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STOCK ASSESSMENT OF THE HORSE MACKEREL, *TRACHURUS MEDITERRANEUS PONTICUS* IN THE BULGARIAN BLACK SEA COAST

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Резюме : *Черноморският сафрид е един от ценните в стопанско и екологическо отношение видове обитаващи българският бряг на Черно море. Промените в запасите му са силно зависими от риболовната преса и интензивната експлоатация.. Стойностите за установяване характера на линейното нарастване на вида са: L_t=21.48(1^{-e}-0.341 (t+0.8194) за мъжките и L_t=19.26(1^{-e} - 0.270(t+0.9341) за женските екземпляри. Получената стойност на "Z" по метода на Jones and Van Zalinge (1981) = 1.0241 год.$^{-1}$ за мъжките и 1.1441 год.$^{-1}$ за женските екземпляри. Коефициентта на естестевена смъртност е "M"= 0.78 год.$^{-1}$ за мъжките и 0.70 год.$^{-1}$ за женските риби.*

Ключови думи: *ихтиология, сафрид, Tr .m.ponticus, запас, черноморско крайбрежие*

INTRODUCTION

The fishes of the family Carangidae, popularly known as horse mackerel and scads are a fairly important group of pelagic fishes caught by midwater trawls. They contribute a large percentage of the total catch of the midwater trawls fishery. Despite the economic importance of fishes belonging to the family Carangidae in the Bulgarian Black Sea coast, relatively little is known about stock assessment studied.

VPA estimates in the Black Sea showed that the stock was highest in 1984-1988 (Prodanov *et al*. 1984). According to Bryantsev *et al.* (1994) and Chashchin (1998), the intensive fishing in Turkish waters in 1985 – 1989 led to overfishing of horse mackerel population and reduction of the stock and catches in the subsequent years. A drastic decline in stock abundance occurred after 1990 when the stock was diminished by 56%. In 1991 the horse mackerel stock dropped to a minimum of 75 thousand tons and the catch dropped to 4.7 thousand tons that was a twenty fold reduction compared to the average annual catch in 1985 – 1989. During 1985 – 1993, a relatively successful recruitment was recorded only in 1988. Despite its coincidence with the first year of *M. leidyi* outbreak, the juveniles from this cohort were sufficiently well-supplied with food. As the first outburst of *M. leidyi* occurred in the autumn of 1988, the summer zooplankton maximum production did not suffer much from the devastating effect of *M. leidyi.* The copepods *Oithona nana* and *Oithona similis* which constituted the main food of larval horse mackerel (Revina 1964) were especially abundant. However, the favorable trophic conditions for larvae in summer 1988 failed to ensure the

formation of a strong year-class because juveniles were faced with strong feeding competition with *M. leidyi* further in the year. Sharp decline in Oithona under the predation pressure of *M. leidyi* in the subsequent years (Shushkina and Musaeva, 1990; Vinogradov *et al*., 1993) affected the survival of horse mackerel. Dietary studies of juvenile and adult horse mackerel (Revina 1964) have shown that both the habitat diet of juvenile horse mackerel and *M. leidyi* overlapped, therefore the strong feeding pressure by *M. leidyi* on zooplankton directly affected larval and juvenile horse mackerel. The current stock status of the horse mackerel in the Black Sea, according to the last research (Cardinale *et al.* 2015) indicated that fishing mortality in 2014 was estimated to be F = 1.5, corresponding to an exploitation rate of E = 0.79, which is almost twice the F_{MSY} exploitation rate of E = 0.4. The stock has been exploited at rates exceeding F_{MSY} for several years (Cardinale *et al.* 2015).

The present study discusses and estimates the basic parameters required for assessing and managing of *T. m. ponticus* stock in the Bulgarian Black Sea coast.

MATERIALS AND METHODS

Length frequency data of *Tr. mediterraneus* were collected from trawl and fishing net catches in the Bulgarian Black Sea territorial waters during the period May 2013 to December 2013. A total of 3400 fish were collected throughout the study period.

