

REPORT



**BIOLOGICAL MONITORING OF TURBOT
(*SCOPHTHALMUS MAXIMUS*) LANDINGS AT THE
BULGARIAN BLACK SEA DURING AUTUMN-WINTER
SEASON 2016**

Agricultural Academy, Sofia

Institute of Fisheries and Aquaculture, Plovdiv

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List of authors:



Institute of Fisheries and Aquaculture, Plovdiv

- Prof. Tania Hubenova, PhD;
- Prof. Angel Zaikov, PhD;
- Assis.Prof. Angelina Ivanova, PhD;
- Assis.Prof. Maria Gevezova, PhD;
- Assis.Prof. Georgi Rusenov

1. Purpose

The purpose of the biological monitoring of the turbot catches at the Bulgarian Black Sea was to collect biological data which will be used for analysis of the catches, and for the development of data base for tracking the changes in the catches' structure over the years. The collecting of biological samples, from landing of turbot catches during autumn-winter season 2016, consists of the following main tasks:

- Collecting data for landing ports, vessels selected for sampling, number of collected samples, number of studied individuals, geographical data for the catches;
- Determination of size-weight structure of the landings of turbot
- Characterization of the reproductive biology of turbot.

2. Materials and methods

2.1. Collection of biological data from landing operations

The biological data collection is performed in autumn - winter period 2016 at the northern Bulgarian Black Sea coastal zone.

2.1.1. Ports for collection of biological data

From ports where landings of turbot are permitted - Kavarna, Balchik and Varna ports are used for biological data collection.

2.1.2. Vessels for sample collections

Biological data is collected from 14 ships – 8 ships from Kavarna port, 2 ships from Balchik port and 4 ships from Varna port. The information is presented in **Table 1**

2.1.3. Number of collected samples

Biological data is collected from 26 catches unloaded from the vessels on the three ports – Kavarna, Balchik and Varna.

2.1.4. Number of measured turbot

The total number of fish used for biological data collection is 372, with required minimum of 300 specimens under contract D-59/05.07.2016 from IAFA.

Table 1. Ports and vessels used for monitoring and biological data collection during landings of turbot caught in December 2016

№	Port Kavarna	
	ships	
1	KB 6241 Hera	
2	BH 4321 Gondola	
3	BH 4601	
4	BH 4496 Amber	
5	KB 5642 Puldin	
6	KB 6296 Pirania	
7	KB 6262 Hishtnik	
8	KB 5562 Gulliver	
Port Balchik		
ships		
9	BH 7643 KorsarII	
10	BC 5322 Eliz	
Port Varna		
ships		
11	BH 8195 Egeo 3	
12	BH 4926 Hermes 3	
13	BH 8194 Iva 1	
14	BH 3554 St. George	

2.1.5. Geographical data of the fish catches

The coordinates and depth of places of catch for ships that landed at port Kavarna, Balchik and Varna are shown in **Table 2**. For 6 ships the catch places are not presented, but the missing catch sites are close to the ones in the table.

Table 2. Coordinates and depth of the turbot catch place

№	Ship	Coordinates of catch places		Depth of catch places
		latitude	longitude	
1.	Hera/KB 6241	43° 11' 5"	28° 18' 59"	55-60
2.	Gondola/BH 4321	42° 12' 47"	28° 17' 40"	62
3.	BH 4601	42° 13' 4"	28° 12' 25"	60-66
4.	Amber/BH 4496	43° 13' 5"	28° 14' 53"	64-65
5.	Puldin/KB 5642	43° 10' 1"	28° 16' 29"	60
6.	Hera/KB 6241	43° 11' 5"	28° 18' 59"	60-62
7.	Puldin/KB 5642	43° 10' 1"	28° 16' 29"	60-62.5
8.	Pirania/KB 6296	43° 13' 16"	28° 12' 48"	70-73
9.	Hishtnik/KB 6262	43° 13' 39"	28° 10' 13"	60
10.	Puldin/KB 5642	43° 13' 20"	28° 13' 10"	67

11.	Amber/BH 4496	43° 13' 5"	28° 14' 53"	62.5
12.	Gondola/BH 4321	43° 13' 1"	28° 14' 10"	63
13.	Hera/KB 6241	43° 13' 55"	28° 11' 19"	65
14.	Hera/KB 6241	43° 13' 55"	28° 11' 19"	63
15.	Puldin/KB 5642	43° 12' 57"	28° 11' 48"	60
16.	Gulliver/KB 5562	43° 13' 6"	28° 9' 44"	66
17.	Amber/BH 4496			63
18.	BH 4601			62
19.	KorsarII/BH 7643	43° 17' 14"	28° 11' 10"	60
20.	KorsarII/BH 7643			62.5
21.	KorsarII/BH 7643	43° 13' 39"	28° 11' 10"	63
22.	Eliz/BC 5322			65
23.	Egeo 3/BH 8195			
24.	Hermes 3/BH 4926			
25.	Iva 1/BH 8194			
26.	St. George/BH 3554	42° 34' 12"	28° 5' 24"	

2.2. Determining the size and weight structure of turbot landings

The measurements of the fish are made on board of the ships immediately after docking at the port, on fresh ice-cooled subjects. The weight measurement is done with a precision of 0.1 g, while that of total and standard lengths – with a precision of 0.1 cm.

