Studies on the Migration Behavior of the Species *Engraulis encrasicolus* from the Romanian Black Sea Coast *(Mădălina Galaţchi, George Ţiganov, Cătălin Păun, Cristian Danilov, Daniela Roşioru, Valodia Maximov, Mioara Costache)*	**"Cercetări Marine" Issue no. 49** **Pages 125 - 132**	**2019**

STUDIES ON THE MIGRATION BEHAVIOR OF THE SPECIES *Engraulis encrasicolus* FROM THE ROMANIAN BLACK SEA COAST

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ABSTRACT

The purpose of this study is to highlight new aspects regarding the behavior of *Engraulis encrasicolus* (Linnaeus, 1758) anchovy on the Romanian Black Sea coast, anchovy being one of the most important economically species in the Black Sea riparian countries and with great importance in the trophic chain of the marine ecosystem. Thus, some behavioral aspects in the migration process of anchovy for feeding, reproduction and for wintering are underlined.

Different changes were observed in anchovy behavior: the feeding period overlaps with the breeding period, the temperature is a declining factor of the breeding process, the preparation for wintering determine increased levels of lipids.

Key-Words*:* anchovy, behavior, feeding, reproduction, wintering

AIMS AND BACKGROUND

The main commercial fish species on the Romanian Black Sea coast are: sprat, anchovy, horse mackerel, red mullet, turbot, shark and whiting (Maximov *et al.*, 2018).

In recent decades, the stock of anchovy in the Black Sea has suffered greatly as a result of overexploitation and other factors (Galatchi *et al.*, 2015). The study of anchovy behavior (migration for feeding, reproduction and wintering) is important for understanding changes at the population level and identifying sustainable solutions to manage these problems.

The novelty of this study derives from the highlighting of changes in some aspects of biology and ecology of the anchovy from the Romanian seaside, in the migration process that takes place in the marine basin for feeding, reproduction and wintering. The studies were carried out during the period 2011-2016.

After analyzing the samples collected, it can be noticed that the anchovy biomass captured in the Romanian Black Sea waters registered some fluctuations. The anchovy biomass from Romanian Black Sea coast, had suffered very much after 90's (Fig. 1) the period after the introduction of the ctenophores *Mnemiopsis leidyi* in the marine basin.

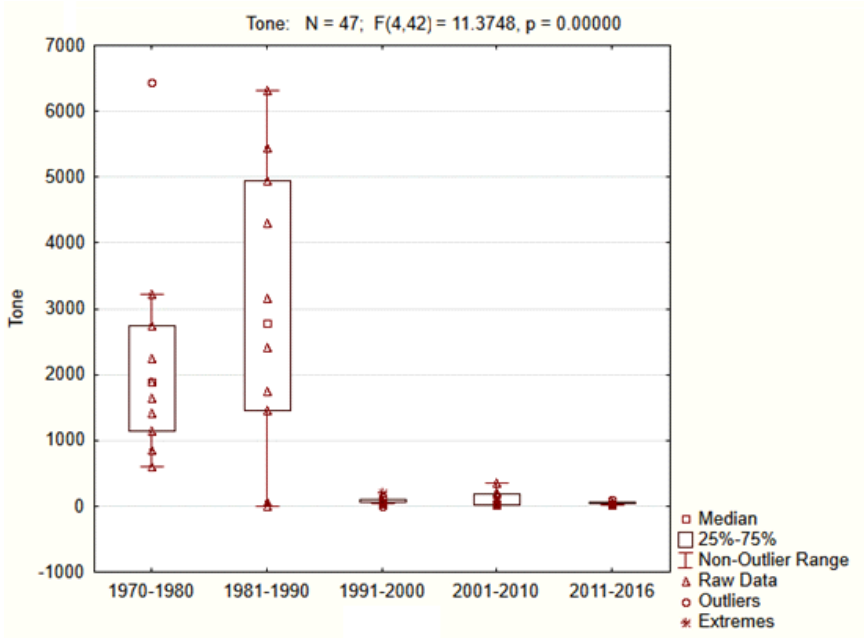

Fig. 1. Evolution on anchovy biomass on Romanian Black Sea coast during 1970-2016 *(NIMRD data).*

At the entire Black Sea basin, the exploitation rates have shown a slight decrease over the past ten years but estimate variances have been very high in the past five years. The three-year recent average exploitation rate of 0.53 is higher than the 0.4 recommended for small pelagic and the stock is determined to be at an intermediate rate of overfishing (Gücü, Ali Cemal 2015).

By-catch discard rates are relatively low, ranging from 1 to 5% for Black Sea purse seiners in general, and 1.64% in Turkish waters, and estimated at 5.1% for pelagic trawlers in Bulgarian and Turkish waters (GFCM and FAO 2016).

