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RECENT FINDINGS ON TURBOT'S SPAWNING PERIOD AT THE ROMANIAN COAST

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ABSTRACT

Spawning is the most critical stage in the life cycle of a species,on which its perpetuation depends. Given the context generated by climate change, manifested by rising air and seawater temperatures, there have been observed changes in recent years in the breeding behaviour of some fish species in the Black Sea. Thus, for the turbot *Scophthalmus maeoticus* (Pallas, 1814), one of the species with high economic value, we conducted a study on five females, captured at the end of May 2020. The individuals had a total body weight varying between 1400-2700 g and a total length between 43-56 cm, respectively.

Our research highlighted a high value of the gonadosomatic index, between 10.41-15.39% and the relative fecundity varying between 298,000-450,150 eggs/kg body weight. Analyzing the maturity degree of the gonads, a differentiated development of the oocytes was observed, indicating a high probability that the spwaning period continued until the end of June.

These results show a high reproductive activity at the end of the prohibition period, as it is currently stipulated, thus requiring a re-evaluation of the temporal placement of these yearly restrictions.

Key-Words*:* turbot, gonadosomatic index, relative fecundity, prohibition

AIMS AND BACKGROUND

One of the most valuable commercial fish species, turbot inhabits the continental shelf of the Black Sea (Nelson, 2006; Maximov, 2012).

Also, it is a species with particular importance, being suitable for practicing fishing industry. By ensuring a proper management of the operation, turbot may give a chance to relaunch marine fisheries, considering that the supply of valuable local fishery products on the market is currently quite weak (Niţă, 2013).

The fish and the seafood consumption (coming both from local production and import) in Romania has increased in recent years; if in 2017 it

was estimated at 5.96 kg per capita (Fig. 1), in 2018 it was estimated at 7.90 kg per year (Eumofa, The EU Fish Market, 2019).

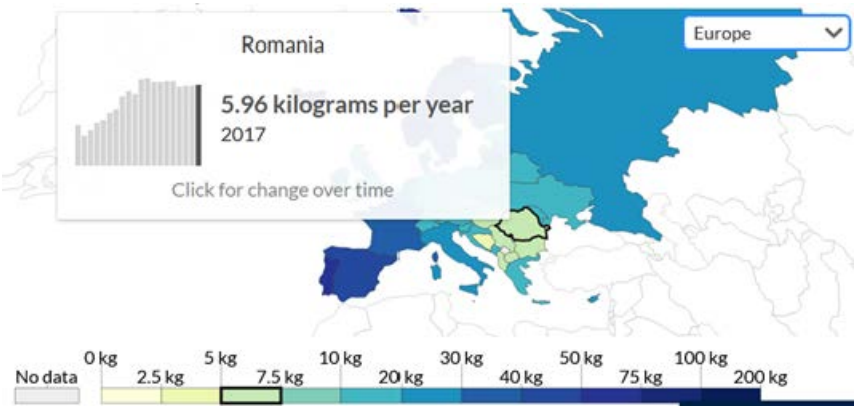


Fig. 1. Fish and seafood consumption per capita, 2017
Source: *www.ourworldindata.org/UN-FAO*

However, we estimate higher consumption from recreational fisheries, another fishing subsector for which data are typically limited and from illegal, unreported and unregulated fishing (IUU). The main IUU fishing species in the Black Sea is the turbot (Öztürk, 2013).

In Bulgaria it is caught by specialized bottom – set gill nets, as well as illegally by bottom trawls. Turbot is also by – catch of sprat fisheries and beam trawls targeting on *Rapana venosa* (Panayoyova et al., 2012).

Thus, the pressure on living marine resources, at Romanian coast, has also increased in recent years (Fig. 2).