The relation between length (TL, cm) and weight (W, g) is determined using LeCren (1959) equation:

$$W = aL^b, \text{ where:}$$

- W – weight (g);
- L – total length (TL, cm);
- a – constant;
- b – growth coefficient.

2.3. Fulton's coefficient

Fulton's coefficient is calculated using the formula $K = W/L^3 * 100$

2.4. Determination of fish age

The age of the fish (50 specimens) is determined by the concentric circles (zones) of the otoliths which correspond to periods of growth. Otoliths are taken out through the gills of the fish, without opening the skull, each pair is carefully detached without damaging the otoliths.

After the otoliths are cleaned, the age of the individuals is determined by using stereomicroscope.



2.5. Characteristics of the reproductive biology of turbot

50 specimens of turbot, caught during the autumn and winter season, were bought for gender and age structure analysis. From the collected samples of the reproductive organs gender, gender ratio, gonadosomatic index, maturation of sex organs is determined.

• Gender ratio

The gender of 50 specimens of turbot caught during the autumn-winter season is determined. The ratio between female and male is expressed, together with the relation between gender and age, and age and total length.

• Gonadosomatic index (GSI, %)

Gonadosomatic index (GSI,%) is defined based on 50 individuals during autumn - winter season of 2016 - 33 female and 17 male fish. GSI is calculated as % of weight for each gender

separately, using the data from weight measures of the body and the gonads of female and male fish, according to Wootton formula (1998):

$$\text{GSI (\%)} = 100W_G \cdot W^{-1}, \text{where:}$$

W_G -weight of the gonads, g;

W -body weight, g.

• **Determination of the maturity stage of the reproductive organs**

The reproductive organs collected from the fish are dissected and fixed in formaldehyde for further processing to determine the maturity stage of the testis and ovary.

3. Results

3.1. Number of fish caught from each vessel

The total number of fish, used for biological data collection, is 372. The number of fish caught from each vessel and their percentage distribution is presented in **Fig. 1** and **Fig. 2**. An average of 27 turbot is caught from each ship, with maximum of 61 and minimum of 3 turbot.

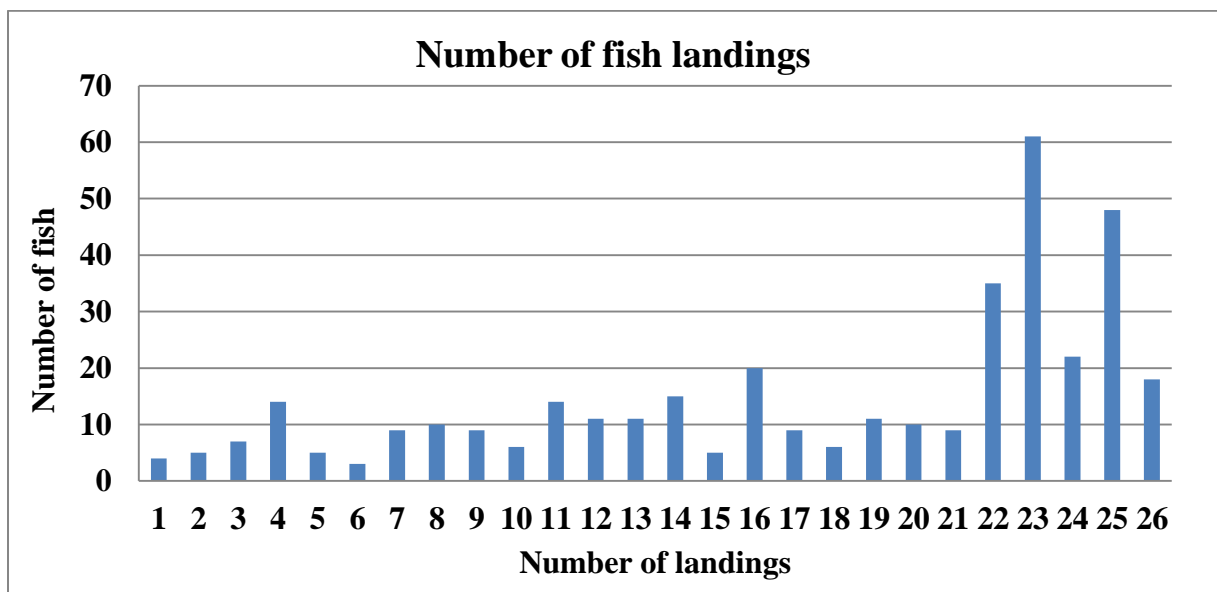


Fig. 1. Number of fish landings

93 turbot or 25% have weight up to 2 kg and 204 or 55% have weight of 3 kg. Therefore, 80% of all turbot have weight of 3kg.

