2021

BIOLOGICAL MONITORING OF LANDINGS OF COMMERCIALLY IMPORTANT SPECIES

Scientific report on contract N197/10/12/2019 covering the results of 1st and 2nd quarter of 2021

ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ ФОНД ЗА МОРСКО ДЕЛО И РИБАРСТВО

МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО, ХРАНИТЕ И ГОРИТЕ

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

This survey was conducted thanks to the financial support of the European Commission under the REGULATION (EU) 2017/1004 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2017 on the establishment of a Union framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the common fisheries policy and repealing Council Regulation (EC) No 199/2008 (recast)

BULGARIAN ACADEMY OF SCIENCES
INSTITUTE OF OCEANOLOGY VARNA

Проект № BG14MFOP001-3.003-0002-C02„Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

List of authors:

Associate Professor Maria Yankova, Ph.D.

Associate Professor Violin Raykov, Ph.D.

Associate Professor Petya Ivanova, Ph.D.

Associate Professor Kremena Stefnova, Ph.D.

Main assistant Nina Djembekova Ph.D

Main assistant Elica Stefanova Ph.D

Ecologist Hristiyana Stamatova

Ph.D student Yordan Raev

Technician Neli Valcheva

Technician Diana Hristova

Logistics Dobroslav Dechev

Logistics Petar Trandafilov

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I. Biological monitoring of sprat (*Sprattus sprattus*) landings

I.1 Objectives

Sprat (*Sprattus sprattus* L.) is a key species in the Black Sea ecosystem. Multi-year biological monitoring of landings provides so-called "fisheries-dependent" information. The purpose of this study is to collect and analyze the dynamics of length, weight and age distribution, as well as to determine the condition of the observed species using the so-called condition factor (Ricker, 1975). Biological information on a species is collected every month and thus analyzed and compared with previous periods and can then be used to assess growth parameters. These indicators are very important for species with a short life cycle. Long-term information is also crucial for the assessment of fish stocks, fisheries management, and the decision-making process in general.

I.2 Sampling

I.2.1 Geographic area coverage

The data from the current analysis is collected directly from the landings in the ports of the Bulgarian Black Sea coast. During the period of the study - January –June were collected **6 samples with 1024 specimens.**

I.2.2 Sampling period

Date	**Harbor**	**F/V**	**Landing/kg**
21.1.2021	Sozopol	HERSON	360
11.2.2021	Nesebar	NIKO	350
5.3.2021	Nesebar	FV 41	280
7.4.2021	Nesebar	FV 26	3450
20.5.2021	Nesebar	FV 41	3000
9.6.2021	Nesebar	НИКО	3600

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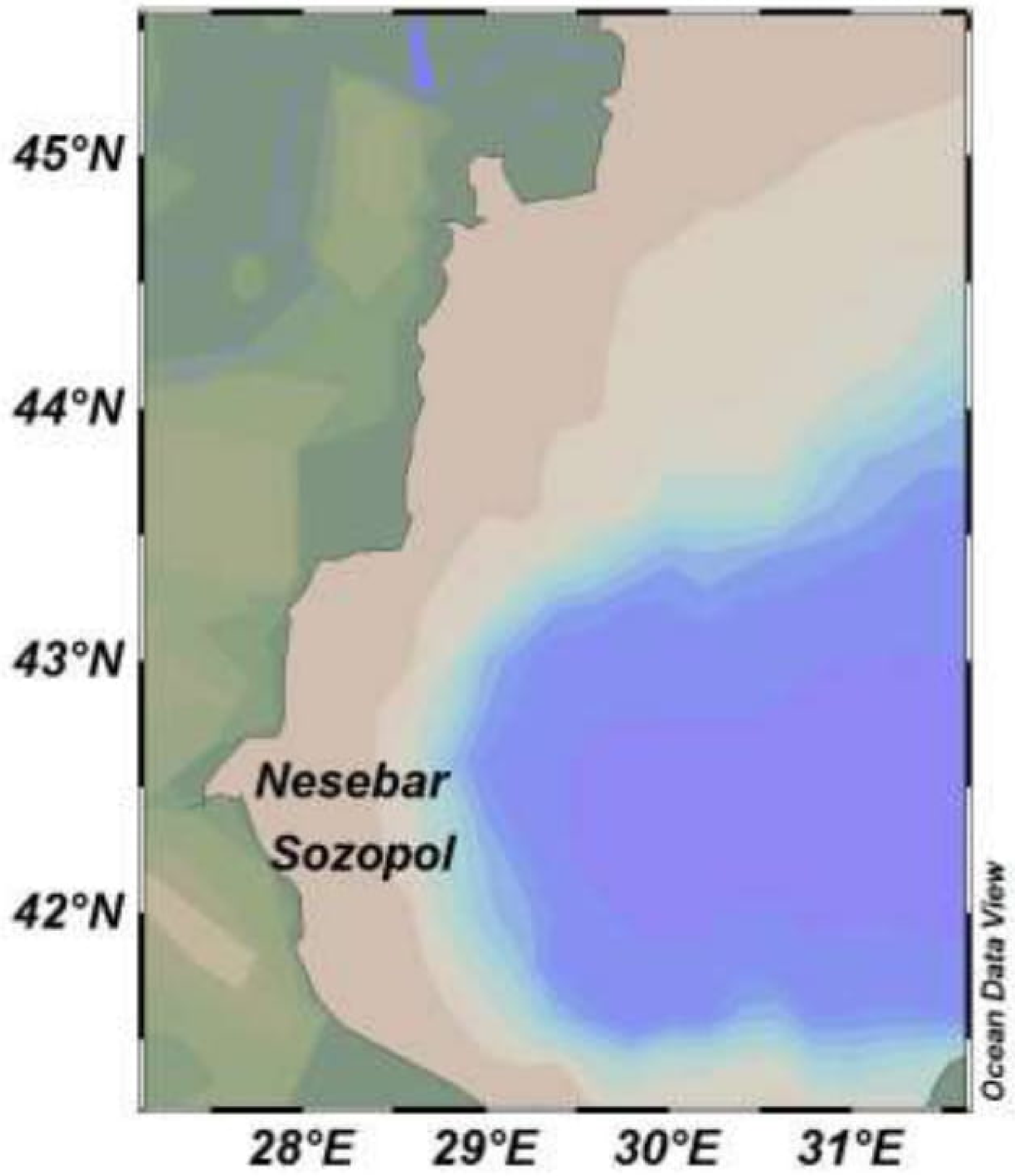

Figure 2.2.1 Research area and plan of the sampling ports of Bulgarian Black Sea coast.

I.2.3 Statistical analysis of data

All samples tend to be collected in accordance with the variation statistics from significant landings in terms of quantity where is possible. Random sampling theory was followed when taking the sample. The samples were processed in laboratory conditions. Total length (TL, ±0.5 cm precision) was measured using an ichtyometer, and total fresh weight was measured using an electronic analytical balance (W, ±1g precision). The study used otoliths to determine age, which was determined from otolith rings. Otoliths were removed and dried in the laboratory and stored in labeled envelopes. Age was determined by microscope Olympus CX 31RTSF-6 and recorded. Thus, the yearly annulus was detected as hyaline and opaque zones, shifting active growing with period of growth stagnation. Sections from the other otoliths were judged illegible and were excluded from this study. In order to check the accuracy of the age readings in the present study, an ageing intercalibration exercise was carried out between the authors. Age readings were compared using a signed rank statistical test. We found consistent agreement between readers with low average percentage error (APE) values.
The condition factor was obtained from Fulton´s equation (Ricker, 1975): where *W* is total weight (g) and *L* is length (cm) cubed, multiplied by 100 to represent values as percentages.

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$$K = \frac{W}{L^3} * 100$$

The condition factor 'K' was computed for each age groups separately for different months. For all the samples "Age-Length" (Weight) Keys were created. Thus, the mean values of length, weight and condition factor were resulted. The share (in %) of individuals per age groups and length groups were reflected in the analysis as well.
The coefficient of variation (CV) is defined as the ratio of the standard deviation σ to the mean μ:

$$c_v = \frac{\sigma}{\mu}$$

The coefficient of variation is useful because the standard deviation of data must always be understood in the context of the mean of the data. In contrast, the actual value of the CV is independent of the unit in which the measurement has been taken, so it is a dimensionless number. For comparison between data sets with different units or widely different means, one should use the coefficient of variation instead of the standard deviation.
Batch fecundity: All fish were measured to the nearest 1 mm in the Total Length (TL) and weighted to the nearest 1 g. Gonads of the fish were examined under a dissecting microscope for its external features such as turgidity and colour in order to determine a maturity stage. The sex ratio also calculated in this study (i.e., No. of males/No. of females (Simon et al., 2012). The female was determined by the macroscopic observation of matured ovary (Laevastu, 1965a).
Batch fecundity can vary considerably during the short spawning season, low at the beginning, peaking during high spawning season and declining again towards the end.Annual egg production is the product of the number of batches spawned per year and the average number of eggs spawned per batch. Batch fee undi t Y. of sprat was '. determined as'Hydrated Oocyte Method'. (HUNTER et ale 1985). Oilly hydrated females.were used. After sampling their body cavity was opened and they were 'preserved in a buffered formalin solution (HUNTER 1985). The ovary free female weight ind the ovary"weight were determined: Three tissue samples of - 50 mg were removed from different parts of the ovary and their exact were determined. Under binocuklar number of hydrated oocytes, in each of the three subsamples was determined. Hydrated oocytes can easily be separated from all other types of oocytes because of their large size t their translucent appearance and their wrinkled surface which is due to formalin preservation. Batch fecundity 'was estimated 'based, on· the average number of hydrated oocytes per unit weight of the three subsamples.

Gonadosomatic Index (GSI) was determined monthly. GSI was calculated as:

$$GSI = \frac{GW}{SW} X\ 100$$

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where, GW is gonads weight and SW is somatic weight (represents the BW without GW)

The length – weight relationship is obtained by the following equation:

$$W_t = qL_t^n$$

where: q – condition factor, constant in length-weight relationship; n – constant in length-weight relationship.

I.2.4 Material and methods- feeding

The study includes analysis of stomach content composition of specimens, collected in front of the Bulgarian Black Sea coast in I-VI quarter , 2021. Per trawl catch, 20-25 fish specimens from each species were separated and preserved in 10 % formaldehyde: seawater solution. The absolute length (TL, to the nearest 0.1 cm) and weight (to the nearest 0.01 g) of fish specimens were measured. Under laboratory conditions, the stomachs of the selected animals were weighted with analytical balance (to the nearest 0.0001 g). The food mass of each individual has been calculated as a difference between the weights of full and empty sprat stomach.

Zooplankton species composition of the stomach content and prey number was investigated under binocular microscope “Olympus”. The biomass of prey was estimated by multiplication of the registered number of consumed mesozooplankton species by their individual weights (Petipa, 1959) while zoobenthos species were weighted with an analytical balance.

The following indices were calculated:

1. Stomach fullness index (ISF) as a percent of body mass: (stomach content mass/fish mass) *100; and

2. Index of relative importance - IRI, Pinkas et al. (1971): IRI = (N+M) x FO; where N - the proportion of prey taxa (species) in the diet by numbers (abundance); M - the percentage of prey taxa (s), FO - frequency of occurrence of the prey taxa among the studied fish species.

I.3 Results

I.3.1 Landings statistics

The statistics of the amount of sprat caught (fig) for the first 6 months of 2021 showed low catches in January-February 2021 and higher in the period April-June 2021.

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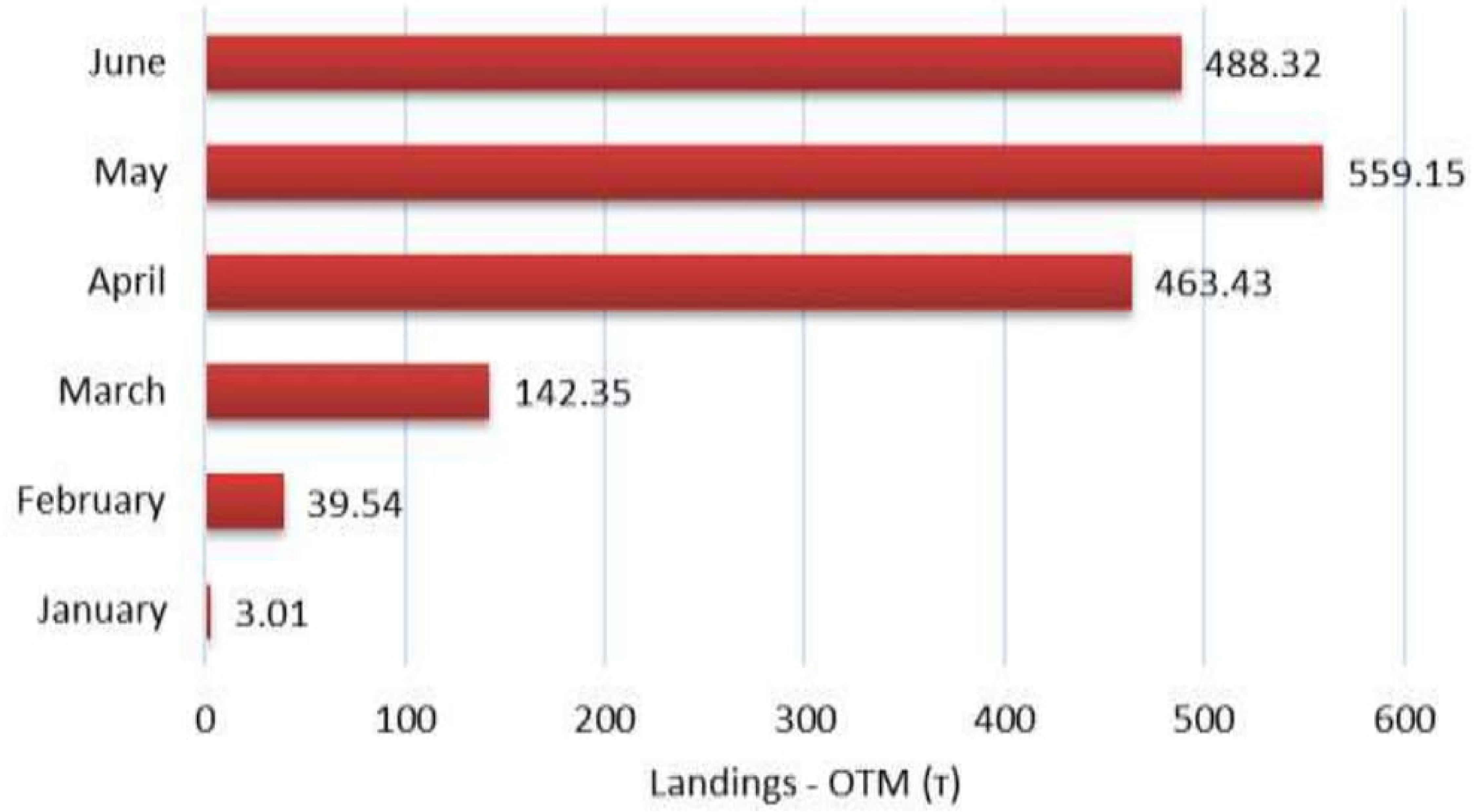

Figure 3.1.1. Sprat landings (OTM) in the period January-March 2021.

I.3.2 Length structure of landings

The size classes of the sprat from the first and second quarters were presented almost equally in the 2 quarters of 2021. The maxima were registered at 7 cm, followed by 6.5 and 7.5 cm size classes. The other size groups had a subordinate position.

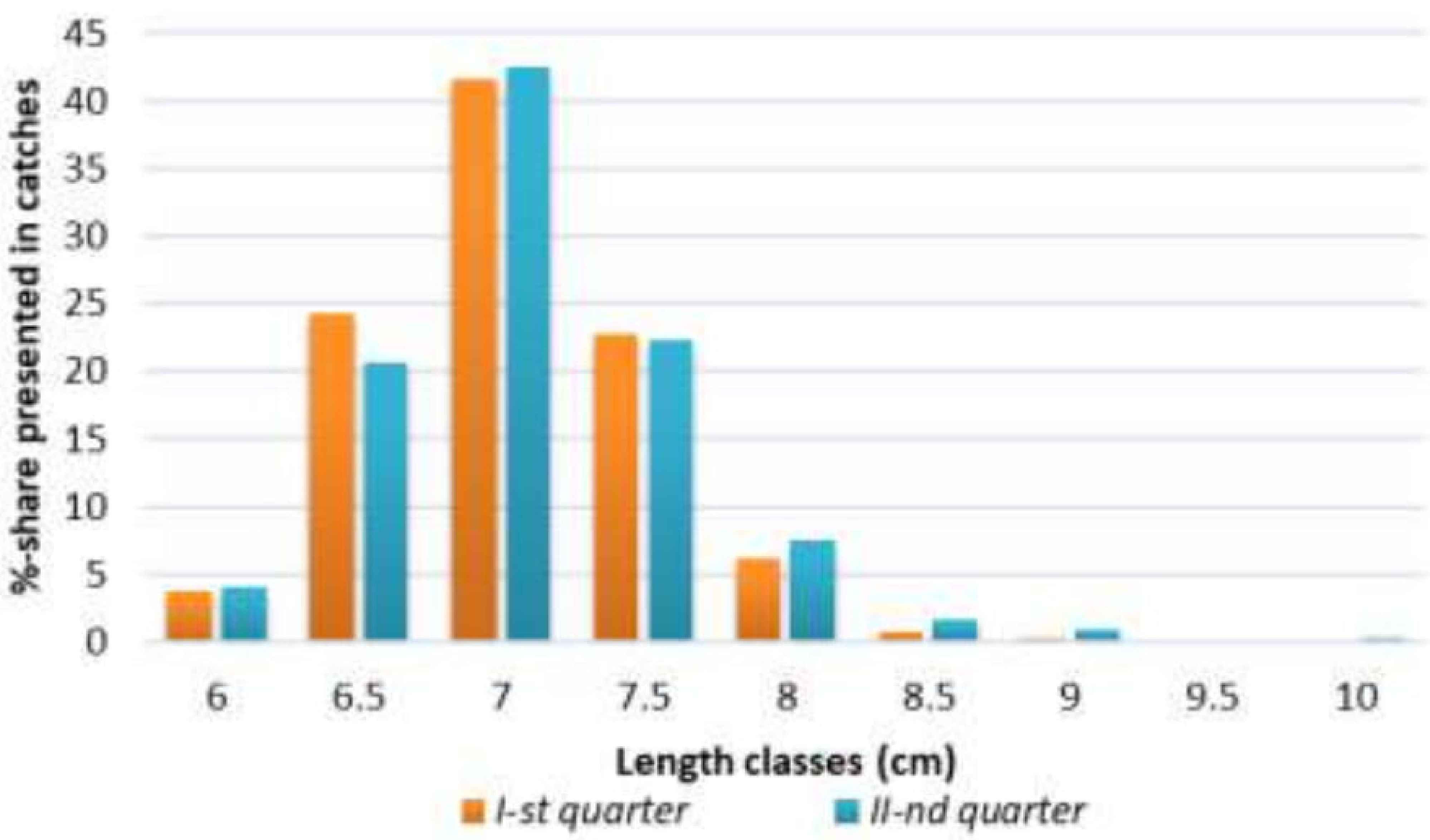

Figure 3.2.1 Length structure of sprat and % share of length classes in the catch composition in the period January-March and April-June 2021.

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I.3.3 Age structure of landings

The three readers determined the age of sprat otoliths, and reader 1 read all otoliths twice. Specimens (**n = 250)** were used for age determination. The age distribution in the first quarter of 2021 was characterized by a high share of recruitment 0 + year (17%), followed by 1-1 + year (61%). 2-2 + d had a 19% presence. 3-3 + year had a very low share in catches (0.3%). Senior groups were absent from catches in the first quarter of 2021.In the second quarter 0+ years old decreased their share, as well as 1-1 + year olds at the expense of 2-2 year olds individuals, who increased their share to 61%. 3-3 + years old had a low share again, and 4-4 + years old were completely missing in the catches.