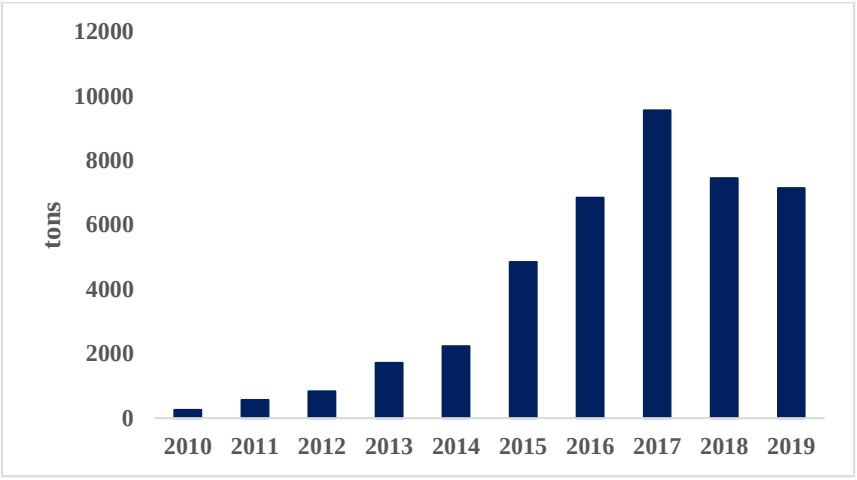


Fig. 2. Total catch of all aquatic organisms (NAFA, 2019)

Although, the total catch has increased, mainly due to the growing interest of economic operators for the *Rapana venosa* species (Maximov et al., 2018), the catches of other species of commercial interest have also increased, including the turbot (Fig. 3).

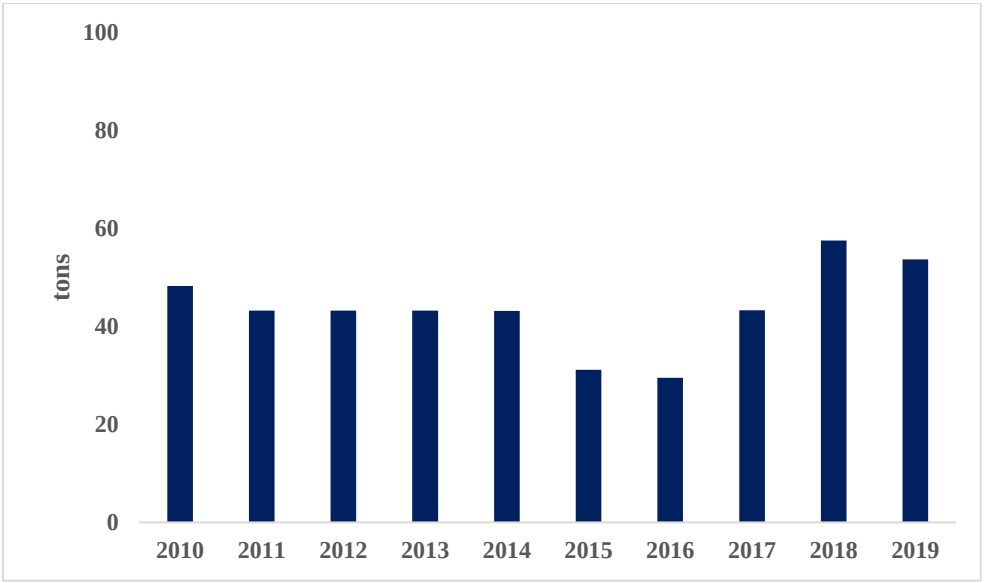
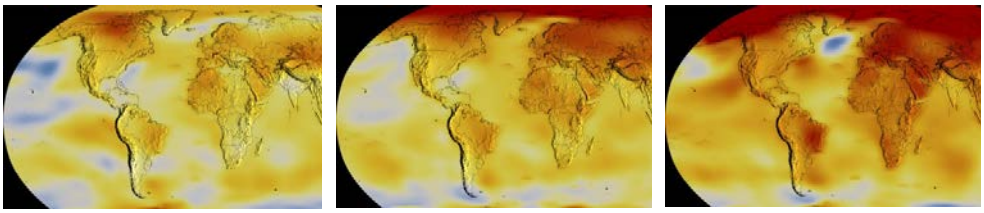


Fig. 3. Total catches of turbot on Romanian coast (NAFA, 2019)

In all Black Sea countries turbot is one of the most valuable fishery resources thus, it is necessary to analyze the changes within the population and the implications for the entire ecosystem where inhabits.