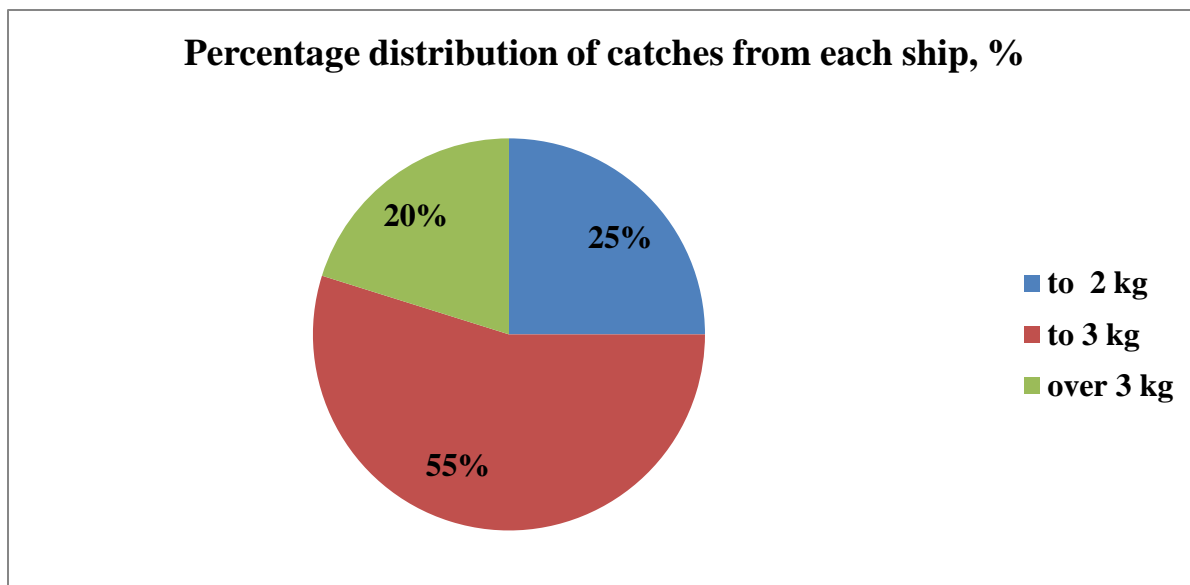


Fig. 2. Percentage distribution of catches from each ship, %

3.2. Weight structure of catches

The average weight of measured turbot is 2.66 kg, and the maximum-minimum range is 6.24-1.60 kg.

Fig. 3 represents the percentage distribution of the different weight groups for all 372 weighed turbot. The highest share is that of the weight group from 2.0 to 3.0 kg - 62%, followed by the weight group of 2.00 kg - 18%. With 10% is represented the group of 3.00 to 4.00 kg. 2% represents the 5.00 kg to 6.00 kg group. The number of larger specimens is insignificant.

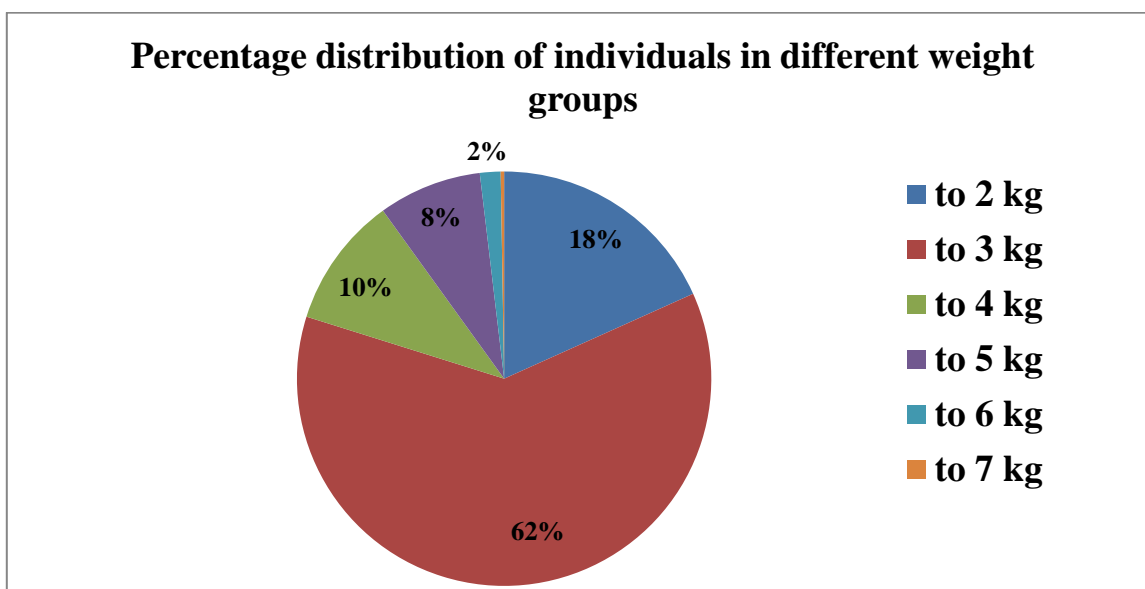


Fig. 3. Percentage distribution of individuals in different weight groups

3.3. Body size structure (total and standard body length) of turbot catches

The average total length of the measured fish is 52.61 cm, the maximum is 69.50 cm, while the minimum - 46.00 cm.