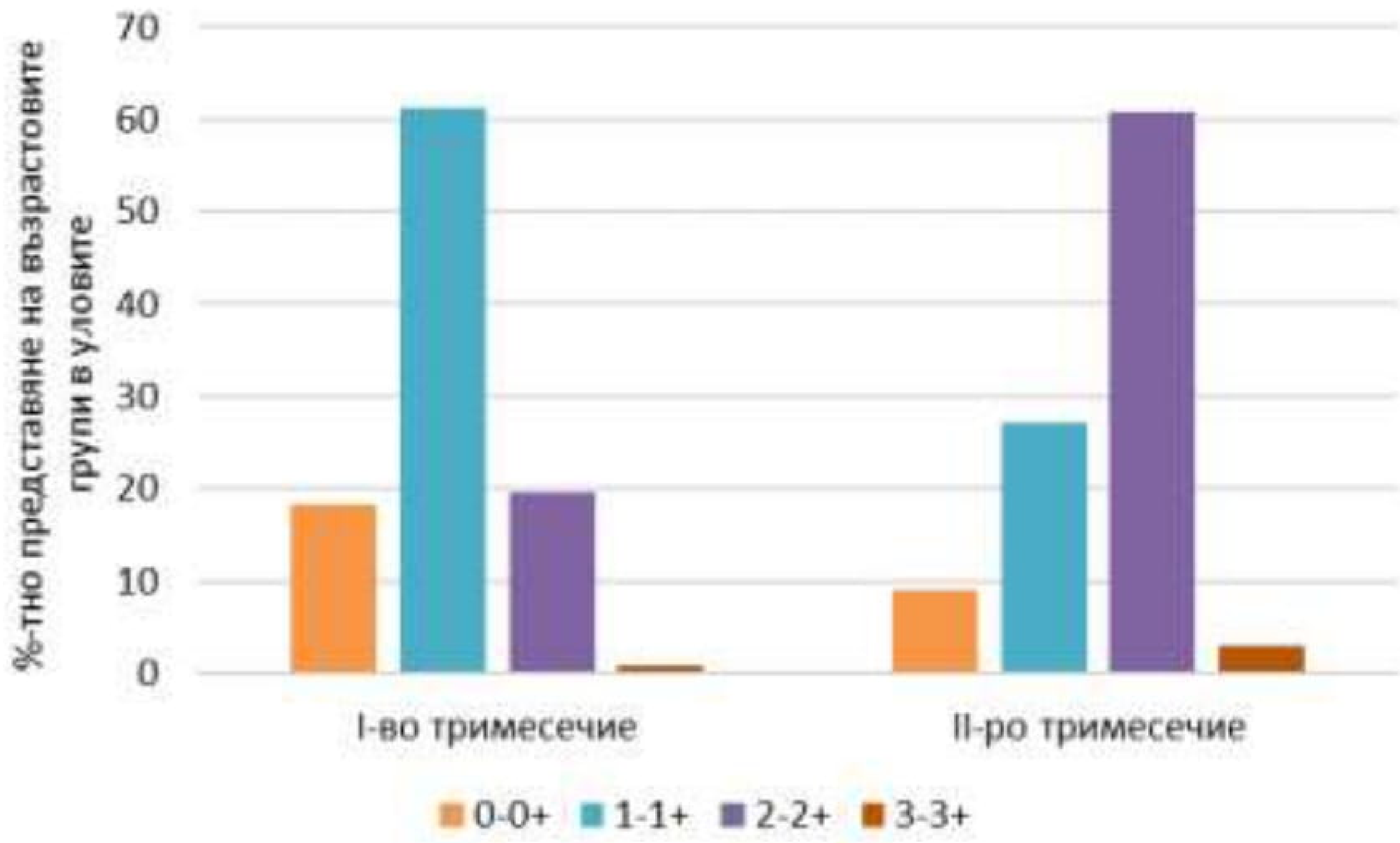

Figure 3.3.1. Age structure of sprat and % share of age groups in the catch composition in the period January-March 2021 and April-June 2021 .

I.3.4 Condition factor

The condition factor of sprat from investigated period show relatively low values due to the lack or low percentage of the largest and oldest groups in the catches. Thus, the condition of sprat varied in narrow limits, reflecting physiological state of the population in this period of the year.

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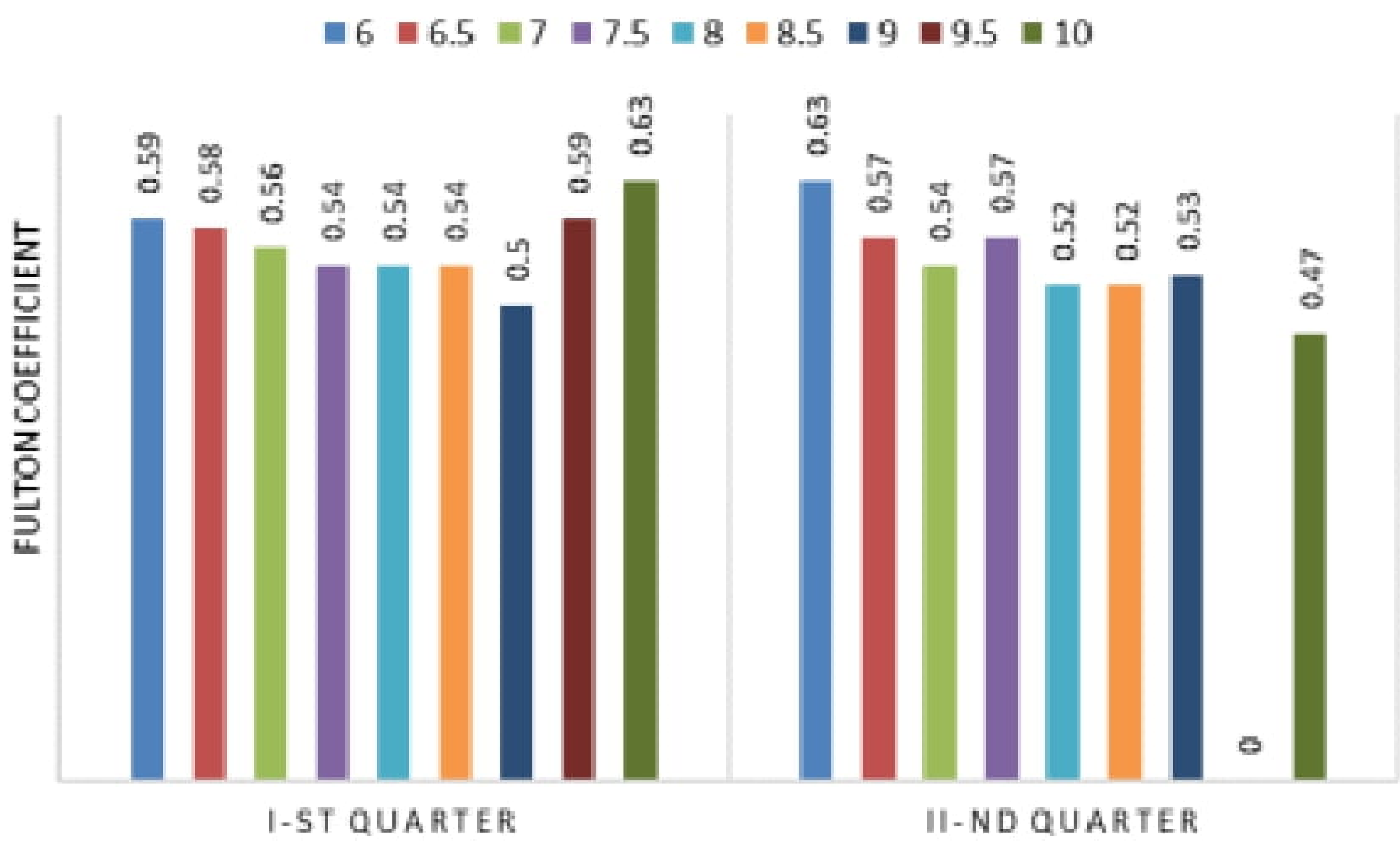

Figure 3.2.3. Fulton condition coefficient of sprat per length classes in the period January – March 2021.

The recruitment condition (0 + years old) was the highest in the first and second quarters of 2021 (0.59- 0.6).

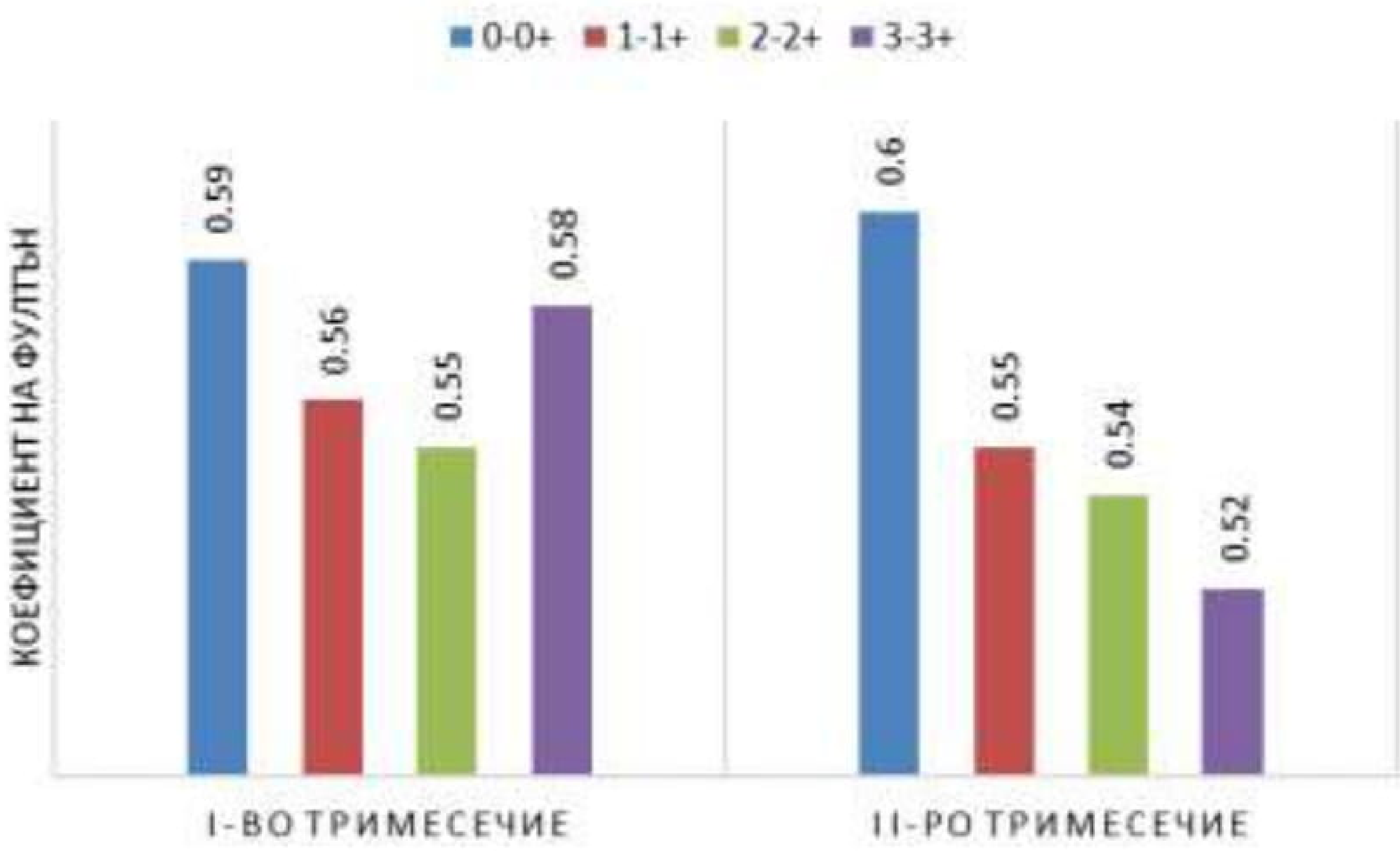

Figure 3.2.4 Condition factor of the sprat by age groups for the period January - June 2021.

I.3.5 Weight structure of sprat

Weight was measured of **1024 specimens** (period January - June 2021). Mean weights in first and second trimester of the 2021 show similar values in all age groups.

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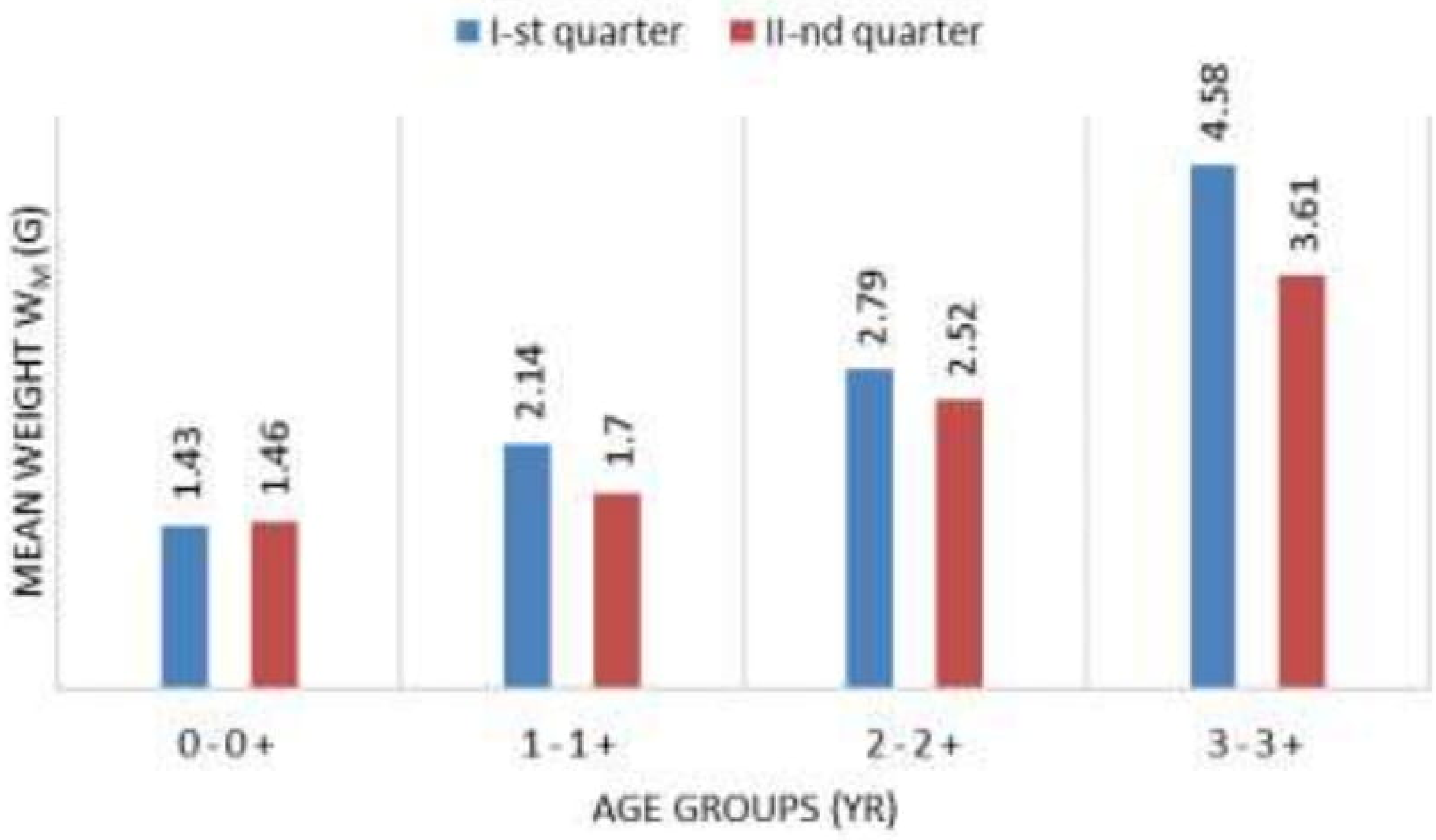

Figure 3.5.1 Weight structure of sprat by age.

I.3.6 Size structure of sprat by age group

Size was measured of **1024 specimens**. The average lengths in the first and second quarters of 2021 show similar values in all size groups of groups.

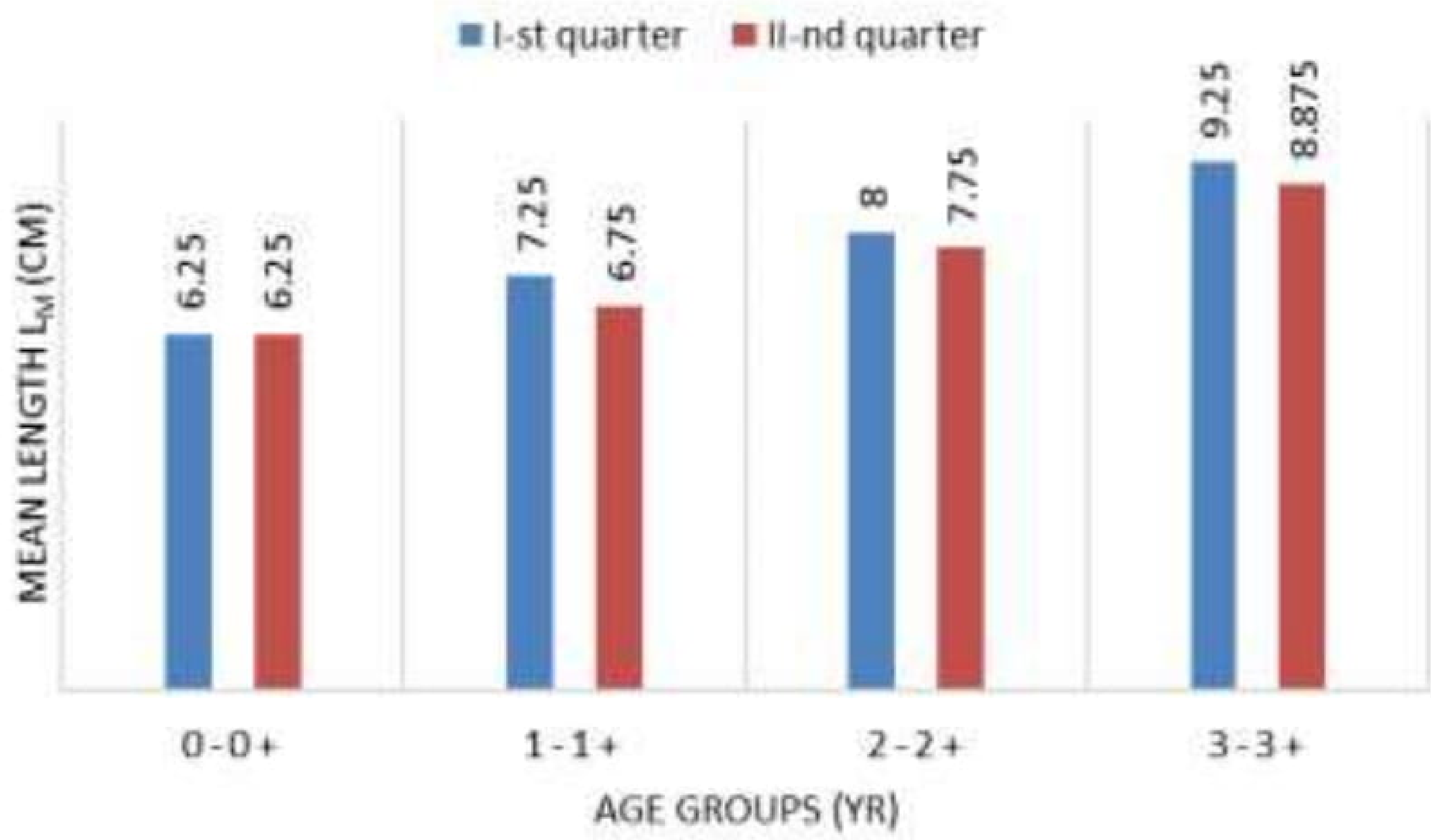

Figure 3.6.1. Structure of the size of the sprat by age.