The temperature changes, that cause global warming, can modify the structure of the ecosystem community over a period of time (Hiddink and Ter Hofstede, 2008; Stuart-Smith et al., 2010). Globally, the average temperature of the Earth's surface has increased by more than 0.8° C since the middle of the XIXth century and continues (Fig. 4), is heating at a rate of over 0.1° C in each decade (Hansen et al., 2010).



2000 2009 2019

Fig. 4. The change in global temperature over time
Source: https://climate.nasa.gov/vital-signs/global-temperature/

In the current context generated by climate change, modifications have been observed in recent years in the reproductive behaviour of some species of fish in the Black Sea (Schulman et al., 2011; Gucu et al., 2016; Galaţchi et al., 2019).

Various studies have shown that in addition to sea currents (Laevastu et al., 1996; Do Prado FD et al. 2018) other external factors also have effects on turbot spawning, water temperature being the one that triggers this process (Maximov, 2012).

EXPERIMENTAL

In late of May this year NIMRD scientists, carried out research surveys with research vessel equipped with demersal trawl, operated survey along the Black Sea coast, and sampled ichthyofauna for qualitative and quantitative analysis of catches; the information obtained is necessary for the evaluation of fish stocks within the National Fisheries Data Collection Program.

Turbot specimens collected during research expeditions were measured, weighed and female gonads were removed and preserved in alcohol. Then, in the laboratory the gonadosomatic index (GSI) and relative fecundity were calculated. The gonadosomatic index represents the ratio of gonad weight to body weight used to estimate reproductive status (Radu et al., 2006) GSI= g x 100/G.

Yeldan and Avsar (2000) reported that GSI is widely used in order to examine the spawning period because its value is directly related to the development of the gonad.

The gonadosomatic index is the most vital parameter which provides significant information about the cyclic changes taking place during different seasons (Jan and Jan, 2017).

Relative fecundity was expressed in number of eggs to kg of body weight (Hara et al., 2002). Fecundity is the physiological maximum potential reproductive output of an individual (usually female) over its lifetime and represents one of the major cornerstones of theoretical and applied population biology (Bradshaw and McMahon, 2008).

This information is needed to analyze the reproductive potential and its survival rate in order to develop an adequate management of turbot fishing; these were correlated with temperature changes.

RESULTS AND DISCUSSION

Sexual maturity and the intensity of reproduction in fish are of great practical importance Yeldan and Avsar, 2000). A species that reproduces late (such as turbot) must be exploited responsibly so that the population is not affected.

Factors influencing temporal variation in fecundity include age, body size relationships, the effects of population density, mate choice, and environmental variability (Bradshaw and McMahon, 2008).

Temperature has actions on hormone synthesis, secretion and metabolism. Consequently, higer than normal temperatures can substantially modify endocrine profiles (Kraak and Pankhurst, 2003).

During the expedition for fisheries data collection, when ichthyological samples were taken, the sea surface temperatures varied between 16.5-20.5°C (Fig. 5).

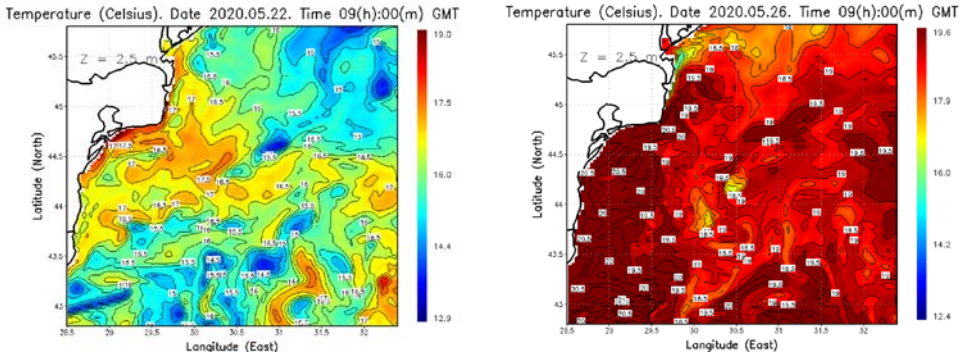


Fig. 5. Sea surface temperature during the sampling period
Source: http://www.rmri.ro/Home/Products.Forecasts.html

In the field expedition from the end of April to the beginning of May, in 2019, the percentage of females that had already laid eggs was over 70% of all captured individuals. In this year's expedition, at the end of May, the percentage of females in full reproduction phase (Photo 1) was about 80%.