The most numerous is the group of turbot with total body length (TL, cm) within 49-52 cm range - 34.41%, followed with an insignificant difference by 53-56 cm group (33.87%). Turbot with total body length from 49 to 56 cm comprised for 68% (254 fish) of the entire sample. Fish with total body length of 45-48 cm are 17.47% (65 fish) of all measured turbot. The shares of the different size groups (at 3 cm intervals) showed that two size groups are most frequently encountered: 49-52 cm and 53-56 cm (Fig. 4).

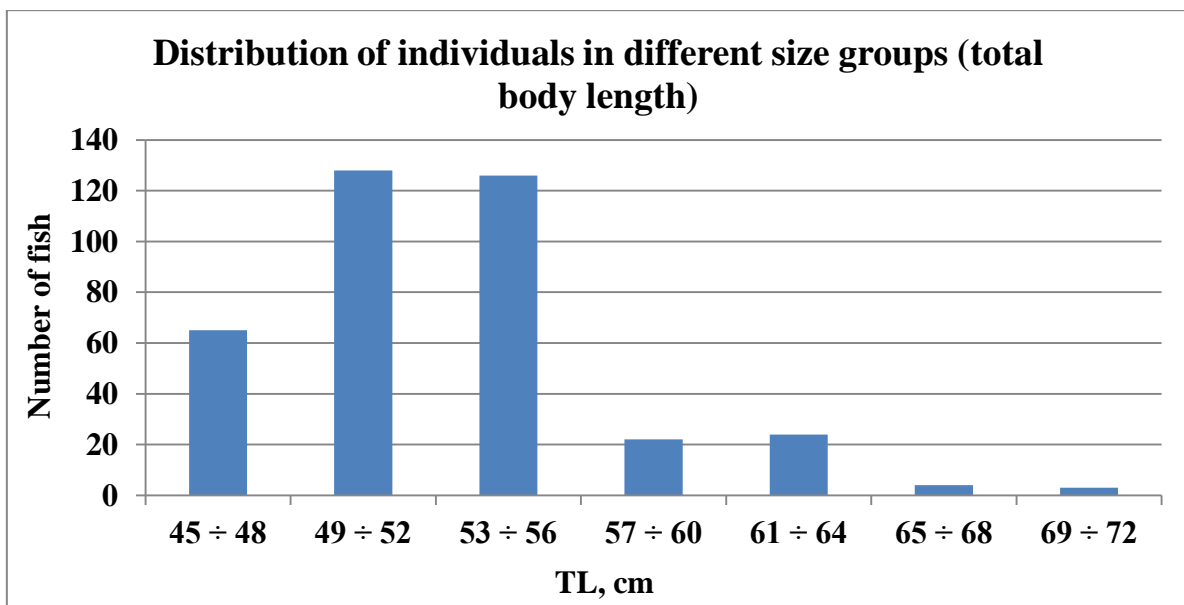


Fig. 4. Distribution of individuals in different size groups, according to the total body lengths (TL, cm)

The average standard body length of measured fish is 42.06 cm, the maximum - 56.50 cm, and the minimum – 37.00 cm.

The most numerous is the group of turbot with standard body length (SL, cm) within 43-46 cm range– 38.17 %, followed with an insignificant difference by the 39-42 cm group(33.87 %).

Individuals with standard body length in the range of 43-46 cm are 142 specimens. Fish with standard body length of 39-42 cm are 126 specimens.

The range of the total length of the body (TL, cm) is 46.00-69.50 cm, and the weight is amended in the range 1.60-6.24kg.