I.3.7 Length- weight relationship

The length-weight relationship for both periods is well described by the exponent and shows allometric (n = 2.94) increase in both periods (R^2 = 0.99).

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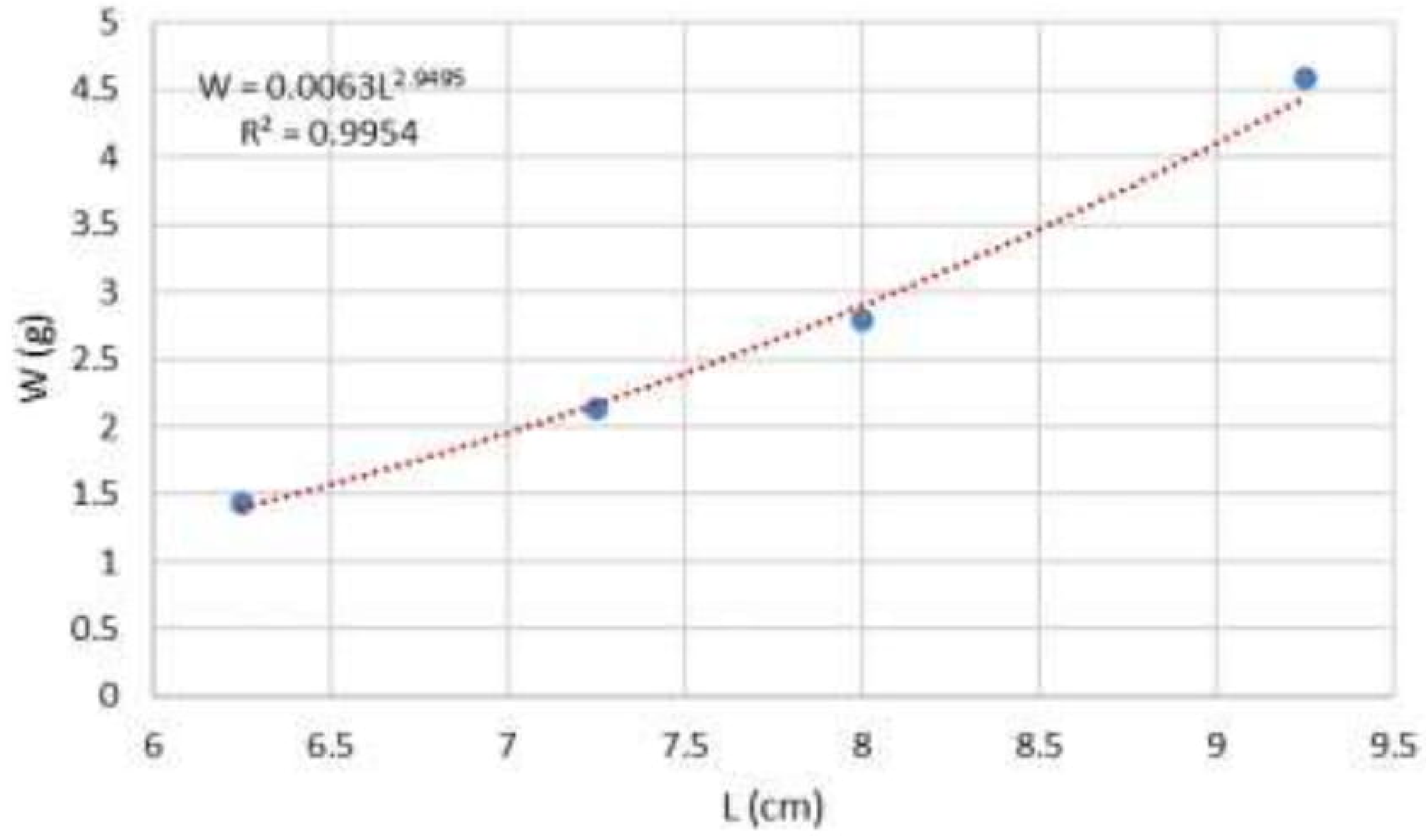

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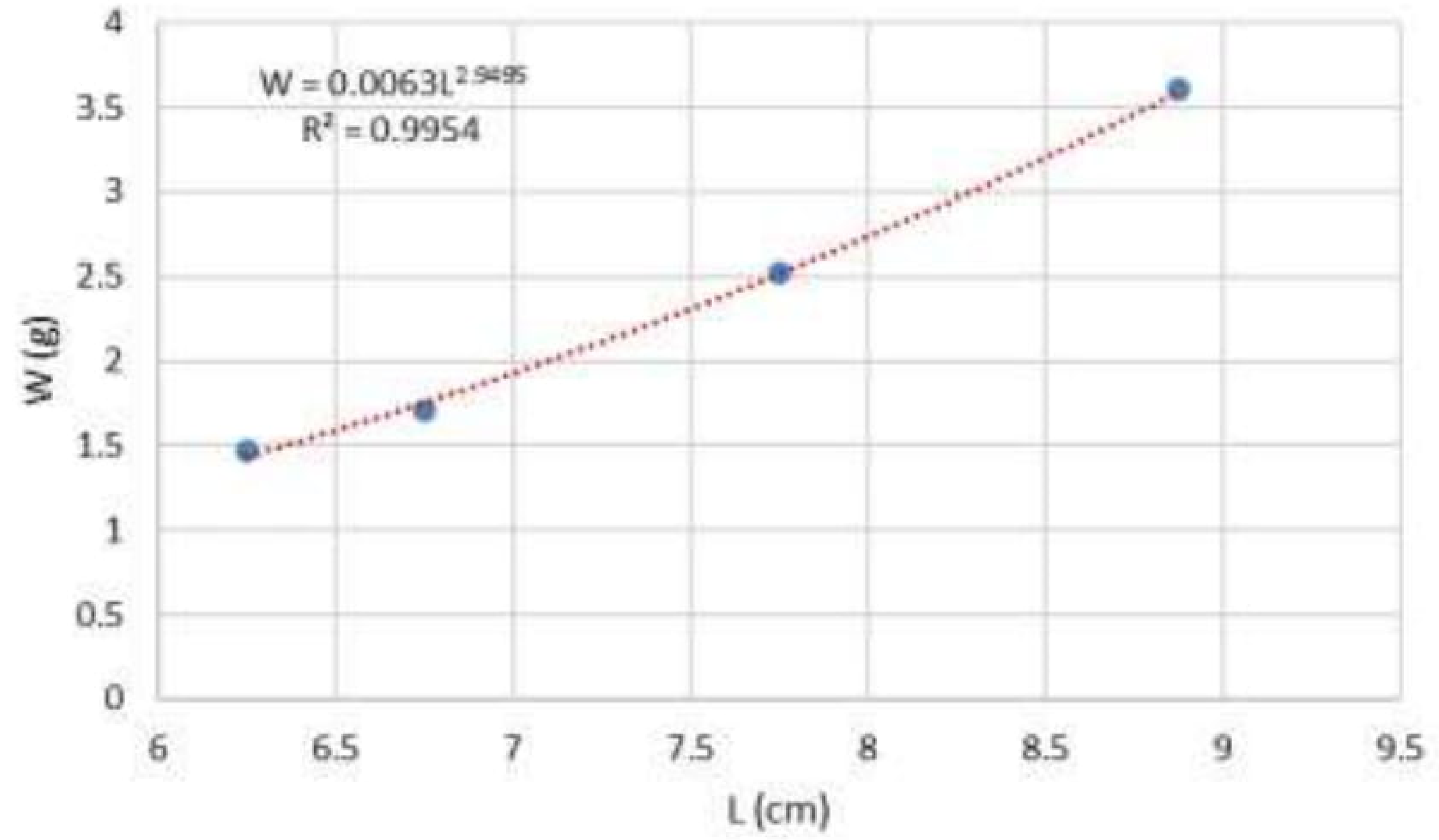

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Figure 3.7.1 Relationship between size and weight of sprat from the – I (a) and II (b) quarter of 2021.

I.3.8 Sex ratio

The sex ratio was determined of **60 individuals**.

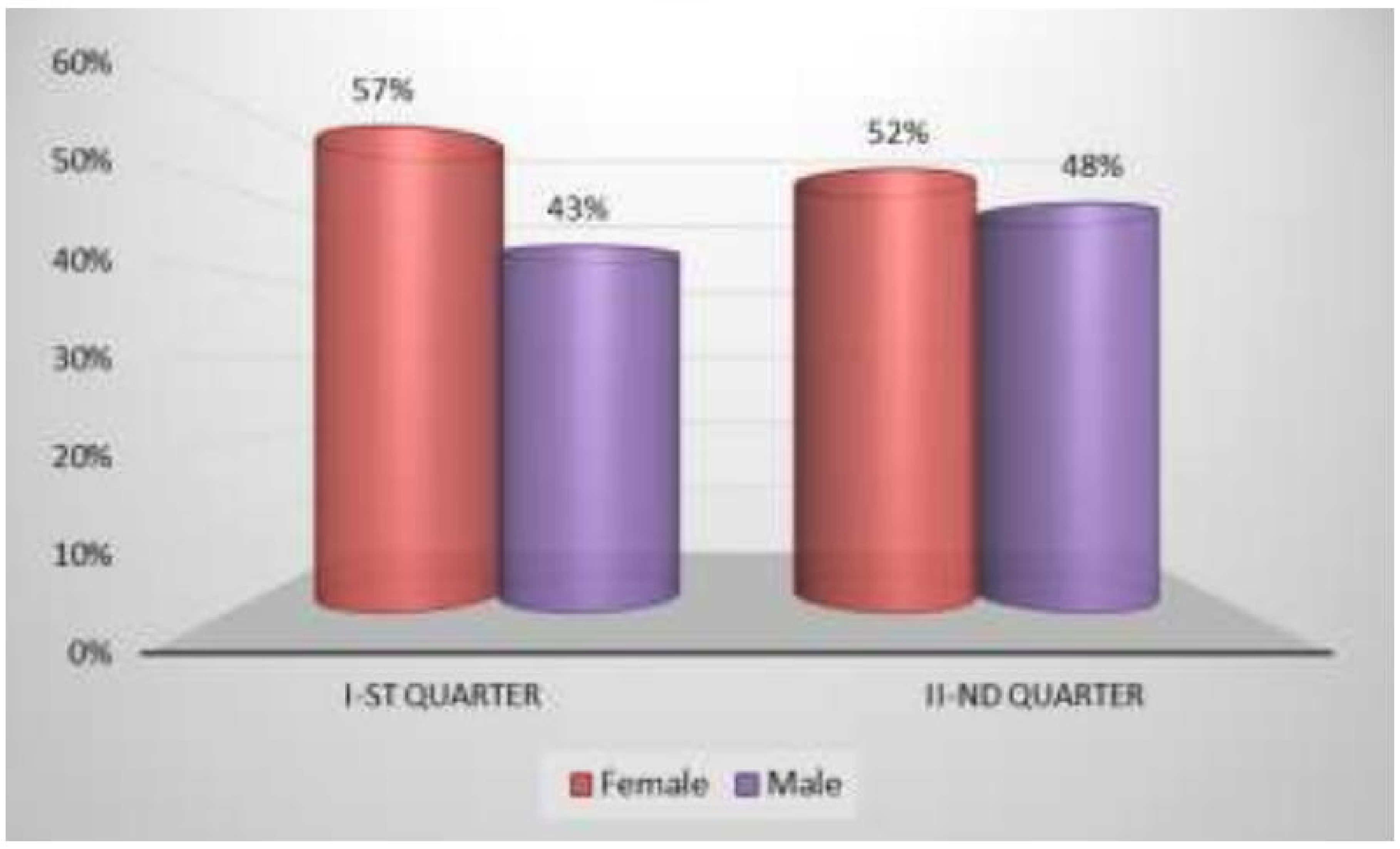

Figure 3.8.1 Sex ratio of Sprat (*Sprattus sprattus*) Jan-March; April-June.

I.3.9 Fertility

Fertility was determined on **60 specimens**. Batch fecundity (Log F) plotted vs. Sprat Length (Log L) show weak relation (R^2 =0.2) which prove weak dependence of fecundity on the individual sizes.

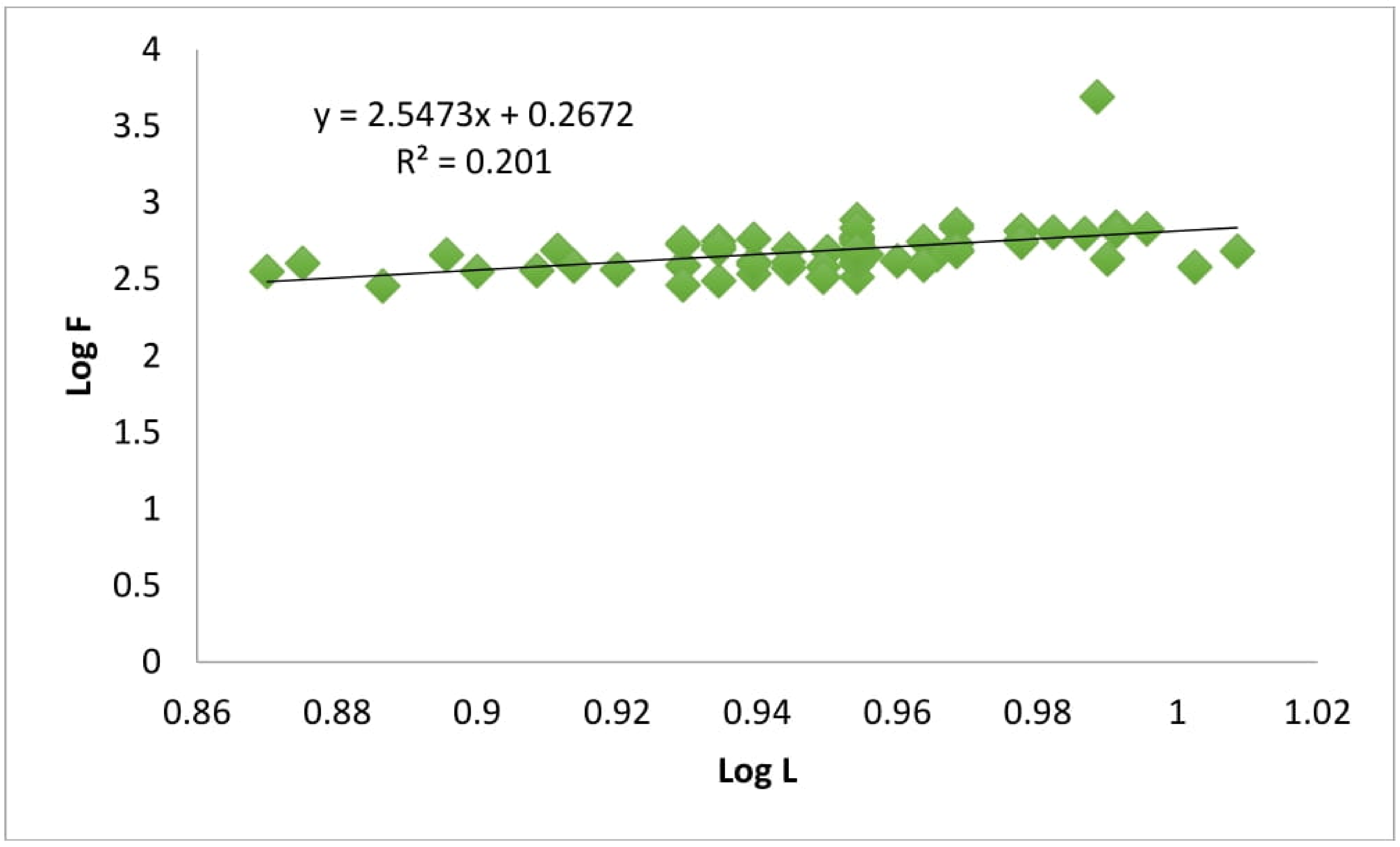

Figure 3.9.1 The relation between Batch fecundity (Log F) plotted vs. Sprat Length (Log L).

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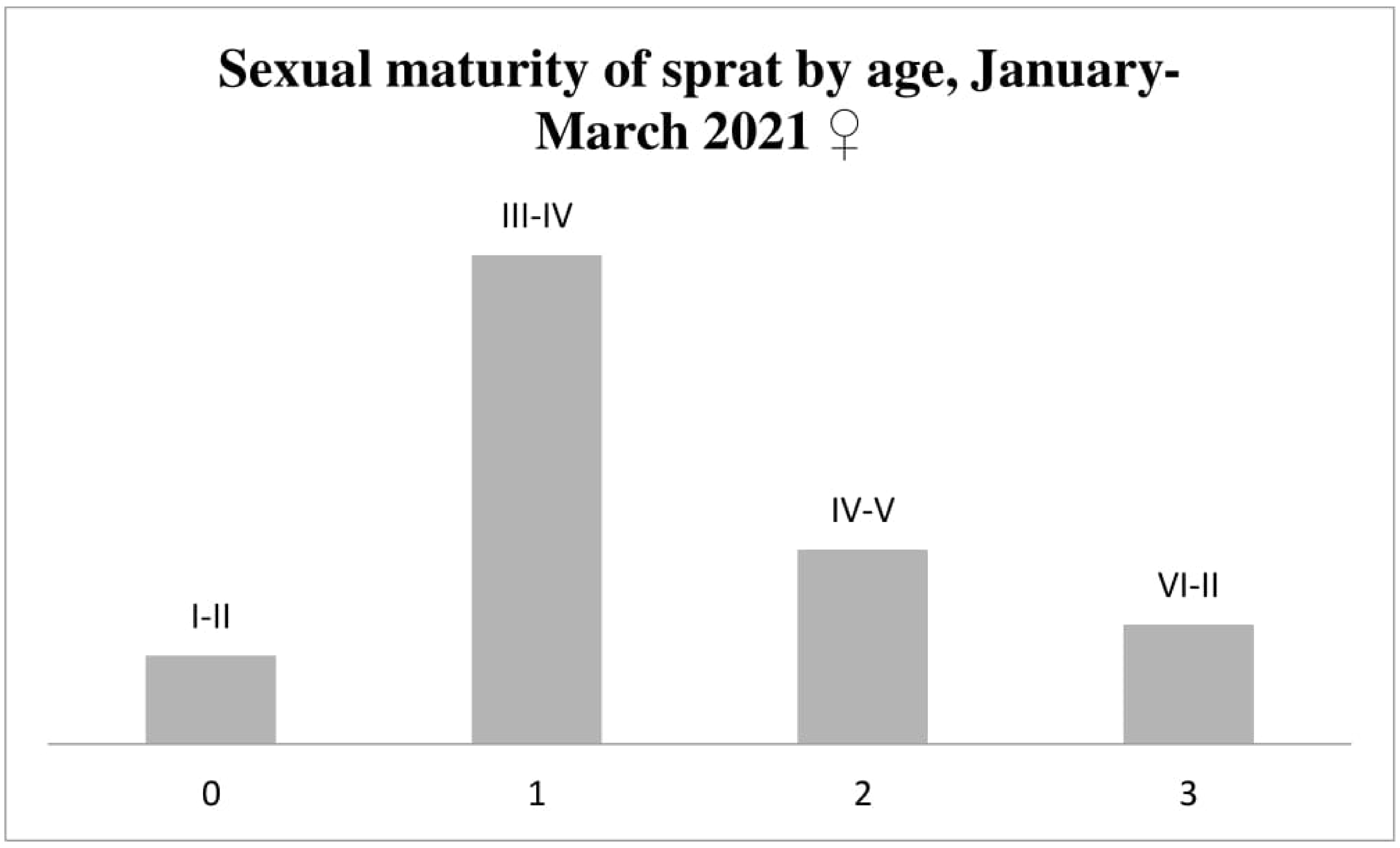
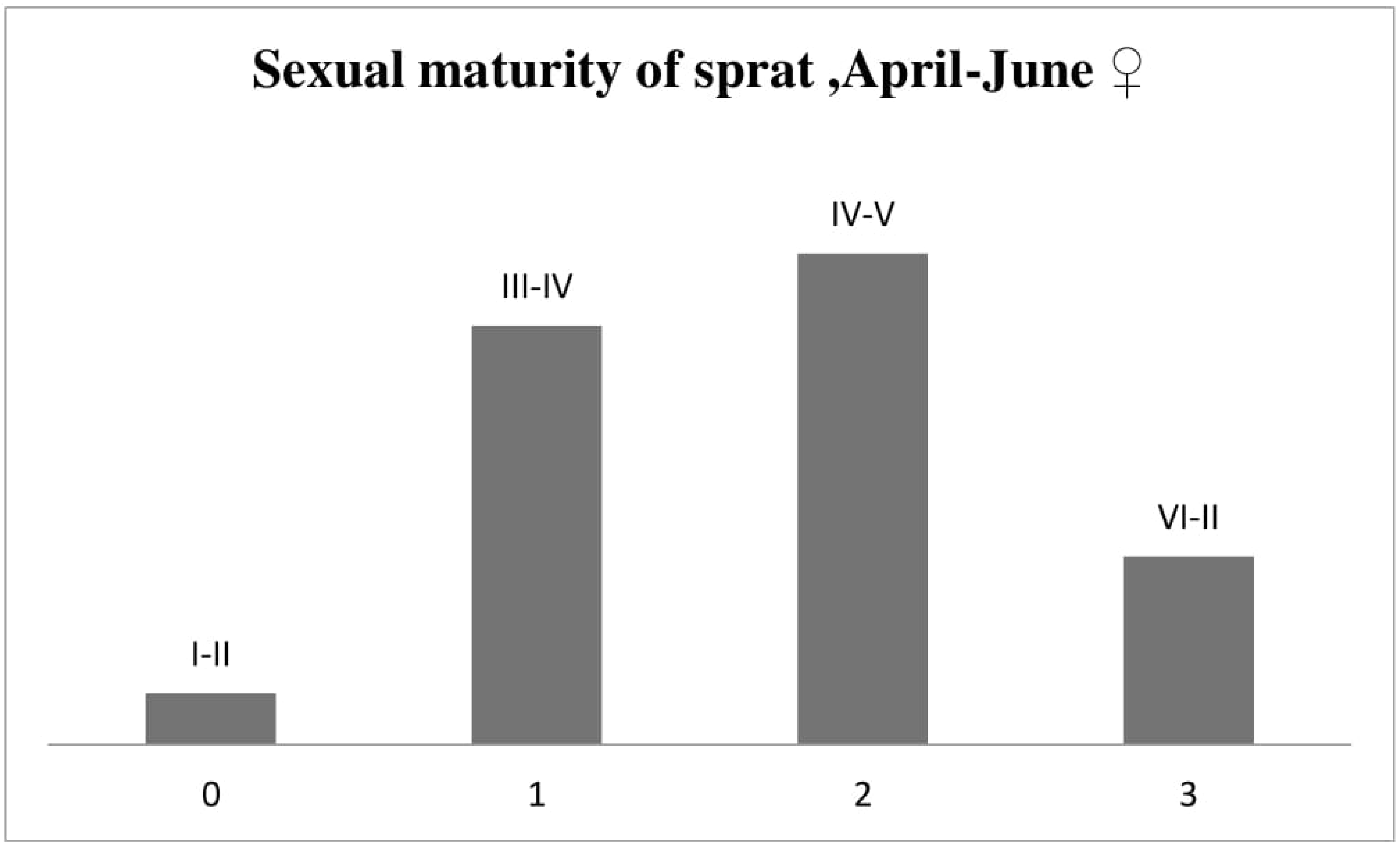
I.3.10 Sexual maturity