Photo 1. Turbot female in full reproductive process (original photos NIMRD, 2020)

In most studies about the spawning period of turbot, in the Black Sea basin (Table 1), it was highlighted that it lasts between April and June.

Table 1. Reproduction period of *S. maeoticus* at Black Sea level

BS area	Ian	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	References
Ro													Radu et al., 2010
Tr													Aydin & Shakin, 2011
Tr													Erylmaz & Daylan, 2015
Ro													Maximov, 2015
Uk													Giragosov et al., 2012
Tr													Aydin et. al., 2019
Ro													Present study

Analyzing the maturity degree of the gonads, a differentiated development of the oocytes was observed (Photo 2).

Photo 2. Differentiated development of the oocytes of turbot females (original photos, 2020)

This, indicating a high probability that the spawning period continued until the end of June. Shlyakhov and Charova (2003) indicated that the water temperature needed for the spawning of the turbot is 8–12ºC.

A study from Turkish Black Sea coast (Eryilmaz and Dalyan, 2015) showed the optimal temperature for reproduction in May of 12.5ºC.

In our study, we measured the water temperature with CTD in the sampling areas and varied between 12.7-13.5ºC.

Analyzing GSI we noticed a decrease in the value of this indicator when the temperature increased (Table 2). Increasing values of GSI indicate high development of the gonads; values of GSI close to 10% indicate individuals in full reproduction process (Islam et al., 2012).

Our study highlighted high GSI values, which indicates a favorable status for the individuals analyzed, in full reproductive process.

Regarding the relative fecundity values, they varied between 298,000-450,150 eggs/kg body weight.

Table 2. Information regarding the turbot individuals

date	coordinates	length (cm)	total weight (g)	gonads weight (g)	GSI %	Temperature °C
26.05.2020	43°56’353” N 29°24’853” E	50/39/42	2400	250	10.41	13,5
23.05.2020	43°46’535” N 28°44’300” E	56/46/47	2700	300	11.11	13,4
23.05.2020	43°46’535” N 28°44’300” E	47/38/38	2150	250	11.62	13,2
22.05.2020	43°58’113” N 28°53’139” E	43/34/35	1400	200	14.28	12,9
22.05.2020	43°58’113” N 28°53’139” E	42/31/33	1300	200	15.39	12,7

According to Hara (2002), the relative fecundity of turbot (Turkish Black Sea waters) varies between 400,000-500,000 eggs/kg body weight. Hubenova (2019) show for the relative fecundity on turbot (Bulgarian Black Sea waters) values around 470,000 eggs/kg body weight.

Knowing the fecundity of a species is an important factor in the rational exploitation of the fish stock and is also used in the analysis of the breeding and survival potential of the stock (Follesa and Carbonara, 2019), thus, further study on the fecundity of turbot in relation to the environmental factors is necessary to continue.

CONCLUSIONS

Determining sexual maturity and the succession of changes in maturity during the year are of considerable importance in building an in-depth knowledge of the general biology of an exploited stock.

During the sea expedition, at the end of May, the percentage of females in full reproduction phase was about 80%.

The high GSI values (10,41-15,39%) indicated a favorable status of the individuals analyzed.

Analyzing GSI we noticed a decrease in the value of this indicator when the temperature increased.

The relative fecundity values varying between 298,000-450,150 eggs/kg body weight showed that the analyzed specimens were in full reproduction season.

In our opinion, the yearly fishing ban period should be extended until 30 June, due to turbot's spawning period extending to late June.

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