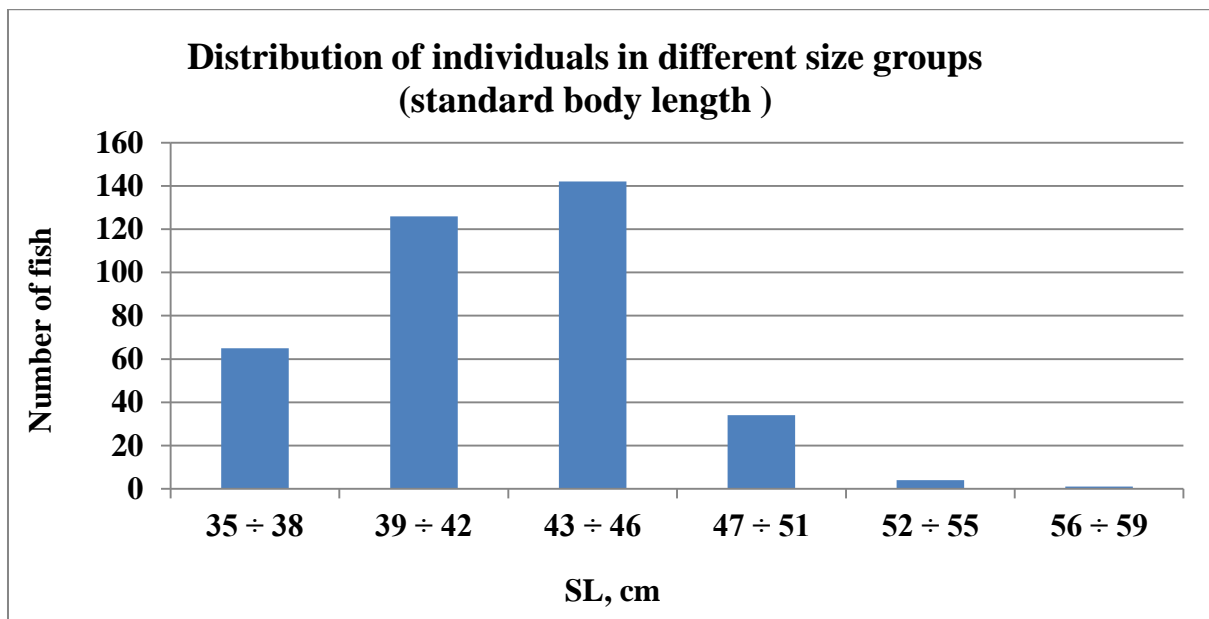


Fig. 5. Distribution of individuals in different size groups, according to the standard body length (SL, cm)

The correlation between the total body length and weight in the turbot landing is presented in **Fig. 6**. The correlation is expressed with the equation $BW = 0.0095 TL^{3.1578}$.

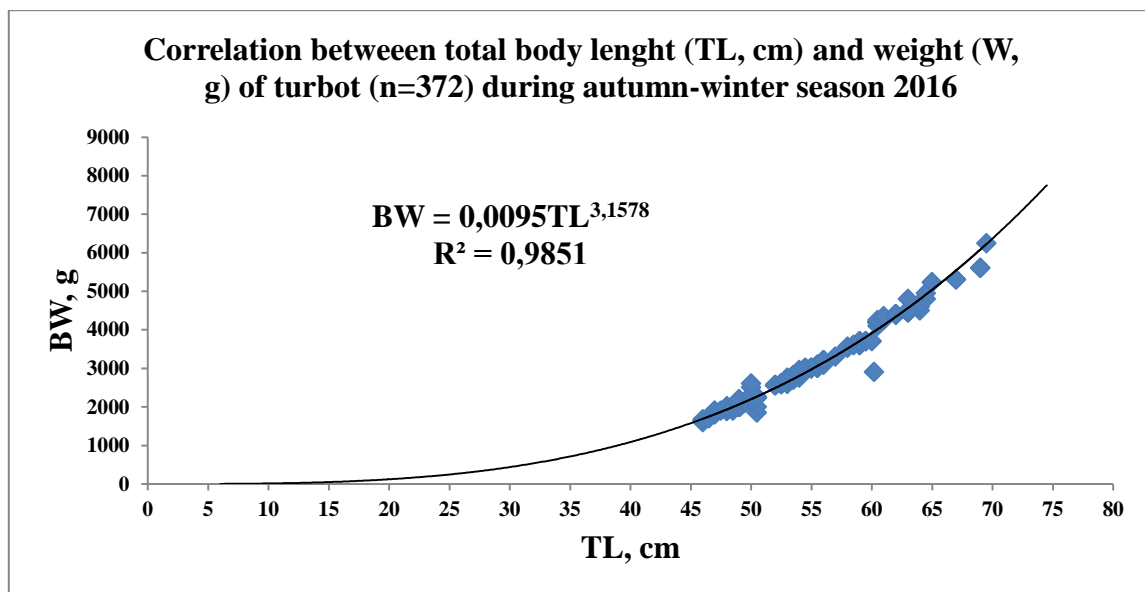


Fig.6. Correlation between total body length (TL, cm) and weight (W, g) of turbot (n=372) during autumn-winter season 2016

3.4. Age structure and growth

To determine the age structure of turbot at the Bulgarian Black Sea coast during the autumn-winter season 2016, 50 pairs of otoliths are studied. The age composition of the captured specimens included 3, 4, 5, 6 and 7 year old individuals, with predominant individuals with an age of 3 to 4 years.

The correlation between the total body length and the age of turbot, for females (n=33) and males (n=17) respectively, is presented in **Fig. 7**, and between body weight and age in **Fig. 8**