500 specimens are used for sexual maturity determination.





a.

Figure 3.10.1 Sex maturity by age – a. females ♀.

The degree of sexual maturity of the sprat by size groups for the period January-March April-June 2021 is presented in **Fig 3.10.2**.The prevailing maturity stage for sprat was IV-V (active spawners), as the eldest age groups have VI-II stages.

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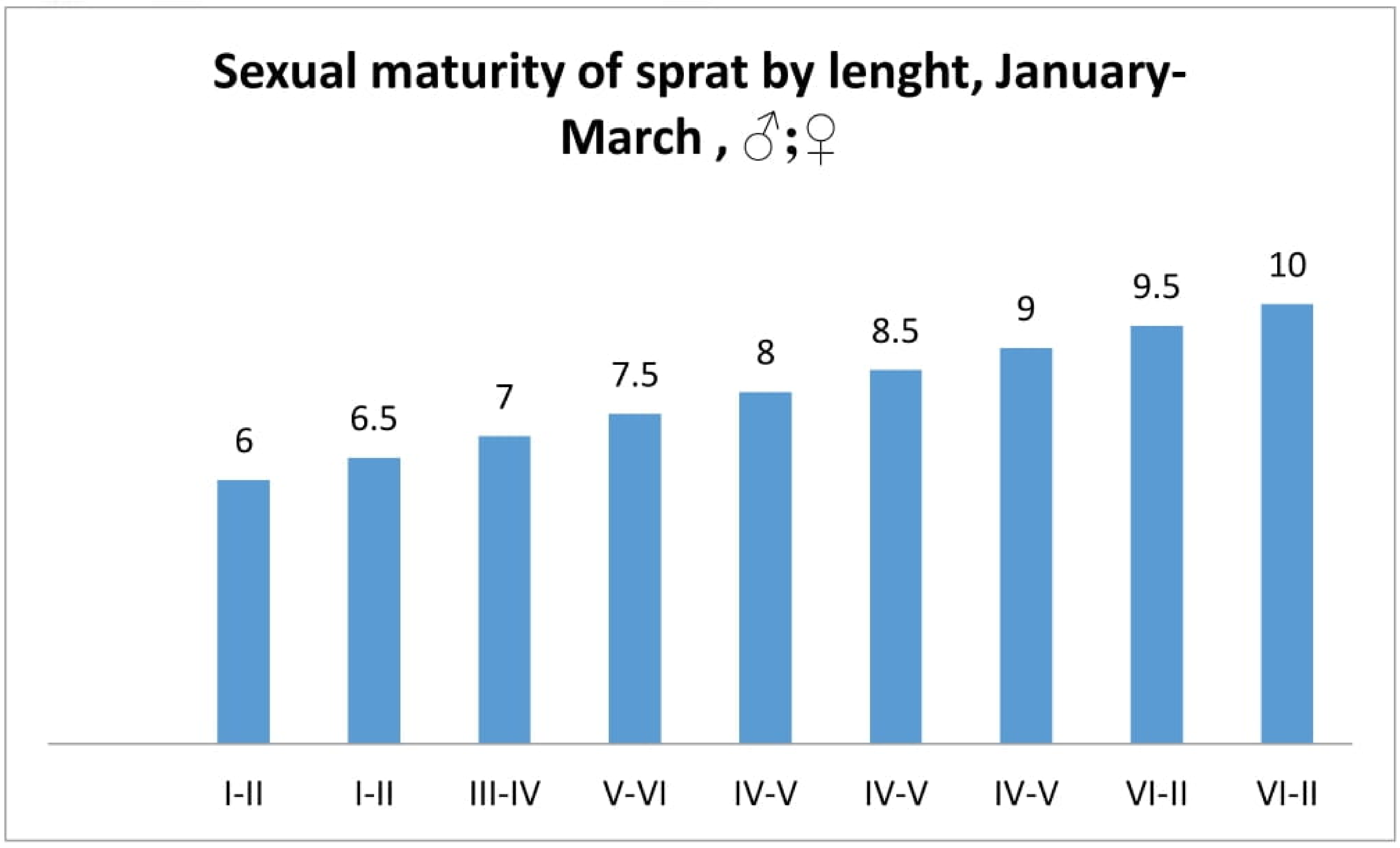

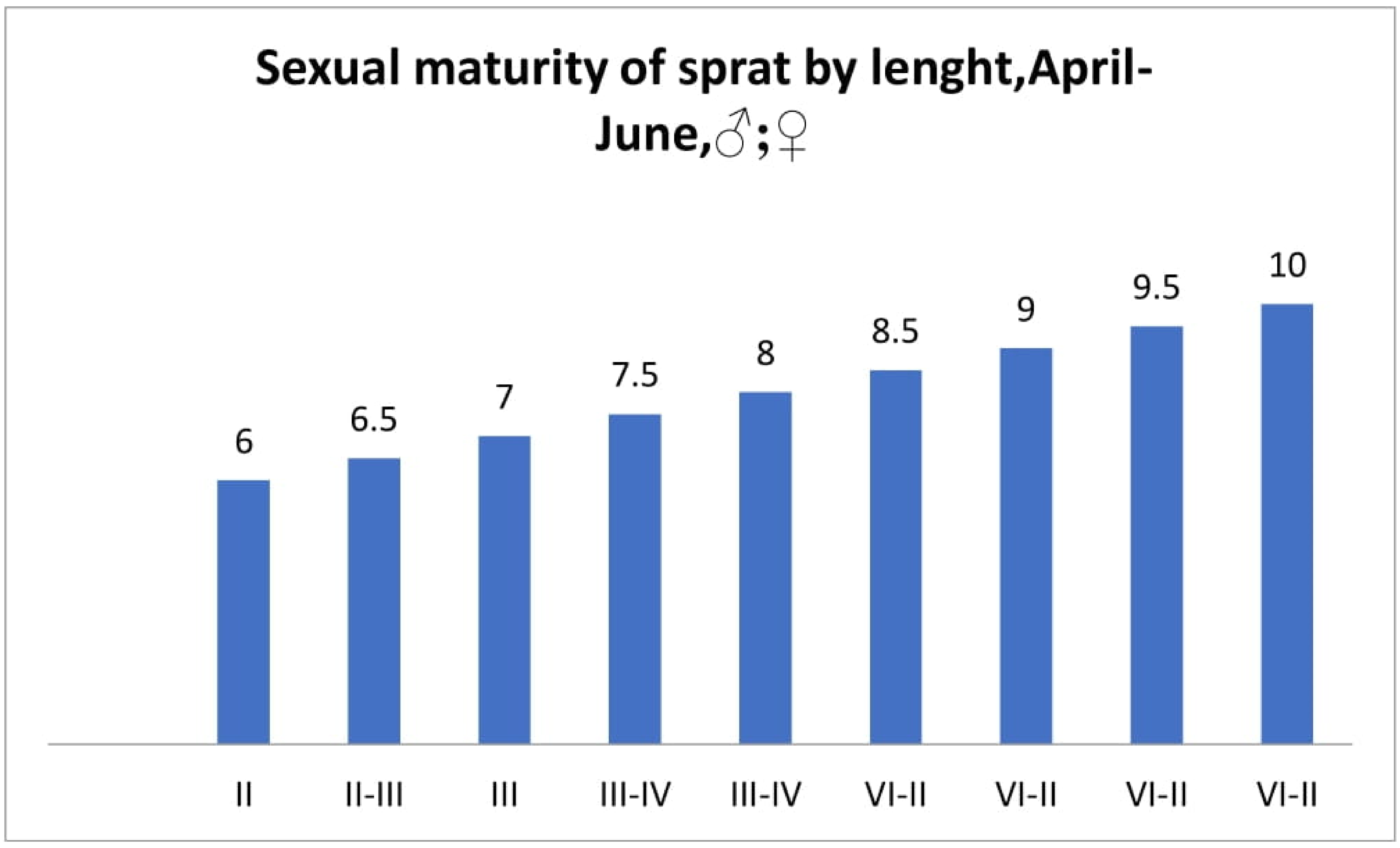

Figure 3.10.2 Sex maturity by length –females ♀ and males ♂ (Jan-March;April-June).

I.3.11 Catch numbers and biomass by age and length

Monthly catches (in tons) together with mean weights of sprat were used to derive the monthly catch numbers. The share (%) by age groups and catch numbers were used to create catch-at-age matrix for selected months by age groups **(Table 3.11.1).**

Table 3.11.1 Catch at length (10^{-6}) and Catch at age (10^{-6}) matrix and biomass (kg) of sprat for selected months.

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Length classes (см)	Catch in numbers *10-3			Biomass (kg)		
	I-st quarter	II-nd quarter	Total	I-st quarter	II-nd quarter	Total
6	4408.52	52878.31	**57286.83**	6899.33	60810.06	**67709.38**
6.5	25397.72	230027.97	**255425.69**	44845.63	311066.82	**355912.46**
7	38467.60	359475.56	**397943.16**	76927.51	643183.28	**720110.79**
7.5	17108.09	149686.29	**166794.38**	42085.90	336794.15	**378880.06**
8	3820.10	46740.37	**50560.47**	11383.89	114603.57	**125987.46**
8.5	401.36	8721.13	**9122.49**	1379.87	25727.33	**27107.20**
9	189.13	4067.56	**4256.69**	689.93	14033.09	**14723.02**
9.5	68.31	0.00	**68.31**	344.97	0.00	**344.97**
10	54.76	1065.29	**1120.05**	344.97	4677.70	**5022.66**
Age groups (yr)	**Catch in numbers *10-3**			**Biomass (kg)**		
	I-st quarter	**II-nd quarter**	**Total**	**I-st quarter**	**II-nd quarter**	**Total**
0-0+	23583.81	188643.32	**212227.13**	33806.71	276245.91	**310052.62**
1-1+	52977.66	542776.45	**595754.11**	113148.99	924578.15	**1037727.13**
2-2+	12977.84	117335.52	**130313.36**	36221.47	295977.76	**332199.24**
3-3+	376.27	3907.20	**4283.47**	1724.83	14094.18	**15819.01**

I.3.12 Coefficient of variation of length

na

I.3.13 Conclusions and recommendations

1) The catch increased after March towards June 2021.
2) The length distribution follow normal pattern as 3 peaks of length classes 6, 6.5 and 7 cm were observed first and second trimester of 2021.
3) The peak of 1-1+y^{-1} (first trimester) and 2-2+y^{-1} (second trimester) were recorded.
4) The condition factor of sprat from investigated period show relatively low values due to the lack or low percentage of the largest and oldest groups in the catches.
5) Mean weights in first and second trimester of the 2021 show similar values in all age groups.
6) The length-weight relationship for both periods is well described by the exponent and shows allometric (n = 2.94) increase in both periods (R^2 = 0.99).
7) Females prevailed with 57 and 52% (first and second trimesters), compared to males 43-48%.

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8) The prevailing maturity stage for sprat was IV-V (active spawners), as the eldest age groups have VI-II stages.

9) Batch fecundity (Log F) plotted vs. Sprat Length (Log L) show weak relation (R^2 =0.2) which prove weak dependence of fecundity on the individual sizes.

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II. Biological monitoring of horse mackerel (*Trachurus mediterraneus*) landings

II.1 Objectives

In the Black Sea, horse mackerel (*Trachurus mediterraneus*) has an important economic importance for Bulgarian fishing. This fact determines the need for annual monitoring of industrial stocks, as well as observations on the size, age and sex composition of the horse mackerel flocks. The purpose of this study is to collect and analyze the dynamics of length, weight and age distribution, as well as to determine the condition of the observed species using the so-called Ricker factor. Biological information for a species is collected every month and thus analysed and compared with previous periods and can then be used to assess growth parameters. These indicators are of very high importance for species. Long-term information is crucial for the assessment of fish stocks, fisheries management and the decision-making process as a whole.

II.2 Sampling

II.2.1 Geographic area coverage

Data of present analysis were collected from landing ports of Bulgarian Black Sea coast. In the 1th and 2th quarters of 2021, **5 samples with 583 specimens** were collected and processed. Information on the size of the catches was also collected.

II.2.2 Sampling period

Date	Sampling ports	Fishing vessel	Catch,kg
22.1.2021	Sozopol	MEDUZA 3	375
2.2.2021	Nesebar	ISHTAR	72
9.3.2021	Sozopol	FV 26	150
April	No OTM catches recorded		
30.5.2021	Sozopol	XERSON	675
20.6.2021	Sozopol	VALNOBOR	100

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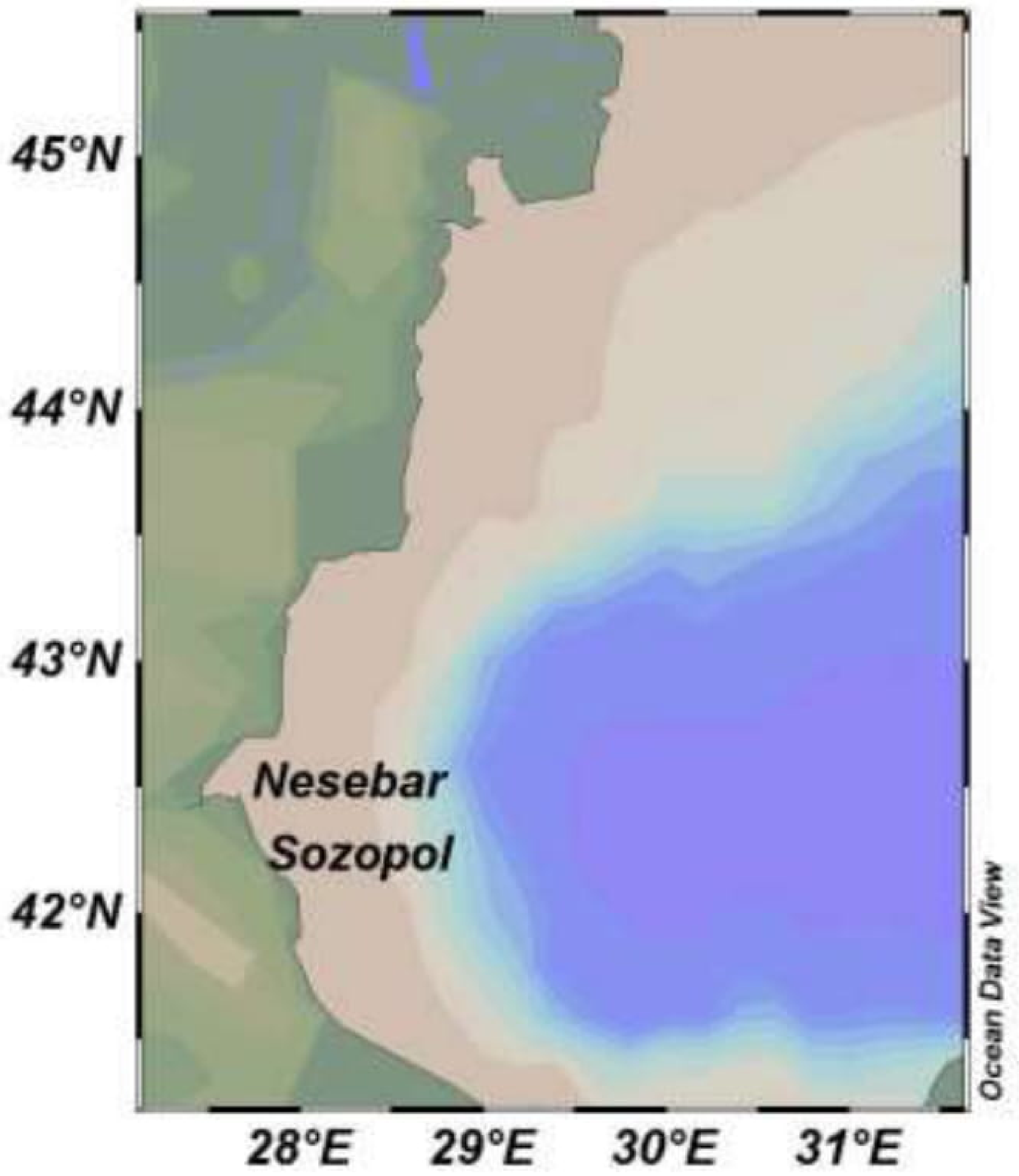

Figure 2.2.1 Research area and plan of the sampling ports of Bulgarian Black Sea coast.