The instantaneous total mortality coefficient (Z) was estimated using the length converted catch curve method (Gayanilo et al. 1989). Natural mortality (M) was estimated by using Pauly's (1980) empirical formula, i.e:

$$\text{Log}(M) = (-0.0066) - 0.279\ \text{Log}(L_\infty) + 0.6543\ \text{Log}(k) + 0.4634\ \text{Log}(T)$$

Where: L_∞ is expressed in cm (total length) and T (ºC) is the mean annual environmental temperature (it was taken at 14ºC).

The relative yield-per-recruit (Y'/R) was estimated using the knife-edge method of Beverton and Holt model (1957):

$$Y'/R = EU^{M/k}[1-(3U/1+m)+(3U^2/1+2m)+(U^3/1+3m)]$$

where: $m = (1 - E)/(M/k) = k/Z$

$$U = 1 - (L_c/ L_\infty)$$

$$E = F/Z$$

RESULTS AND DISCUSSION

Age determination

Otoliths were used to age horse mackerel in the Bulgarian Black Sea coast. By examining the mounting otoliths, the focus appears as a dark point followed by alternating hyaline and opaque zones. Each hyaline zone and opaque zone together makes an annual ring. Several findings indicate that rings on horse mackerel otoliths are true annuli.

Age composition

Age composition of horse mackerel in the Bulgarian Black Sea varied between the two sexes. The results indicated that, the oldest males belonged to age group V while the oldest females belonged to age group IV. It was also noticed that , age group II was the dominant age group in the catch for both sexes and constituted 44.19% for males and 57.10% for females. This means that, *T. mediterraneus* stock in the Bulgarian Black Sea water is fully recruited to the purse seine fishery at age group II.

Growth in length

The otolith measurements of 354 males and 220 females of *T. mediterraneus* were used to describe the relationship between the total length and the otolith radius. This relationship is linear and can be represented by the following equations :

$$\text{Males: } L=3.8765+4.1298S \text{ with } r=0.9122$$

$$\text{Females: } L=3.4375+4.5912S \text{ with } r=0.9542$$

Where: L is the total length in centimeter, S the otolith radius in millimeter and r the correlation coefficient.

The total lengths at the end of each year of life were back-calculated using Lee's equation (1920) as follows:

$$\text{Males: } L_n=(L-3.92123)S_n/S+3.38979$$

$$\text{Females: } L_n=(L-3.4512)S_n/S+3.78992$$

Where: L_n is the length at the end of n year, S_n the radius of otolith to n^{th} annulus, S the total radius of otolith and L the total length at capture.

Growth parameters of the von Bertalanffy equation were separately evaluated for females and males as follows: $L_t=21.48\{1-\exp[-0.341(t+0.8194)]\}$ for males and $L_t=19.26\{1-\exp[-0.270(t+0.9341]\}$ for females.

Length-weight relationship

Length and weight measurements of 354 males and 611 females were used to describe the length-weight relationship of *T. mediterraneus*. For males, the total length varied from 7 to 18.5 cm while the total weight ranged between 9 and 26g. For females, the total length ranged between 8 and 17.5cm while the total weight varied between 10 and 24g. The obtained equations were as follows:

$$\text{Males: } W=0.008339L^{3.055}$$

$$\text{Females: } W=0.007557L^{3.055}$$

The values of the constant "b" obtained from this study are more or less similar to those mentioned in the previous studies (Yankova, 2009; Yankova, Raykov 2009; Yankova et al., 2010).

Growth in weight

The obtained results indicated that the growth rate in weight for both males and females was much slower during the first year of life. The annual growth increment in weight increased with further increase in age until it reached its maximum value at the end of the third year of life after which, a decrease in the growth increment was observed.

Mortality rates

The instantaneous total mortality coefficient "Z" of *T. mediterraneus* was estimated by two different methods. The first depends on the analysis of catch curve based on age composition data (Ricker, 1975) and the second depends on the analysis of catch curve based on the length frequency data (Jones and Van Zahnge, 1981) (Fig.1). The obtained results indicated that, the estimated values of Z and S from applying the two methods are very close to each other. It is obvious also that, females are characterized by a relatively higher Z values than males Z= 1.0241 $year^{-1}$ for males and 1.1441 $year^{-1}$ for females.