EXPERIMENTAL

Information on the Black Sea anchovy migration was obtained by analyzing the samples collected from the fishery points along the Romanian Black Sea coast and the samples collected in the pelagic trawl fishing campaigns from 2011 - 2016. Thus, some aspects of the anchovy biology and ethology were highlighted in the migration period for feeding, reproduction and wintering.

The samples collected were brought and analyzed in the NIMRD Grigore Antipa ichthyology laboratory. The stomach filling coefficient was analyzed using the formula FC = ms / mp x 100 (Frost and Smyly, 1952). After the biometric measurements and the weighing of the individuals the Fulton coefficient was calculated (K), (Beverton& Holt, 1957): K = (g / l 3) x 100.

Fig. 2. The analysis of collected samples *(original photo)*.

The calculation of the gonadal-somatic index was made according to the formula Radu and Maximov, 2006: IGS = Gonad Weight / Total Weight * 100.

Determination of the lipid levels in anchovy tissue was carried out in the Laboratory of Biochemistry of NIMRD "Grigore Antipa", and standard methods of analysis were developed (Roşioru, 2008).

The results were statistically interpreted with both Microsoft Excel 2007 (T, One-Way Anova - Analysis of Variance) and the Statistics v. 10 program. https://statistica.software.informer.com/versions

RESULTS AND DISCUSSION

By analyzing the stomach content of the anchovy specimens collected from May to September, 2014 and 2015, the preference of the anchovy for the zooplanktonic component was represented by: copepods, mollusc larvae, Balanus nauplii; in the analyzed period, the Copepoda group being the one that predominated.

Regarding the value of the Stomach Fill Rate, calculated for the intense feeding period, our results indicate values ranging between 3.96 - 6.77% (average 4.75 ± 0.58%) in 2014 and between 4,21-6,61% (mean value 5,07 ± 0,84%) in 2015.

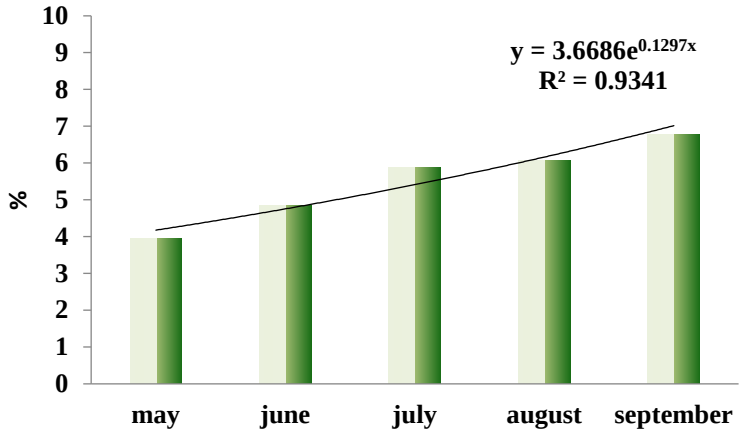

Fig. 3. Anchovy stomach filling factor - monthly average *(original).*

The higher values from one month to the next indicate a continuous increase in the concern of individuals for feeding but also the availability of food (Fig. 3).

Although, CU FC values are similar in both females and males, a higher value was observed in females.

Regarding the stomach filling coefficient (FC), its values for the anchovy batches taken from the feeding, reproduction and wintering areas are significantly different ($p < 0.05$) Fig. 4.

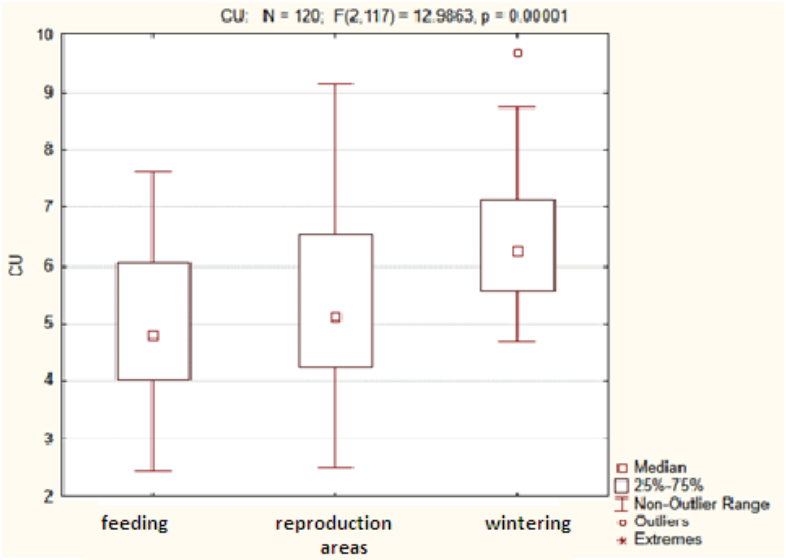

Fig. 4. Comparative values of stomach filling coefficient for anchovy lots in feeding, reproduction and wintering areas *(original).*

Thus, it is noted that the highest value of the CU was identified for the anchovy group in the wintering zone. This confirms the preparation of the species for winter offshore migration where the food resources are limited and the need for accumulation of reserves for survival has increased.