II.2.3 Statistical analysis of data

See section statistical analysis of sprat

II.3 Results

II.3.1 Landings statistics

In January the highest catches of Black Sea horse mackerel were made in the Bulgarian water area of the Black Sea (3690 kg), **Figure 3.1.1.**

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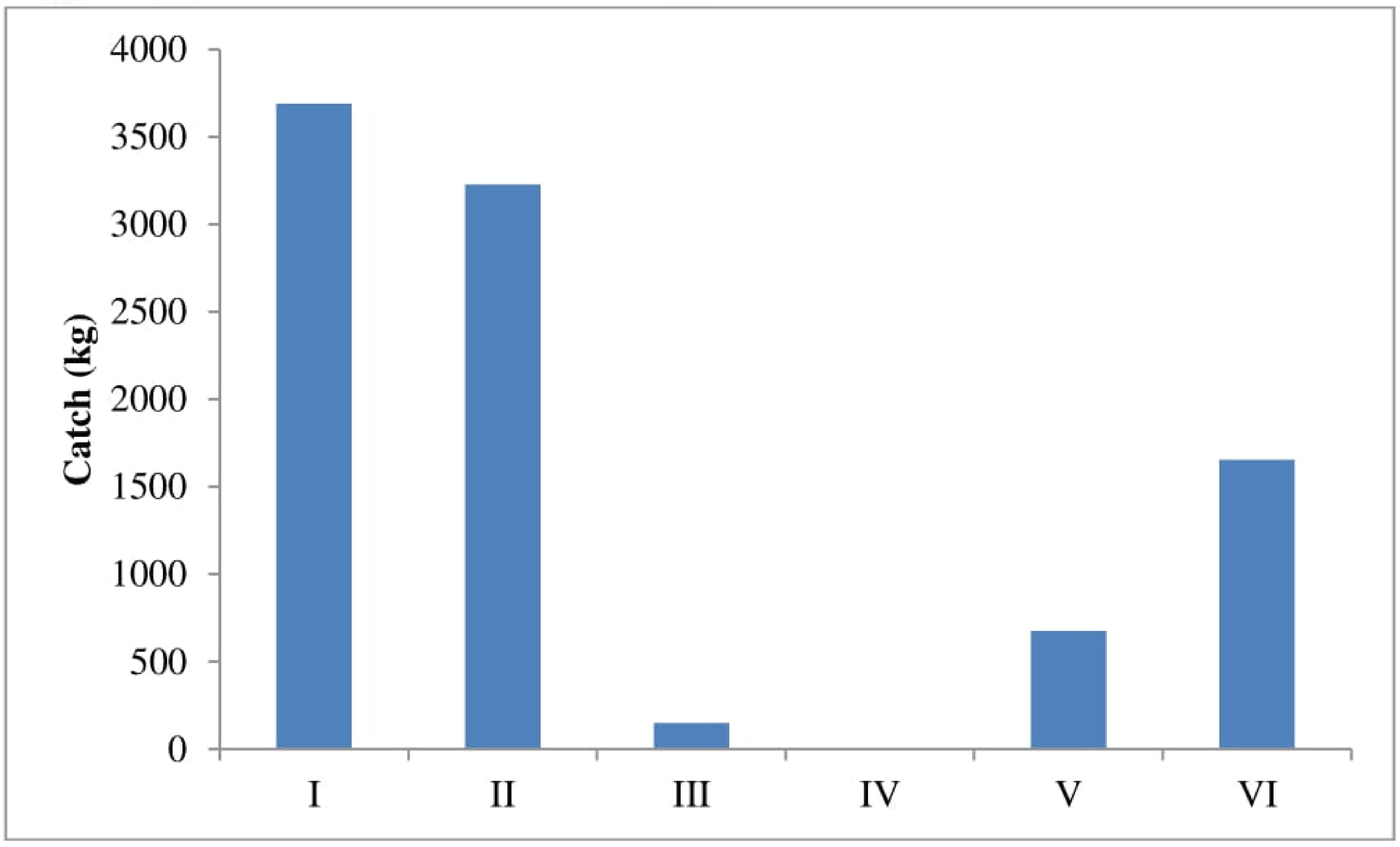

Figure 3.1.1 Landings statistics of horse mackerel.

II.3.2 Length structure of landings

In the catches of the Bulgarian aquaria of the Black Sea during the study period, the species is presented with individuals from 6.0 to 13.5 cm in length. In the size composition of catches in January and February, the size classes 8-8.5 and 9.5-10.0 cm are dominant. In March, the species was presented with individuals 7-12 cm in length, similar to the distribution in June of 7.5-12 cm. In March and June, they prevailed in size groups -9,5 and 10 cm. The size frequencies of the species in May ranged from 7,5-11,5 cm and dominated the 9,5-10 size classes (**Figure 3.2.1**).

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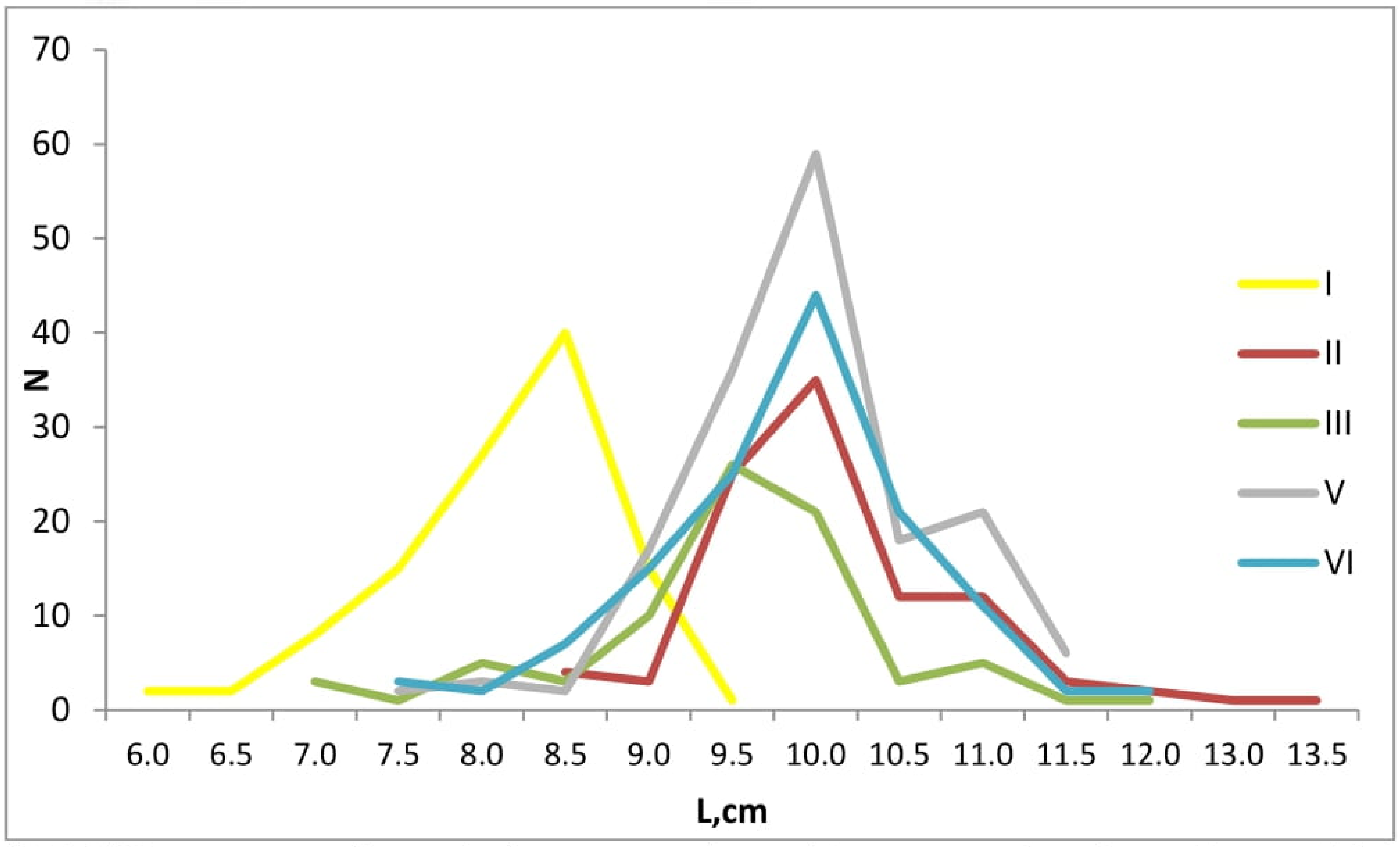

Figure 3.2.1 Histogram of length frequency data of horse mackerel landings, 2021.

II.3.3 Age structure of landings

The three readers determined the age of horse mackerel otoliths, and reader 1 read all otoliths twice. Specimens **(n = 400)** were used for age determination. The age structure of January and February is formed by 4 age groups, respectively -0, 1, 2, 3 (January) and 1, 2, 3 and 4 years old (February). Zero-year-olds in February are not registered. In March and May there is a significant participation of one and two-year-old fish. In June, 0, 1 and 2 year olds prevailed, reducing 3 and 4 year olds. According to multi-year observations, small size horse mackerel approached in large numbers in June. Five-year-olds are completely absent from the first half of 2021 **(Figure 3.3.1)**.

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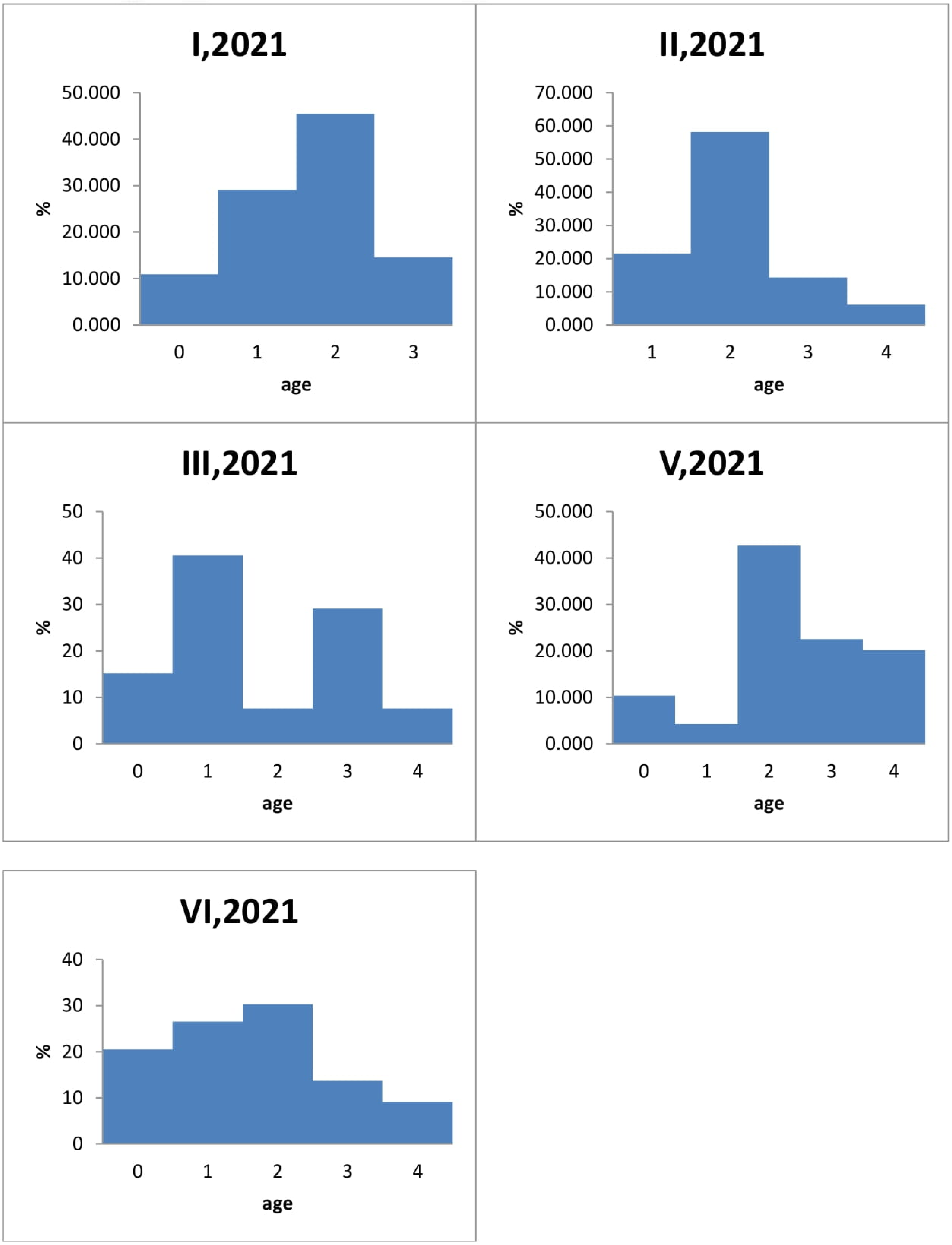

Figure 3.3.1 Age distribution of horse mackerel.

The summary graph for 1st and 2nd quarter of 2021, 1 and 3-year-olds and preponderance of two-year-olds by 36.54%, respectively, with the distribution of age groups as follows: 0-11.66%, 1-21.27%, 3-20.24% and 4-10.29% **(Figure 3.3.2)**.

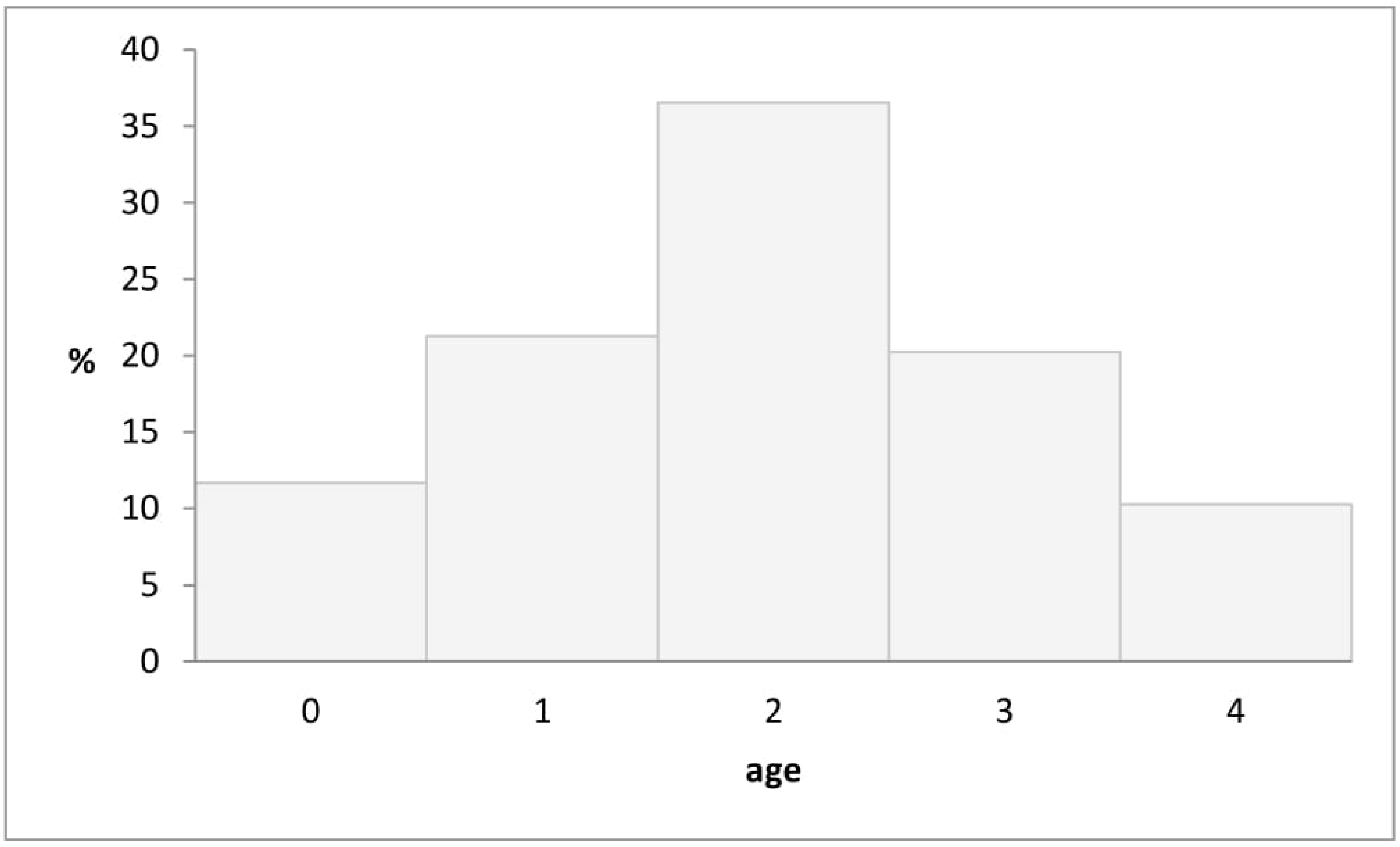

Figure 3.3.2 Age distribution of horse mackerel for 1st and 2nd quarter quarter of 2021.

II.3.4 Condition factor

Fulton's average rate in January was 0.5896, up from 0.8370 and 0.8101 in May and June respectively **(Fig. 3.4.1).** The fluctuation of conditioning fathor by age group showed differences **(Figure 3.4.2)**. The highest average K values in January were in 1 year (0.6105), 3-year-old fish showed the lowest values (0.5516). Fulton's average in February was 0.7746. The lowest values were recorded in individuals belonging to age 2-2+ (0.7688), and the largest mean (c.f) were observed at 1-1+ (0.7941).

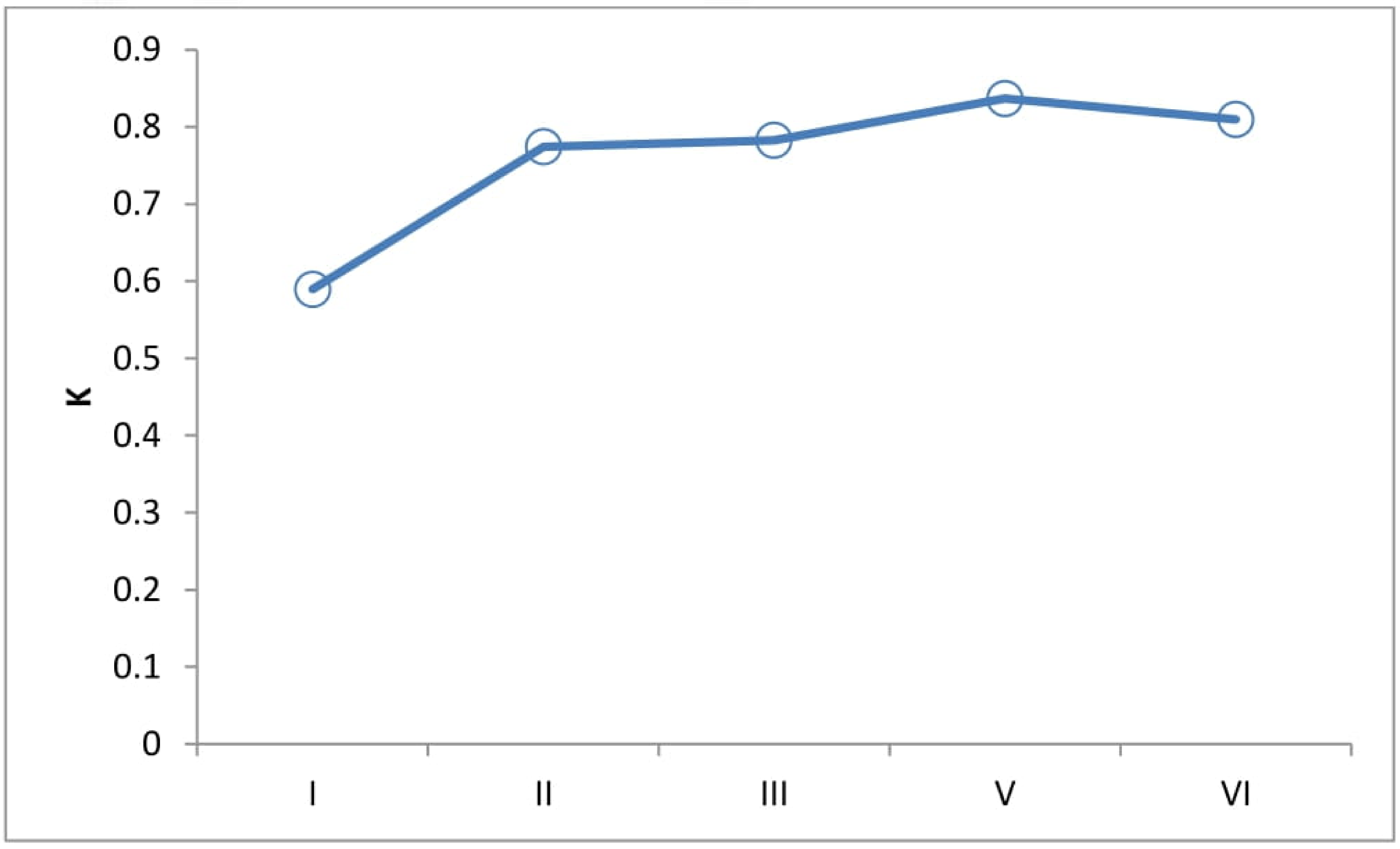

Figure 3.4.1 Condition factor of horse mackerel.