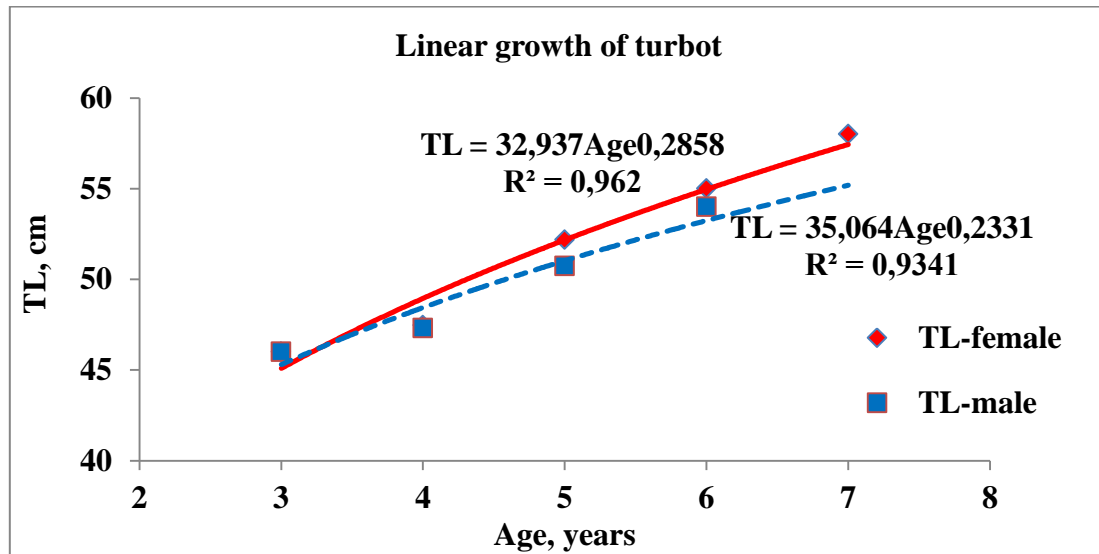


Fig.7. Linear growth of female and male individuals depending on their age during autumn-winter season 2016

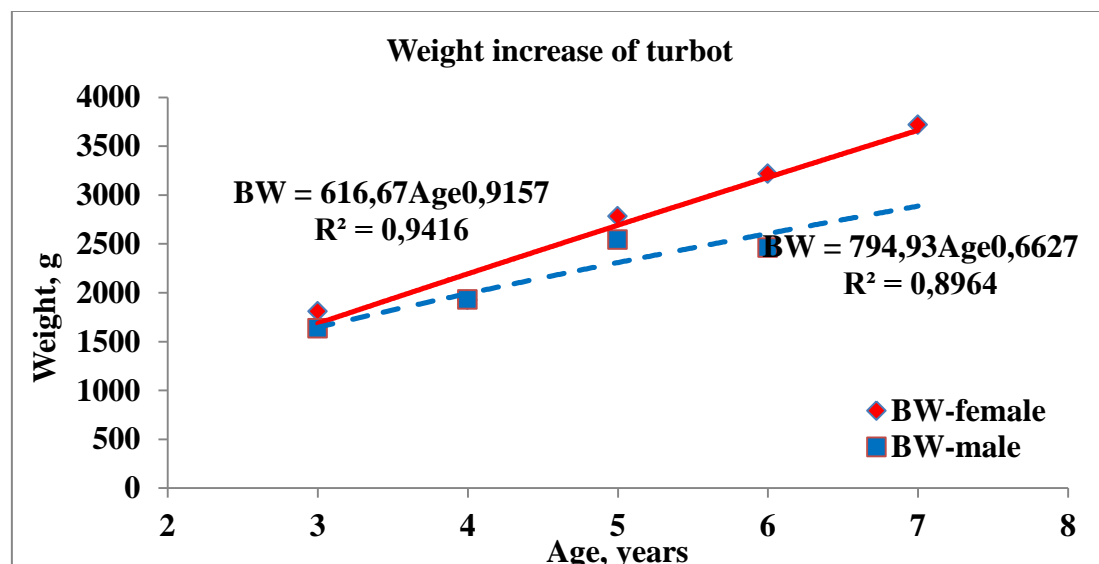


Fig. 8. Growth of female and male individuals depending on their age during autumn-winter season 2016

It can be seen from **Fig. 7** and **Fig. 8** that the female specimens after reaching 45 cm, grow in length and in weight faster than males.

3.5. Fulton's coefficient

Fig.9 presents the correlation between Fulton's coefficient and age of turbot for both sexes and **Table 3** presents the values for the Fulton's coefficient for both genders separately.