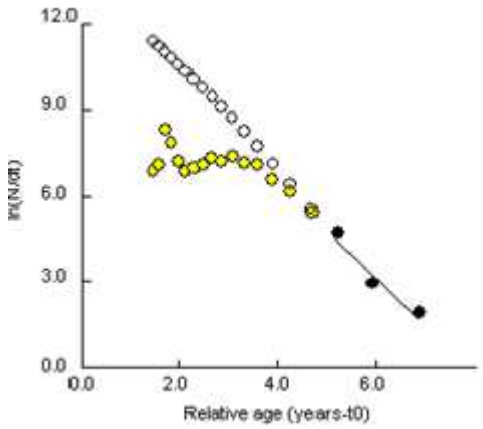

Figure 1. Estimation of "Z" value of *T. m. ponticus* from Bulgarian Black Sea coast using Jones and Van Zalinge 1981 method.

Natural mortality coefficient

In the present study the formula suggested by Pauly was applied to estimate the natural mortality coeficient M of males, females and sexes combined of *T. mediterraneus ponticus* in the Bulgarian Black Sea coast. The obtained results indicated that M values of males and females of *T. mediterraneus* are 0.78 год$^{-1}$ and 0,70 год$^{-1}$ respectively.

Yield per recruit "Y/R"

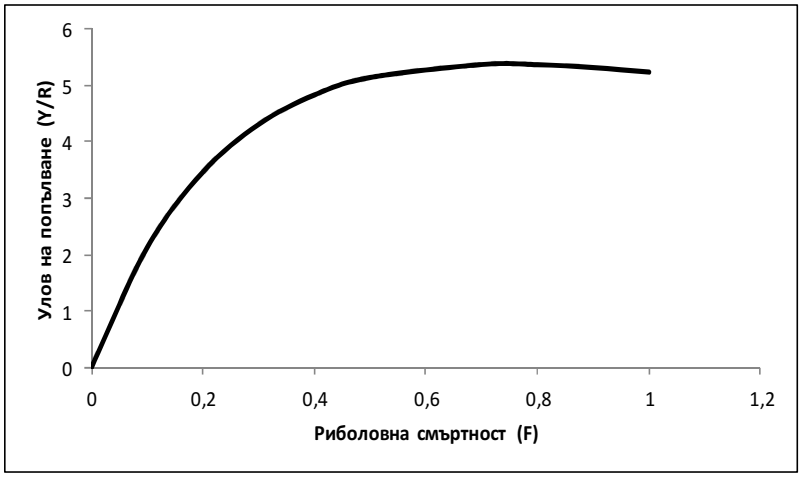

Figure 2. Yield per recruit of horse mackerel as a function of fishing mortality and age at first capture.

The results are represented graphically in Figure 2. As seen from the Figure, the curve starts at the origin where the yield per recruit is zero where the fishing mortality is zero. Then the yield per recruit increases with the increase of fishing mortality and reaches its maximum value at fishing mortality coefficient equal to 0.6, after which, the yield per recruit decreases with further increase in fishing mortality.

The obtained results indicated that the horse mackerel stock in the Bulgarian waters in a situation of overexploitation and the fishing effort must be reduced as well as the age at first capture must be raised to maintain the productivity of this stock.

REFERENCES

Beverton, R.J.H., Holt, S.J., 1957. A review of methods for estimating mortality rates in exploited fish populationsq with special reference to sources of bias in catch sampling. Rapp. P.-V. Reun. CIEM, 154:44-67.

Bryantsev, V. A., Serobaba I. I., Shlyakhov V. A., Yakovlev V. N. 1994. Biological resources of the Black Sea in the present ecological conditions. Proceeding of the Black Sea Symposium Ecological Problems and Economical Prospects (Ed. K. C. Guven). Istanbul, Acar Matbaacilik A.S, 293-296.