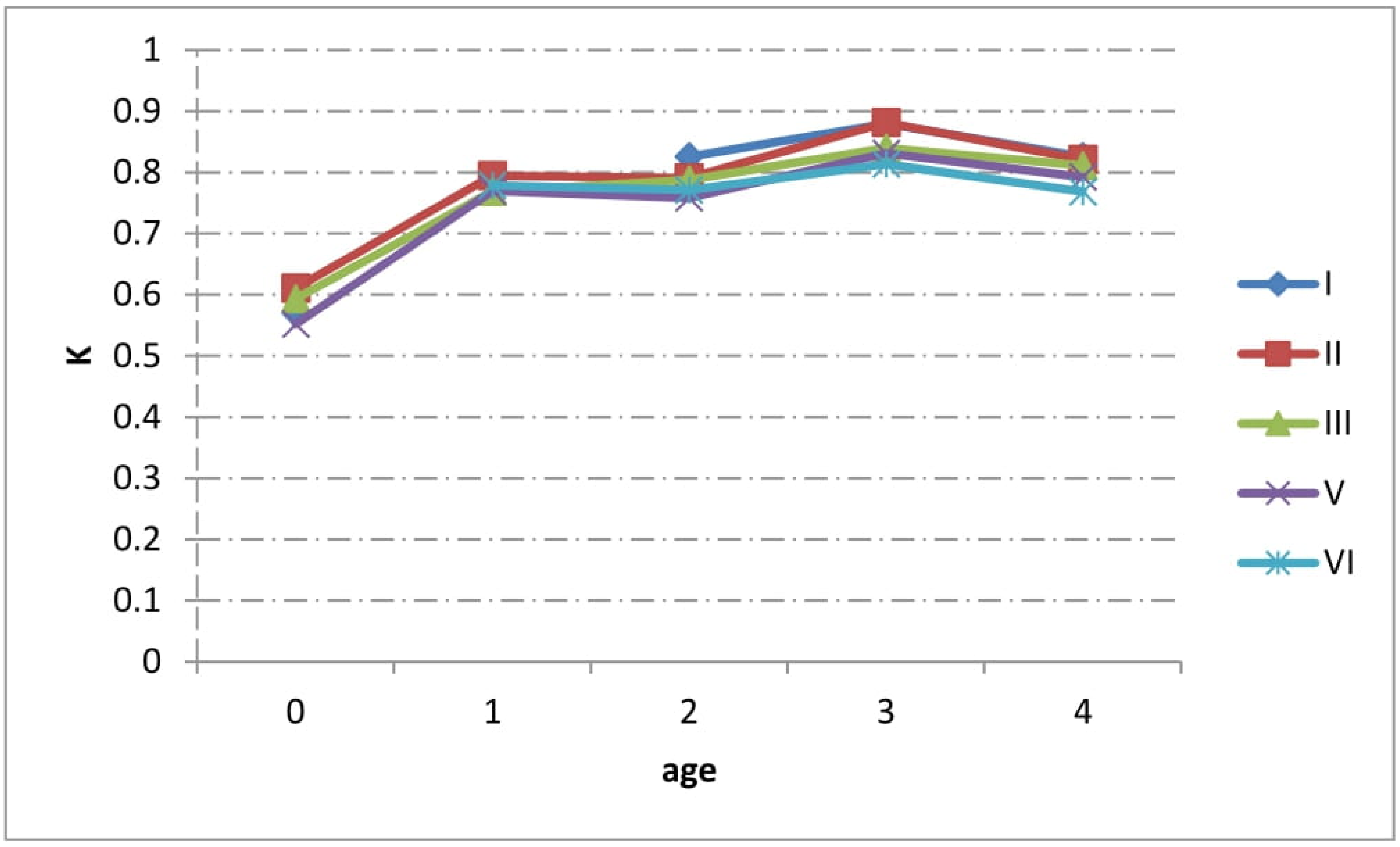

Figure 3.4.2 Condition factor of horse mackerel by age groups, 2021.

II.3.5 Weight structure of horse mackerel

The weight was measured on **583 specimens**. The total average weight of the mackerel showed the following averages for January 2021. - 3,336 g, February 2021 - 8,186g, March - 6,918g, May-7,839g and June-8,330g. The highest weight showed the four-year-old fish, and the lowest weight showed the zero-year-old fish.

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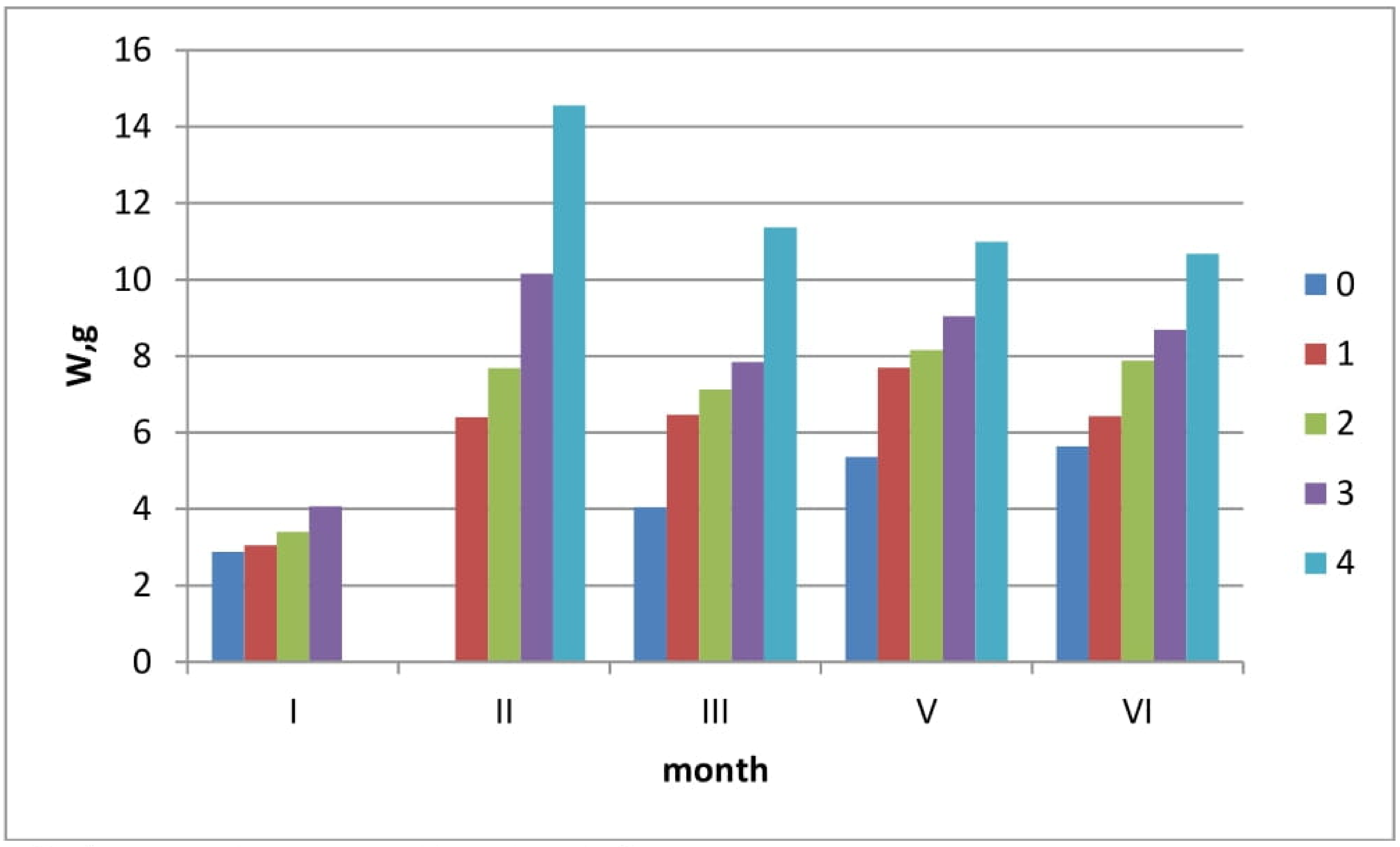

Figure 3.5.1 Average horse mackerel weights by age.

II.3.6 Size structure of horse mackerel by age group

The fish length was measured of **583 specimens**. The senior age groups show the highest values in terms of average lengths **(Figure 3.6.1**).

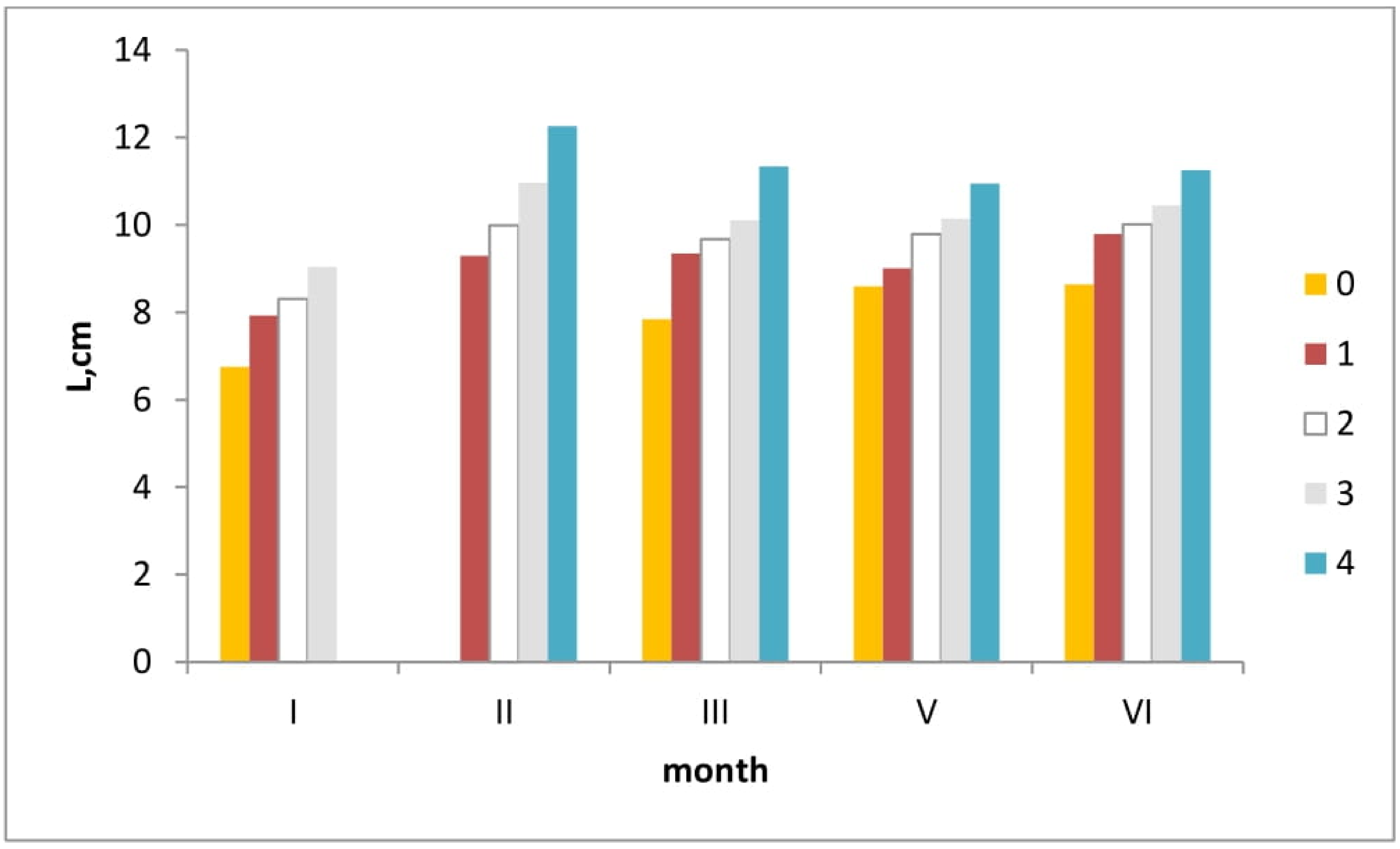

Figure 3.6.1 Average horse mackerel lengths by age.

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II.3.7 Length- weight relationship

The interrelation between the size (L) and the weight (W) of the sampled specimens is described by the equation: $W = 0.0902 * L^{3.2411}$

From the analysis, it follows that the increase in the horse mackerel is allometric ($n \neq 3$).

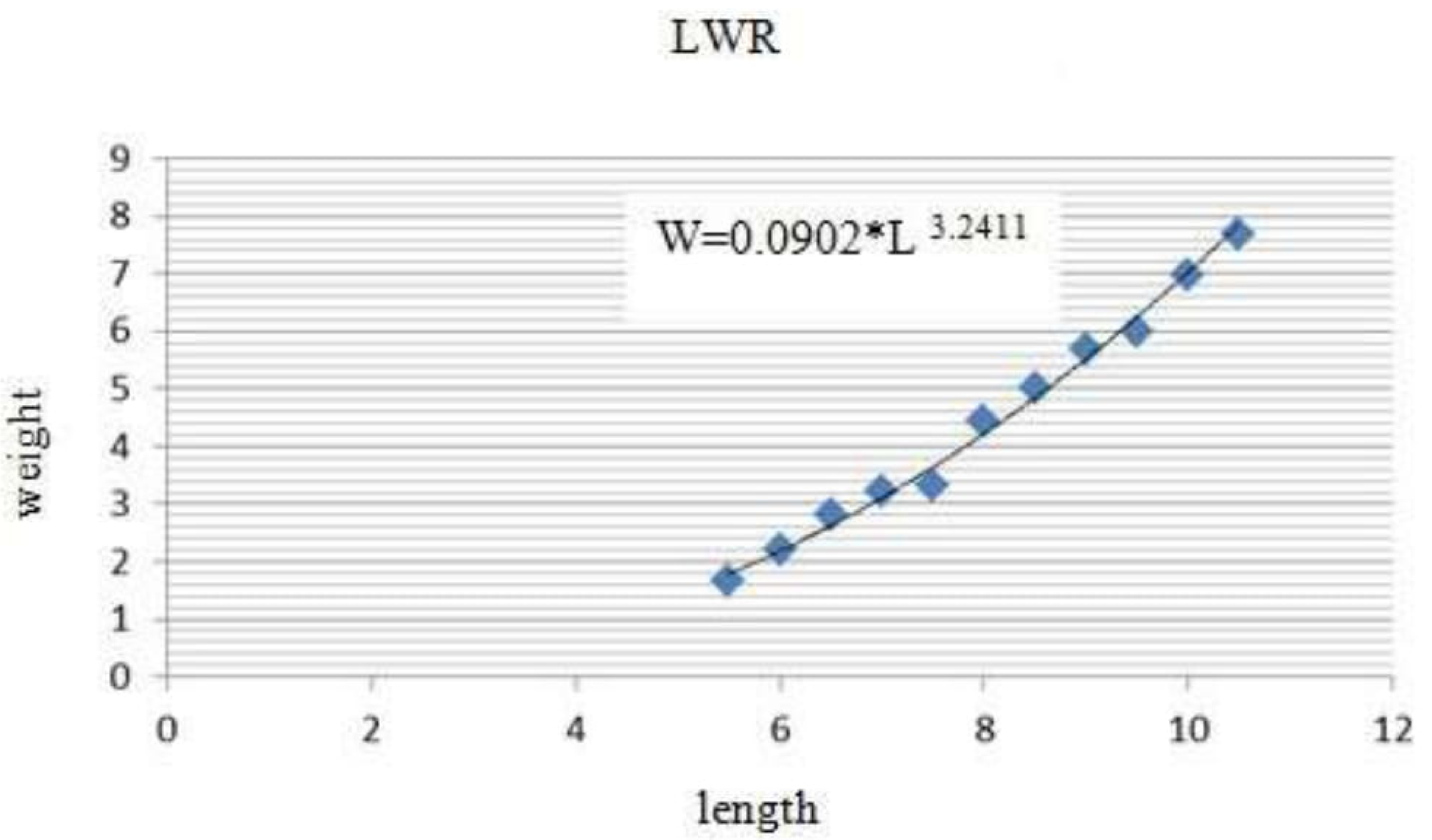

Figure 3.7.1 Length (L) - weight(W) relationship of horse mackerel.

Table 3.7.1 Length-weight relation parameters.

year	**a**	**n**
2021	0.0902	3.2411

II.3.8 Sex structure

At **250 samples**, the sex ratio is determined. Females (♀) prevailed by 53%, followed by male (♂) specimens by (47%) **(Figure 3.8.1)**.