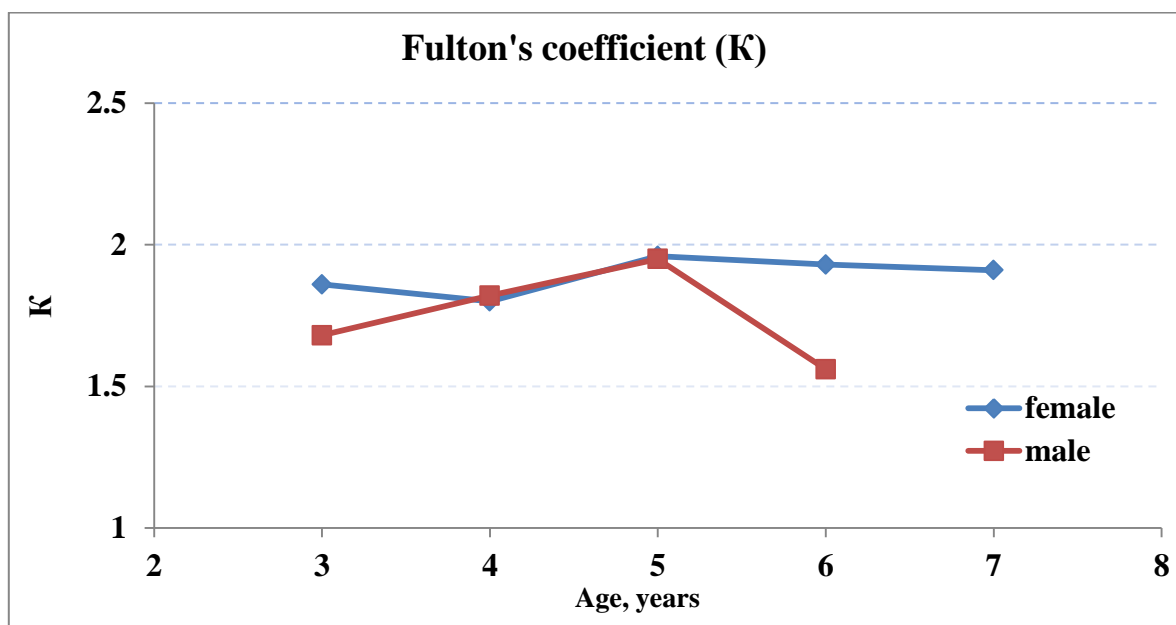


Fig. 9.Fulton's coefficient, defined by age and gender

Table 3.Fulton coefficient, defined by age and gender, n=50

Age, years	Female fish (n=33)	Male fish (n=17)
3	1.86	1.68
4	1.80	1.82
5	1.96	1.95
6	1.93	1.56
7	1.91	

3.6. Characterization of the reproductive biology of turbot

3.6.1. Gender composition

The percentage distribution of gender composition of the fish is shown in **Fig.10**. From a total of 50 specimens of turbot, 33 are females and 17 are males. The ratio between female and male is 66/34%.

Gender ratio of studied specimens (n=50) during autumn - winter season 2016

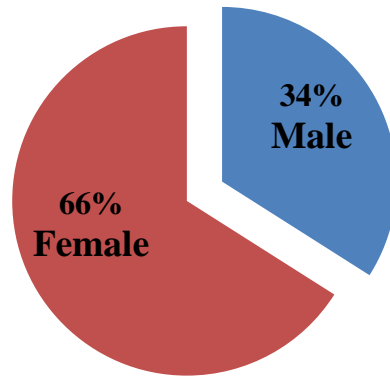


Fig. 10. Gender ratio of studied specimens (n=50) during autumn-winter season 2016.

3.6.2. Gonadosomatic index (GSI, %)

The gonadosomatic index (GSI, %) for females caught in the autumn-winter period in 2016 has an average of 2.25%, with the maximum and minimum values being 7.44% and 0.34% respectively (**Fig. 7**).

In **Table 4** the body weight, GSI,% and age of the females is presented, and **Fig.11** presents GSI, % dynamics.

Table 4.Body weight values (BW, kg), GSI,% and age of female fish

December, 2016			
Number of individuals	BW (kg)	GSI (%)	Age
1	2.76	2.25	5
2	3.72	2.64	7
3	1.81	0.66	3
4	1.83	1.33	4
5	2.89	2.28	5
6	1.58	4.95	4
7	2.19	0.79	5
8	2.69	0.83	5
9	2.07	0.76	4
10	1.61	0.47	4
11	1.75	0.90	4
12	1.55	1.54	4
13	1.25	0.49	4

14	3.07	0.63	6
15	1.50	0.50	4
16	3.35	1.92	6
17	2.25	1.67	4
18	1.69	1.32	4
19	2.46	2.49	4
20	2.11	0.34	4
21	2.34	0.16	4
22	2.99	1.41	5
23	2.24	1.33	4
24	2.55	7.06	4
25	3.23	7.44	6
26	2.64	5.14	5
27	3.14	6.71	6
28	3.03	3.15	6
29	2.60	5.96	5
30	3.13	5.74	6
31	2.69	2.58	5
32	2.53	4.08	5
33	2.70	4.66	5
Average	2.42	2.55	5

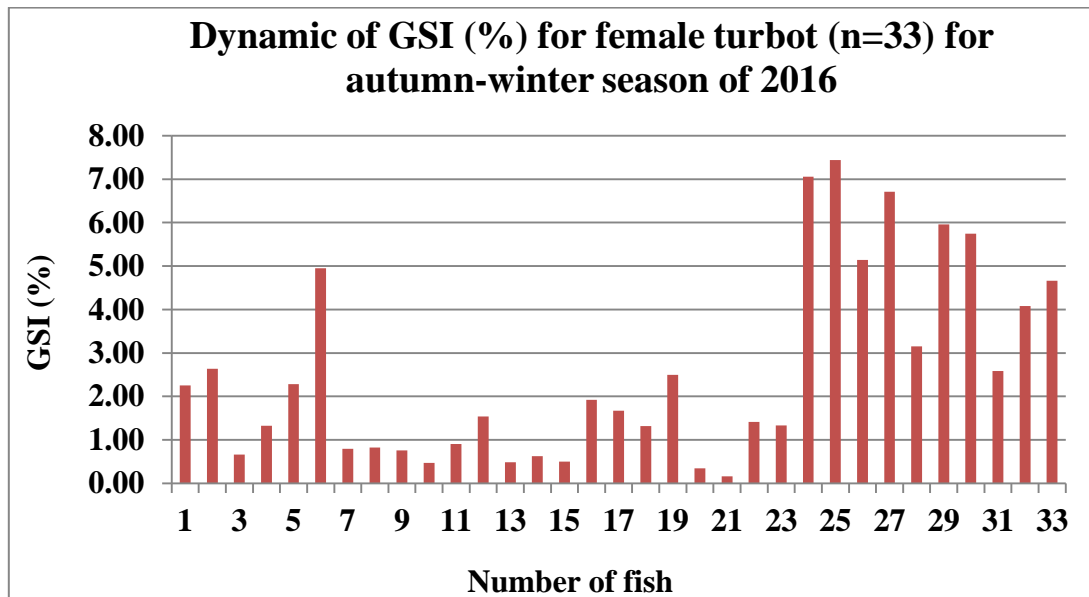


Fig.11. Dynamic of GSI (%) for female turbot (n=33) for autumn-winter season of 2016