The results obtained regarding the reproduction aspects reveal that the breeding process of anchovy from the Romanian seaside takes place during the summer, from May to September with intensity in June-July; anchovy is present in a high percentage in the breeding area at a water temperature between 16 - 24 ºC.

By analyzing the monthly mean values of the Gonado-Somatic Index (GSI), calculated for both periods (2014 and 2015), it was revealed a close link between GSI and maturation grades. Also, the GSI value increased monthly in both analyzed periods, the anchovy specimens analyzed were in full reproduction process (Tab. 1).

Table 1. Monthly GSI% mean of anchovy *(original).*

	2014	**2015**
May	5,54±0,78	5,63±0,37
June	6,21±1,06	6,22±0,98
July	6,92±0,45	7,02±0,47

Anchovy is a species that invests more in the breeding process than in competitiveness, so we can say that it has a developmental model of type r (Cogalniceanu, 2007) with rapid development and early reproduction.

The migratory behavior of anchovy, to offshore area, for wintering involves an energy storage that is highlighted by a higher level of lipids in muscle tissue.

Concerning the consumption of energy used by anchovy in the migration process for feeding, reproduction and wintering, expressed by the percentage of lipids in the muscle tissue different values were highlighted. The analysis of the lipid level identified in the anchovies in the feeding area, during July-September, revealed an ascending evolution, with values ranging from 9.31-14.33% DS-dry substance (mean value 12.56 ± 1 26% DS).

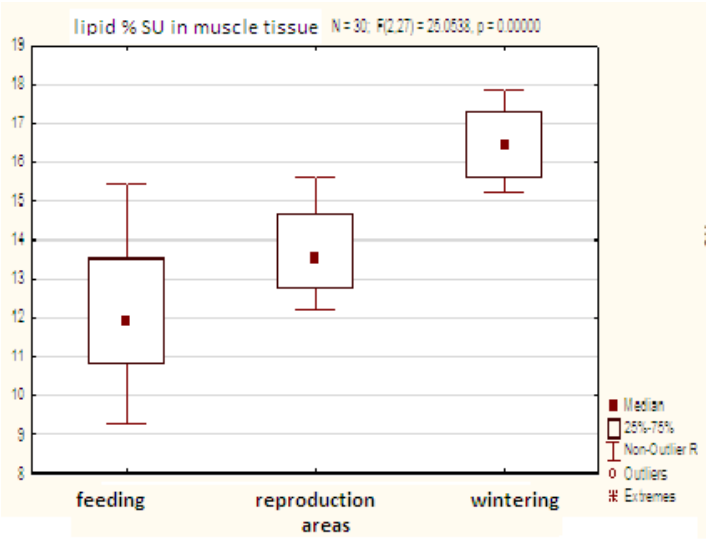

Fig. 5. Comparison of lipid levels in anchovy muscle tissue, for anchovy lots in feeding, breeding and wintering areas *(original)*.

Thus, the highest lipid values analyzed on muscle tissue were identified for the group in the wintering zone (Fig. 5).

Differences in lipid values between groups in feeding and reproduction areas are not significantly different, instead, the lipid values in the wintering zone are significantly different. This highlights the behavior of lipid storage, so energy accumulation, to anchovies, for the lot in the wintering zone. Thus, the behavior of anchovies to accumulate energy (lipid deposits) for the winter period is highlighted.

CONCLUSIONS

Regarding the filling coefficient of the stomach (FC), calculated for the intensive feeding period, the results indicate values ranging between 3.96 - 6.77% (mean 4.75 ± 0.58%) in 2014 and between 4.21-6.61% (average value 5.07 ± 0.84%) in 2015. The higher values from one month to the next indicate a continuous increase in the concern of individuals for feeding, but also availability of food.

By analyzing the monthly mean values of the gonadal-somatic index (GSI) calculated for the period (2014-2015), we identified a close link between IGS and maturation levels. Also, the GSI value increased monthly in both analyzed periods.

Regarding the migration process of anchovies wintering, ranges from October to March and is triggered by a temperature change that has a direct effect on the feeding process. The lipid level identified in the anchovies in the feeding area in July-September showed an upward trend, with values ranging from 9.31-14.33% DS (mean value 12.56 ± 1.26% DS).

By analyzing the anchovy group in the wintering area on the Romanian seaside average values of lipids in the muscle tissue of 16.47 ± 0.28% DS was identified so energy accumulation to anchovies, for the lot in the wintering zone is very high.

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