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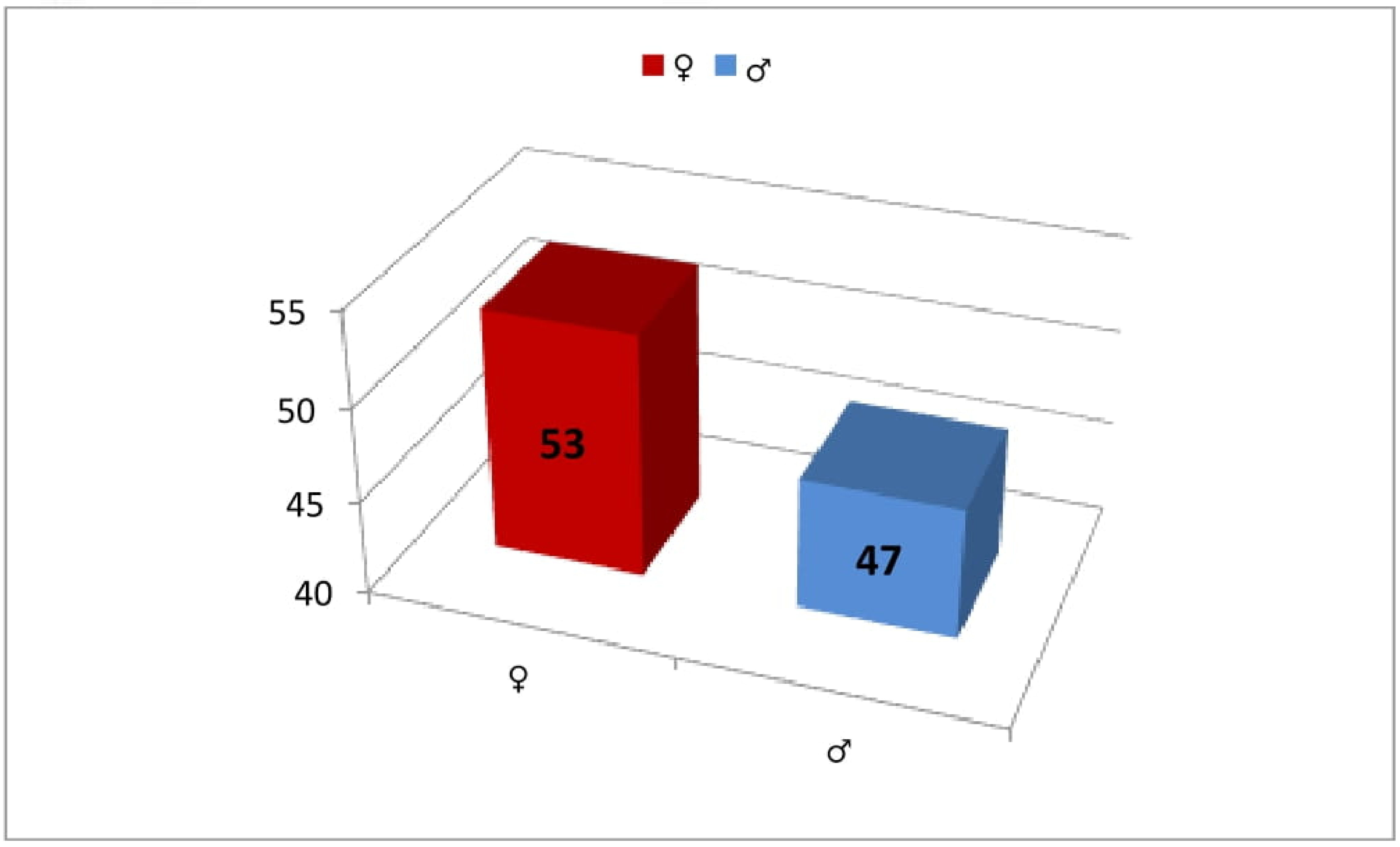

Figure 3.8.1 Sex ratio of horse mackerel caught in the Bulgarian Black Sea waters.

The average lengths in females are higher than the size of male fish **(Figure 3.8.2)**. One year old fish showed close values during the study period.

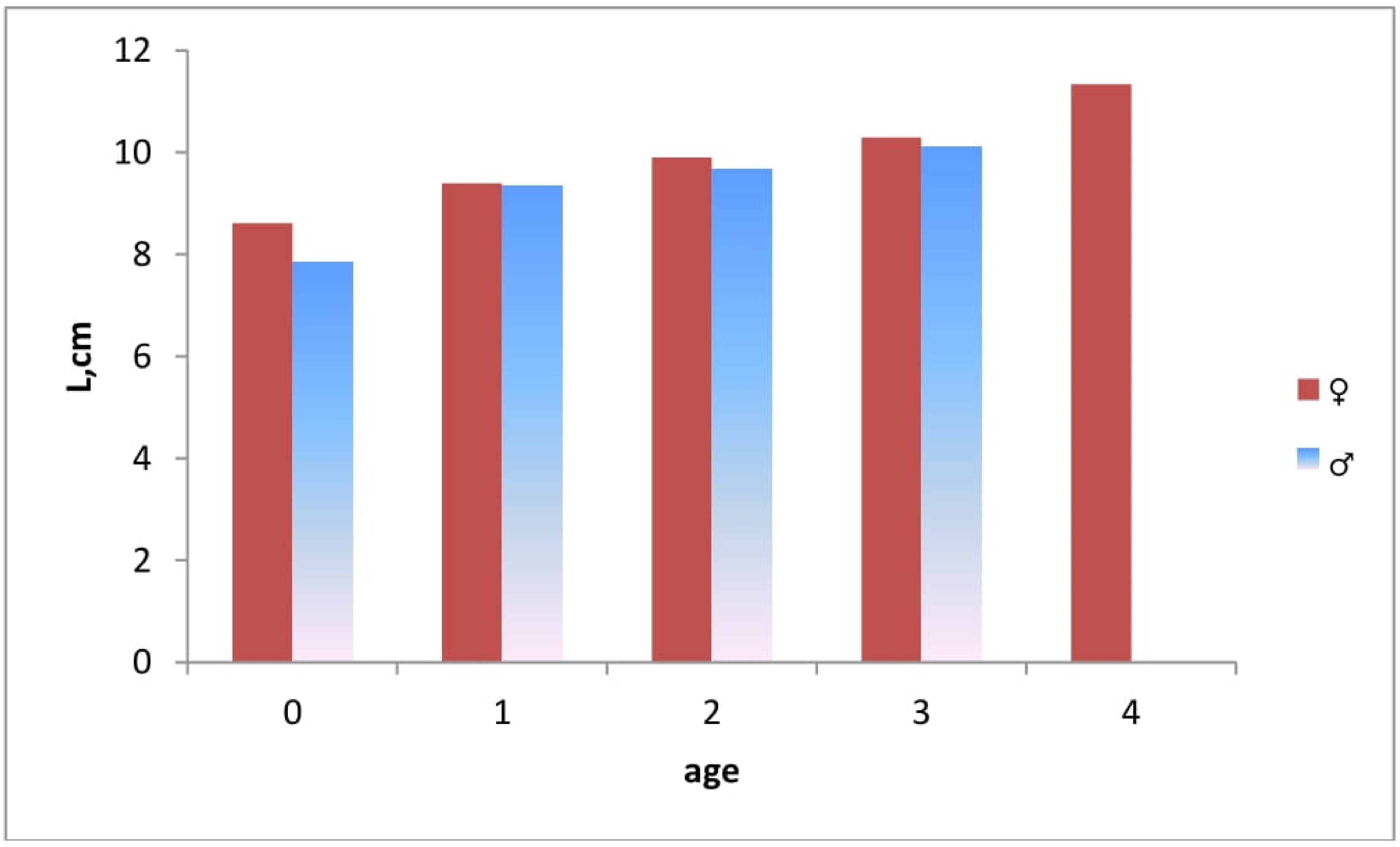

Figure 3.8.2 Sex ratio by size and age of horse mackerel.

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II.3.9 Fertility

Fertility was determined on **100 specimens**. The average weight of sexually mature fish from the samples was 13.10 g at an average length of 12.40 cm. It was found that the number of mature ovocytes in the ovaries had an average of 235.10 pieces, with minimum and maximum values of 145 and 282 pieces respectively.

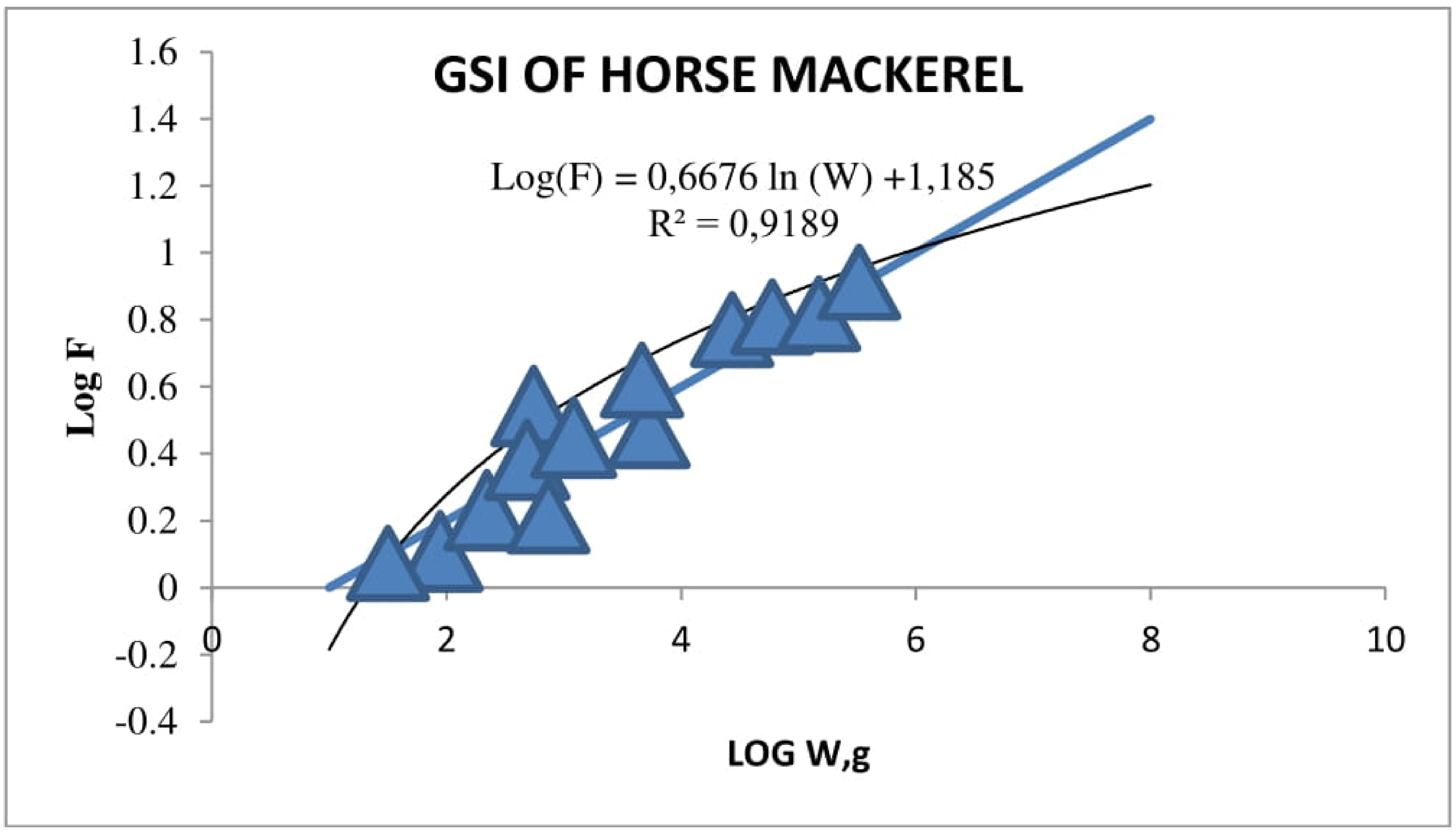

Figure. 3.9.1 Dependence on the weight of the gland of the Gondosoman Index (GSI).

The relationship between the weight and fertility of the mackerel in the spring-summer season of 2021 showed a relatively strong dependence (R^2=0.9120), on the Gonado-somatic index and the weight of the gland (ovary) (**Figure 3.9.2**).

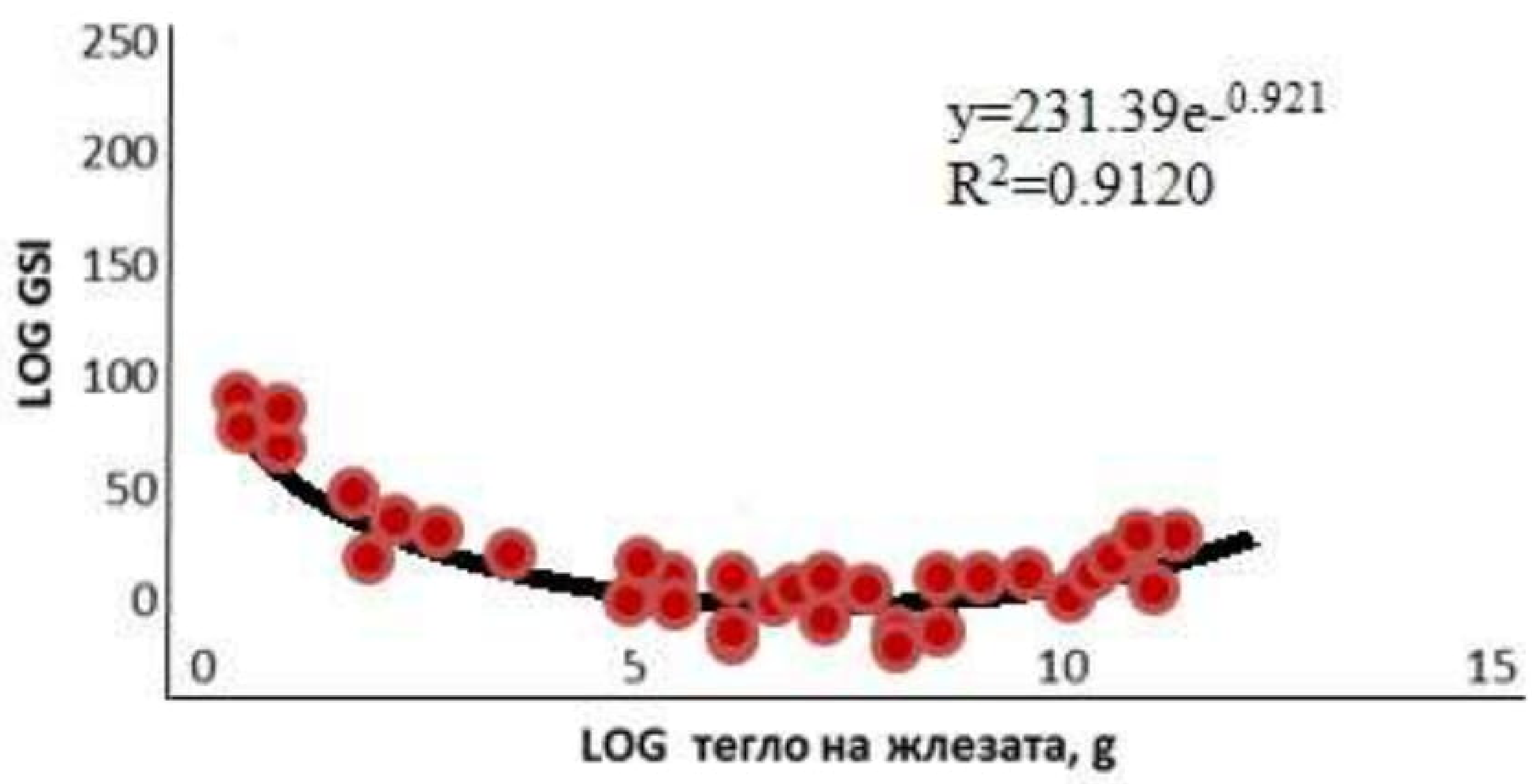

Figure. 3.9.2 Dependence of the ration fertility on the size of horse mackerel.

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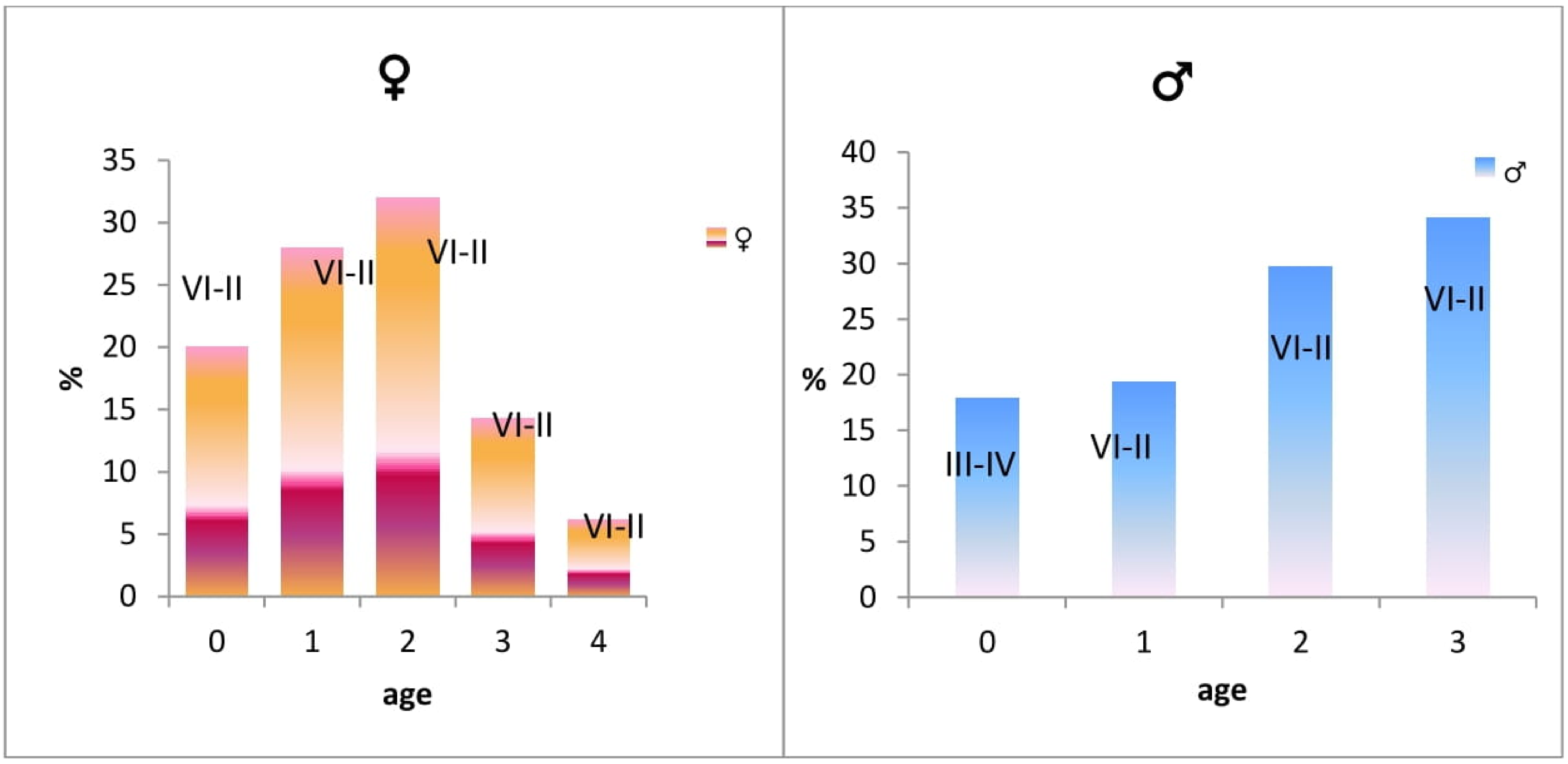
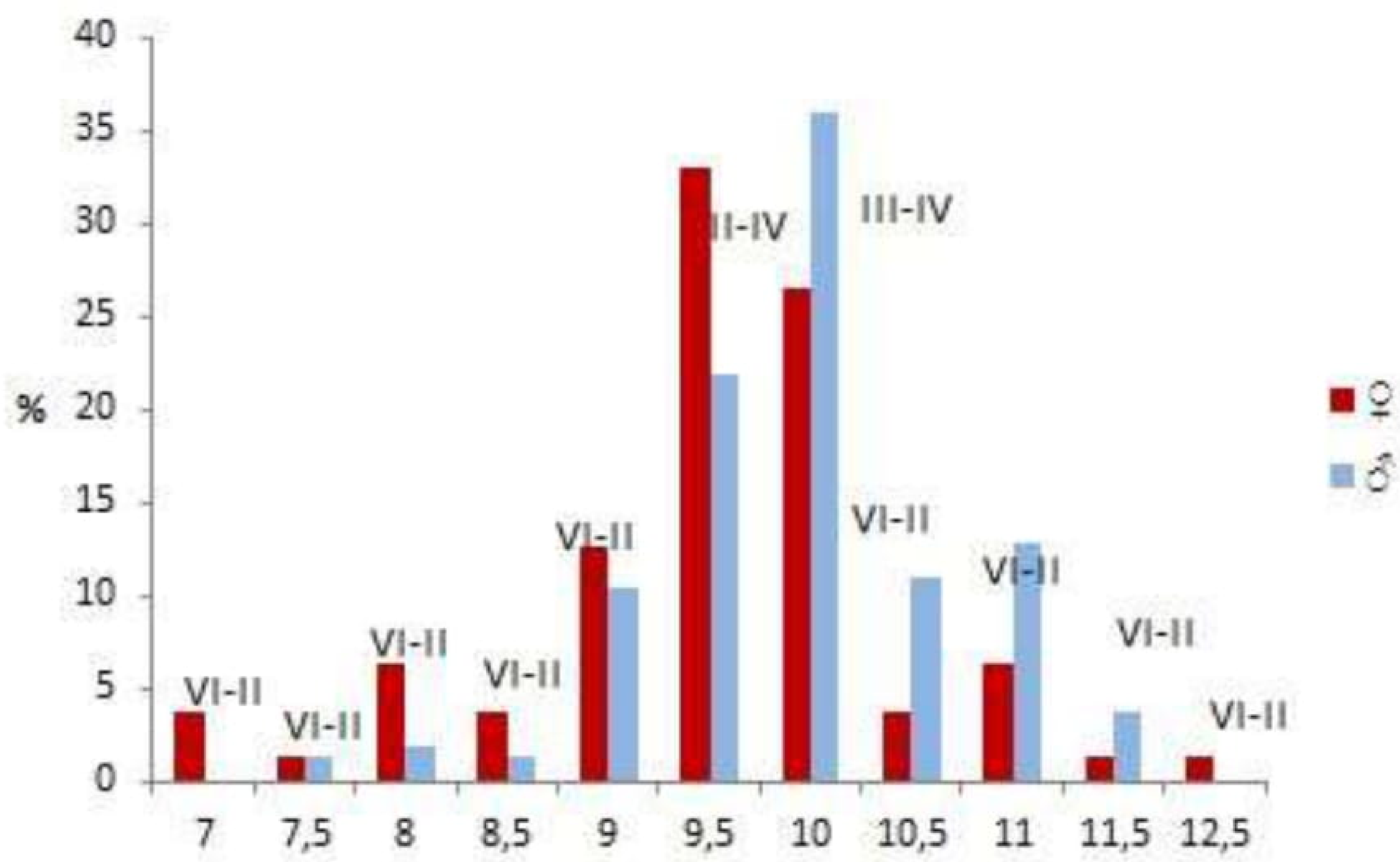
II.3.10 Sexual maturity

250 specimens have been assigned sexual maturity. In June, we watched mass mature sex products in over 75% of the female subjects surveyed.Study specimens showed a degree of running gonads (VI-II), with a small percentage of 17,83% being in grade (III-IV).