Cardinale, M., Daskalov, G., Ak, O., Chashchyn O., Dagtekin M., Duzgunes E., Gucu Ali C., Leonchyk Y., Ligas A., Mannini A., Maximov V., Murenu M., Panayotova M., Radu G., Raykov V., Yankova M., Zengin M. 2015 Scientific, Technical and Economic Committee for Black Sea Assessments (STECF-15-16). EUR – Scientific and Technical Research series – ISSN 1831-9424 (online), ISSN 1018-5593 (print) ISBN 978-92-79-52737, doi:10.2788/29417.

Chashchin, A. K. 1998. The anchovy and other pelagic fish stock transformations in the Azov-Black Sea basin under environmental and fisheries impact. The proceedings of the First International Symposium on Fisheries and Ecology, 1-10.

Gayanilo, F.C. Soriano JR., M., Pauly D., 1989. Adratt guide to the Complete ELEFAN.ICLARM Software, 2,70 p.

Harley, C. D. G., Hughes, A. R., Hultgren, K. M., Miner, B. G., Sorte, C. J. B., Thornber, C. S., Rodriguez, L. F., et al. 2006. The impacts of climate change in coastal marine systems. Ecology Letters, 9: 228–241.

Jones, R., van Zalinge, N.P., 1981. Estimates of mortality rate and population size for shrimp in Kuwait waters. Kuwait Bull. Mar. Sci., 2: 273-278.

Lee, R. M. (1920). A review of the methods of age and growth determination in fishes by means of scales. Fish. Invest. Min. Agr. Fish., Ser. 2, 4 (2): 1 - 32.

Lehodey, P., Alheit, J., Barange, M., Baumgartner, T., Beaugrand, G., Drinkwater, K., Fromentin, J. M. 2006. Climate variability, fish, and fisheries. Journal of Climate, 19: 5009–5030.

MacKenzie, B. R., and Koöster, F.W. 2004. Fish production and climate: Sprat in the Baltic Sea. Ecology, 85: 784–794.

Pauly, D., 1983. Some Simple methods for the assessment of tropical fish stock. FAO Fish. Tech. Pap No. 234, pp: 52.

Prodanov K., Mikhailov K., Daskalov G. M., Maxim K., Chashchin A., Arkhipov A., Shlyakhov V.,Ozdamar E. 1997. Environmental management of fish resources in the Black Sea and theirrational exploitation. Studies and Reviews. GFCM. 68, FAO, Rome, 178pp.

Revina N. I. 1964. Biological research of the Black Sea and its fishing resources. On provision of anchovy and horse mackerel larvae with feed in the Black Sea. Proceedings of AzCherNIRO, Kerch, 23, 105-114 (in Russian).

Ricker, W.E., 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish Res. Board Can., 191: 382.

Shushkina E. A., Musaeva E. I. 1990. Structure of the plankton communities in the epipelagic zone of the Black Sea. Oceanology, 30(2), 306-310 (in Russian).

Tasker, M. (Ed.) 2008. The effects of climate change on the distribution and abundance of marine species in the OSPAR maritime area. ICES Cooperative Research Report, 293. 45 pp.

Von Bertalanffy, L. 1938. A quantitative theory or organic growth laws. Hum. Biol., 10: 181-213.

Vinogradov M. E., Shushkina E. A., Nikolaeva G. G. 1993. State of zoocenoses in the open areas of the Black Sea in late summer 1992. Oceanology, 33(3), 382-387 (in Russian).

Yankova M., 2009. Condition factor, sex ratio and length-weight relationship, of Horse mackerel (*Trachurus mediterraneus*) from the Bulgarian Black Sea coast. Proceedings of the Union of Scientists - Varna, Series “Technical Sciences” 2’2008/1’2009, 70 - 72.

Yankova M., Raykov V., 2009. Resent investigation on population structure of Horse mackerel (Trachurus mediterraneus ponticus Aleev., 1956) in the Bulgarian Black Sea coast. Proceedings of the Institute of Fishing Resources Varna, Volume 27, 39 - 46.

Yankova M., Raykov V., Gerdzhikov D., Bogomilova P., 2010. Growth and Length-Weight Relationships of the Horse Mackerel, *Trachurus mediterraneus ponticus* (Aleev, 1956), in the Bulgarian Black Sea Coast. Turkish Journal of Zoology, Volume 34, Issue 1, 85 - 92.

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