. The lack of young fish maximizes the values of K (Daget 1976). Nevertheless, the growth approach of bogue from otoliths reading overall provided us a good fit: an asymptotic length (L∞) of 30.045 cm TL and growth curvature (K) of 0.117 year-1. These values indicate a small variance between the values, reported by other authors and the current estimations (Table.2). In the Mediterranean Sea, the value of *B. boops* asymptotic length ranged from 24- 33 cm. The asymptotic length of 30.045 cm, estimated in this study, was considerably greater than values, estimated in other studies in Algerian coast (Bou ismail and Oran) but it is similar with results reported by El-Okda (2008) in Egypt.

The selection of appropriate growth parameters for the development of the assessment is important (Anonymous, 2012b). However, it is very difficult to make a comparison between our results and those obtained by other authors in the Mediterranean Sea (Table 2), because the approach used for age determination (scalinometry, otholitometry, and indirect methods) differs from one author to another. In addition, biotic factors (Khemiri *et al*., 2005) and environmental effects (Kooijman and Kooijman, 2010 and Pecquerie, 2007) may affect variability in growth parameters.

Table 2: Growth parameters of bogue estimated by different methods from various regions

| Region | L∞ | K | t0 | Aging method | Authors |
|---|---|---|---|---|---|
| Morocco (Atlantic) | 32 | 0.29 | -1.481 | Length-frequency | Mennes (1985) |
| Adriatic | 33.2 | 0.168 | -1.46 | Otolith | Hernandez (1989) |
| East Tunisia | 26.7 | 0.22 | -1.98 | Otolith | Khemiri *et al.* (2005) |
| Gulf of Tunis | 24.3 | 0.23 | -1.43 | Otolith | Khemiri *et al.* (2005) |
| North Tunis | 28.7 | 0.2 | -1.65 | Otolith | Khemiri *et al.* (2005) |
| Egypt | 30.11 | 0.15 | -0.3 | Otolith | El-Okda (2008) |
| Algeria (West) | 24.04 | 0.4 | -0.39 | Elefan I | in (2011) |
| Algeria (Center) | 29.66 | 0.33 | 0 | Length-frequency | Rachid *et al.* (2014) |
| Algeria (West) | 30.045 | 0.117 | -2.9187 | Otolith | Actual study |

Table 3: Length-weight relationships of *Boops boops* from different regions

| Sex | a | b | Authors | Country |
|---|---|---|---|---|
| Unsexed | 0.007 | 3.13 | Abdallah (2002) | Egypt |
| Unsexed | 0.0161 | 2.812 | Valle *et al.* (2003) | Spain |
| F | 0.013 | 2.951 | in (2011) | Algeria (West) |
| M | 0.011 | 3.005 | in (2011) | Algeria (West) |
| Unsexed | 0.016 | 2.798 | Rachid *et al* (2014) | Algeria (Center) |
| Unsexed | 0.0039 | 3.2658 | Actual study | Algeria (West) |

The relationship between the size of the bogue and its mass is based on measurement data from the size (total length) and weight of 610 individuals without distinction between the sexes. The correlation between the length and the weight is highly significant ($R^2 = 0.92$); based on the comparison of two slopes, provided a value of 0.74, <1.96, for $\alpha = 5\%$. This result allows us to conclude that bogue of both sexes, captured in the study area, was characterized by an isometric growth but comparing with results obtained by other authors in the Mediterranean Sea, Length-weight relationships shows a difference from study to others that may be explained, in addition to the sexes and the validity of equations, by lengths and weights used when not uniform.

Overall, when comparing the current results to the scientific literature (Table 2 and 3), one can see clearly that the considerable geographical variations that are probably due to sampling quality, methods used, sexes and fluctuations in the physic-chemical parameters of the medium.

At the present level of fishing mortality (F = 0.178), the exploitation rate was computed as E = 0.43, this rate indicates that the stock of *B. boops* is not fully exploited.

## CONCLUSION

The study of Bogue in the western region of Algeria showed that fish with an average size ranging from 17.5 cm to 18.5 cm are the most targeted. This study shows to characterize growth in the Algeria‘s western coast of *B. boops*. The settings on the growth have been estimated from the direct reading of the otoliths, it shows that bogue grow rapidly during the first four years of life, after which growth slows. The oldest specimen was nine years old.
the estimates of exploitation rate (E = 0.43) showed that *Boops boops* stock was not fully exploited (Gulland, 1971). Therefore, we preconise to increase the fishing pressure of bogue.

In the light of the results obtained in this study, the dynamic study of population and indirect estimation of the bogue stock of the Algerian can be initiated because the growth study based on otoliths does not a step for any study concerning the exploitation and the stock estimate in Algerian coasts.

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