The gonadosomatic index (GSI, %) for males caught during the autumn and winter of 2016 has an average value of 1, 31%. The maximum and minimum recorded values are respectively 3.43% and 0.42% (**Fig. 12**).

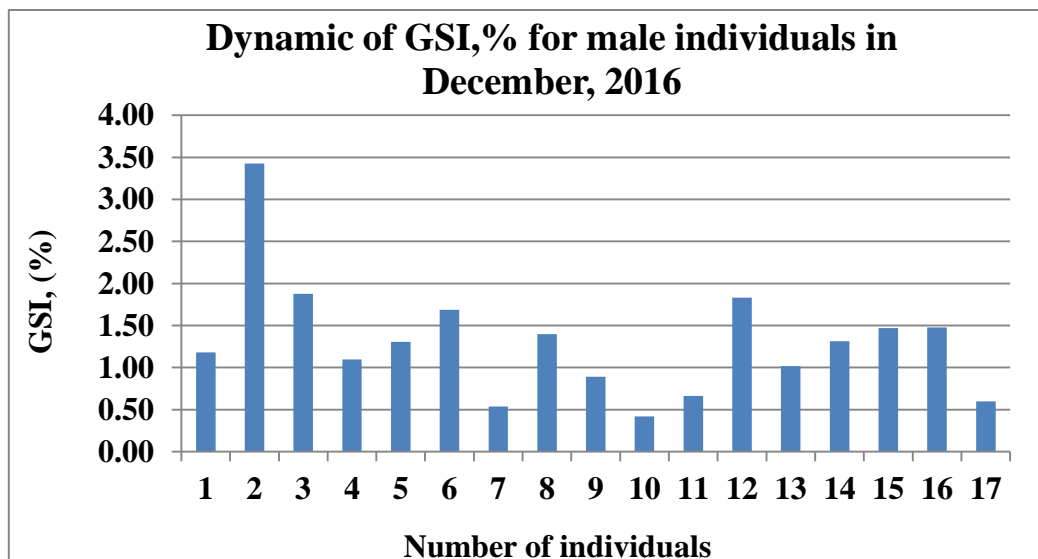


Fig. 12.Values of GSI, % for male individuals in December, 2016, (n=17)

3.6.3. Determination of the maturity stage of the reproductive organs

The ovary and testis in December are in II-III stage (transitional) of maturity.

4. Conclusions and Recommendations

Based on the results of the biological monitoring carried out on turbot catches at the Bulgarian Black Sea coast in autumn and winter of 2016, we can draw the following conclusions and recommendations:

- During the autumn and winter of 2016 fishing boats unload an average of 14 specimens of turbot or an average of 37kg per day. The maximum catch is 61 fish and the minimum – 3 fish.
- A total of 26 landings of monitored ports are measured. 372 specimens of turbot have an average weight of 2.60kg, an average total body length of 52.61 cm and an average standard length of 42.06 cm.
- The maximum measured weight is 6.24 kg, and he minimum measured is 1.60 kg.
- Maximum and minimum size for total body length is 69.50 cm, and for standard length - 56.50cm. The minimum sizes are respectively 46.00 cm and 37.00 cm.
- 93 turbot or 25% of the total number of specimens have weight of 2 kg. 204 individuals, accounting for 55% of the sample, weighed up to 3 kg. Therefore, in the landings of the observed ports within the monitoring, 80% of all turbot weighed up to 3kg.

- From a total of 372 measured individuals, the weight group of up to 2.00 kg constitutes for 18% of the turbot landings. The proportion of the weight group of 2.00 to 3.00 kg is 62%. 10% is represented by the group of 3.00 to 4.00 kg, and 2% by the weight group of 5.00 kg to 6.00 kg. The number of larger specimens is insignificant.
- The age composition of the turbot includes 3, 4, 5, 6 and 7 year old individuals, predominantly individuals at the age of 3 to 4 years.
- Fulton's coefficient for females and males is in the near range - 1.8-1.93 for females and 1.56-1.95 for males.
- The percentage ratio between females and males is 66:34% or 1.9:1
- Female individuals after reaching 45 cm grow in length and increase in weight faster than males.
- The gonadosomatic index (GSI,%) for females caught in the autumn-winter season (December) has an average value of 2.55%, with the highest value being 7.44% and the lowest - 0.16%.
- For males caught in autumn-winter season, GSI, % has an average value of 1.31%. The maximum and minimum values are 3.43% and 0.42% respectively.
- The ovary and testis of the studied individuals in December are in the II-III stage (transitional) of maturity

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