Figute 3.10.1 Sexual maturity by age of horse mackerel - female ♀ and male ♂.



Figute 3.10.2 Sexual maturity by lenght of horse mackerel - female ♀ and male ♂.

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II.3.11 Catch numbers and biomass by age and length

Monthly catches (in tons) together with mean weights of horse mackerel were used to derive the monthly catch numbers. The share (%) by age groups and catch numbers were used to create catch-at-age matrix for selected months by age groups **(Table 3.11.1).**

Table 3.11.1 Catch at age (10^{-6}) matrix and biomass (kg) of horse mackerel for selected months.

Catch-at-Age *10^{-3} (in thousands)		
Age groups	**1st quarter**	**2nd quarter**
0	63,0049	20,7520
1	115,0524	37,8950
2	194,4934	64,0606
3	106,8344	35,1882
4	52,9606	17,4437
∑	**532,3458**	**175,3397**
Biomass (kg)		
Age groups	**1 st quarter**	**2nd quarter**
0	248,0768	81,7095
1	4008,5863	1320,3153
2	1327,1040	437,1107
3	915,1226	301,4156
4	569,1104	187,4489
∑	**7068,00**	**2328,00**

Monthly catches (in tons) together with mean weights of horse mackerel were used to derive the monthly catch numbers. The share (%) by length groups and catch numbers were used to create catch at length matrix for selected months by age groups **(Table 3.11.2).**

Table 3.11.2 Catch at length (10^{-6}) matrix and biomass (kg) of horse mackerel for selected months.

Catch-at-length *10^{-3} (in thousands)		
Length groups (cm)	**1st quarter**	**2nd quarter**
6	1,8262	0,6015
6,5	1,8262	0,6015
7	10,0443	3,3083
7,5	19,1754	6,3158
8	33,7852	11,1279
8,5	51,1344	16,8422

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9	54,7869	18,0453
9,5	103,1819	33,9852
10	145,1852	47,8199
10,5	49,3082	16,2407
11	44,7426	14,7370
11,5	10,9574	3,6091
12	3,6525	1,2030
12,5	0,9131	0,3008
13	0,9131	0,3008
13,5	0,9131	0,3008
∑	**532,3458**	**175,3397**
Biomass	**1st quarter**	**2 nd quarter**
6	13,3181	4,3866
6,5	16,7648	5,5218
7	106,0674	34,9356
7,5	206,1356	67,8953
8	371,2998	122,2957
8,5	574,2395	189,1383
9	684,2880	225,3852
9,5	1342,3971	442,1478
10	1968,7114	648,4381
10,5	704,2220	231,9509
11	760,1770	250,3809
11,5	193,4832	63,7279
12	68,5366	22,5740
12,5	17,7789	5,8559
13	19,0688	6,2807
13,5	21,5223	7,0888
∑	**7068,00**	**2328,00**

The biomass of the horse mackerel was higher in the first quarter (January - March) of the study period (**Figure 3.11.1**).

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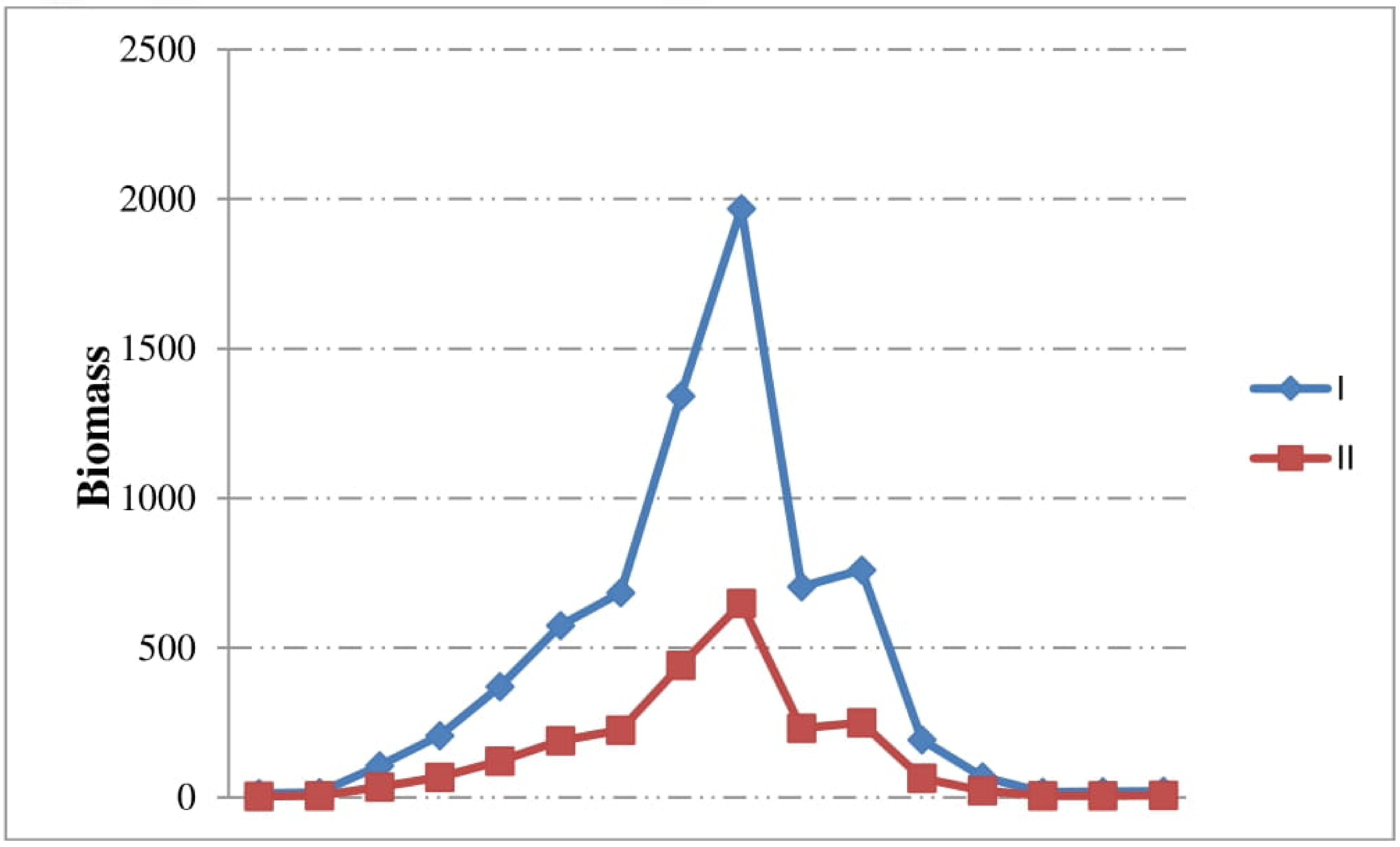

Figure 3.11.1 Biomass dynamics for 1st and 2nd quarter, 2021.

II.3.12 Coefficient of variation of length

NA

II.3.13 Conclusions

The analysis of the biological parameters of the mackerel makes it possible to draw the following **conclusions:**

1) In the catches of the Bulgarian black sea aquaria during the study period, the species is presented with individuals from L6.0 to L13.5 cm in length. In the size composition of early catches, size classes 8.0-8.5 and 9.5-10.0 cm are the dominant.

2) The age composition of catches for the 1nd and 2nd quarters of 2021, 1 and 3-year-olds and preponderance of two-year-olds by 36.54%, respectively, with the distribution of age groups as follows: 0 year-11.66%, 1 year-21.27%, 3-year-olds-20.24% and 4-year-olds-10.29%.

3) The average Fulton coefficient value in January was 0.5896 and in May and June the values were higher, 0.8370 and 0.8101, respectively.

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4) The ratio between females(♀) and males(♂) is 53% : 47%.

5) The average lengths in females are higher than the size of male fish.

6) Analysis of the relationship between size (L) and weight (W) of the mackerel shows that the increase is allometric. The parameter (n) characterizing the increase showed a value of 3.2411.

7) The relationship between the weight and fertility of the mackerel in the spring-summer season of 2021 showed a relatively strong dependence (R^2=0.9120) and a relatively low dependence of fertility on individual weights.

8) In June, mass mature sex products were observed in over 75% of the females ♀ studied.Test specimens showed a rate of flowing gonads (VI-II) as a small percentage -17% were in grade (III-IV).

9) The biomass of the horse mackerel was higher in the first quarter (January - March) of the study period.

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III. Biological monitoring of whiting (*Merlangius merlangus*) landings

III.1 Objectives

The Black Sea of whiting, (*Merlangius merlangus euxinus*) is a marine, cold-loving fish and is a key species for the marine ecosystem. The multi-year biological monitoring of landings provides so-called "Fisheries dependent" information. The purpose of this study is to collect and analyze the dynamics of length, weight and age distribution, as well as to determine the condition of the observed species using the so-called Ricker factor. Biological information for a species is collected each month and thus analysed and compared with previous periods and can then be used to assess growth parameters. These indicators are of very high importance for species. Long-term information is crucial for assessing fish stocks, fisheries management and the decision-making process as a whole.

III. 2 Sampling

III. 2.1 Geographic area coverage

Data of present analysis were collected from Bulgarian Black Sea coast. In the 1th and 2th quarters of 2021, **5 samples with 226 specimens** were collected and processed. Information on the size of the catches was also collected.

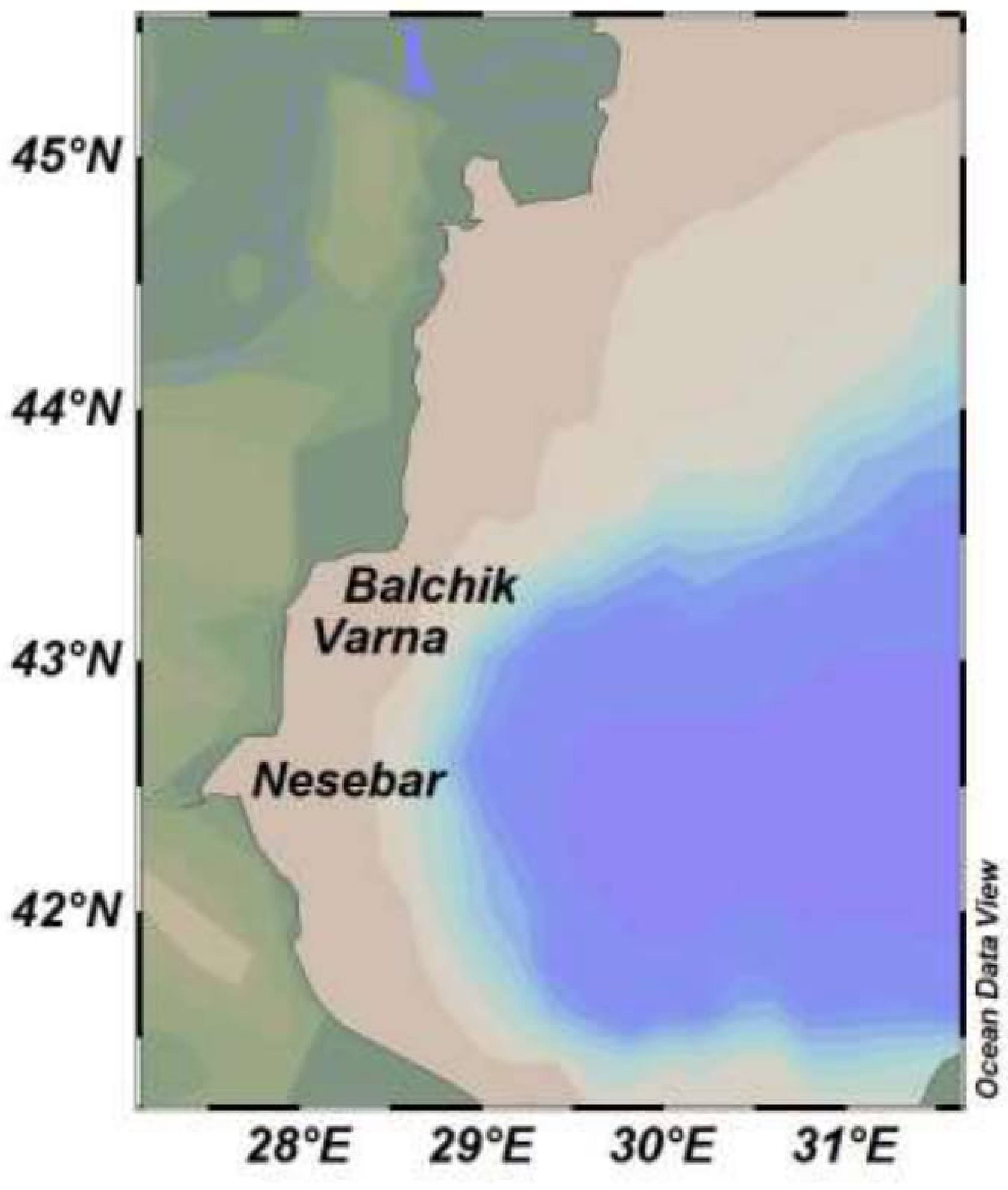

Figure 2.1.1 Research area and plan of the sampling ports of Bulgarian Black Sea coast.

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III. 2.2 Sampling period

Date	Sampling ports	Fishing vessel	Catch/kg
2.2.2021	Nesebar	ISHTAR	40
7.3.2021	Nesebar	BAHARI	70
8.4.2021	Varna	RUSANO	120
4.5.2021	Nesebar	FV 29	100
30.6.2021	Balchik	AFALA I	13

III. 2.3 Statistical analysis of data

See section statistical analysis of sprat.

III.3 Results

III.3.1 Landings statistics

The whiting catches ranged from 100 kg in May and 1270 kg in March 2021 **(Figure 3.1.1).**

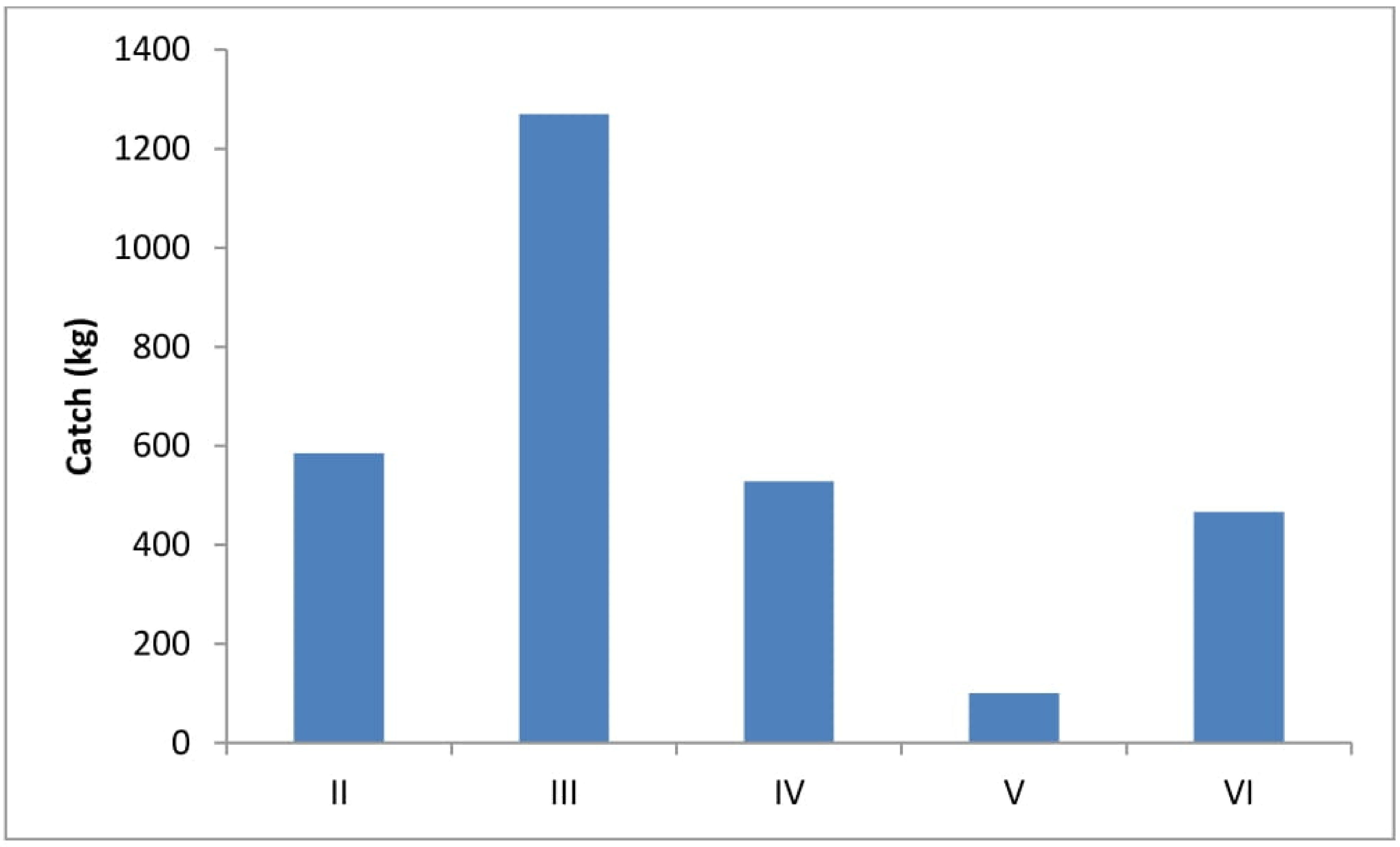

Figure 3.1.1 Landings statistics of whiting.

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

III.3.2 Length structure of landings

In the catches of the Bulgarian area on the Black Sea in 2021, the size composition is represented by individuals with a body length of 6.5 cm to 19.0 cm. In the landings during the study period 12.5 cm prevailed in a size group .

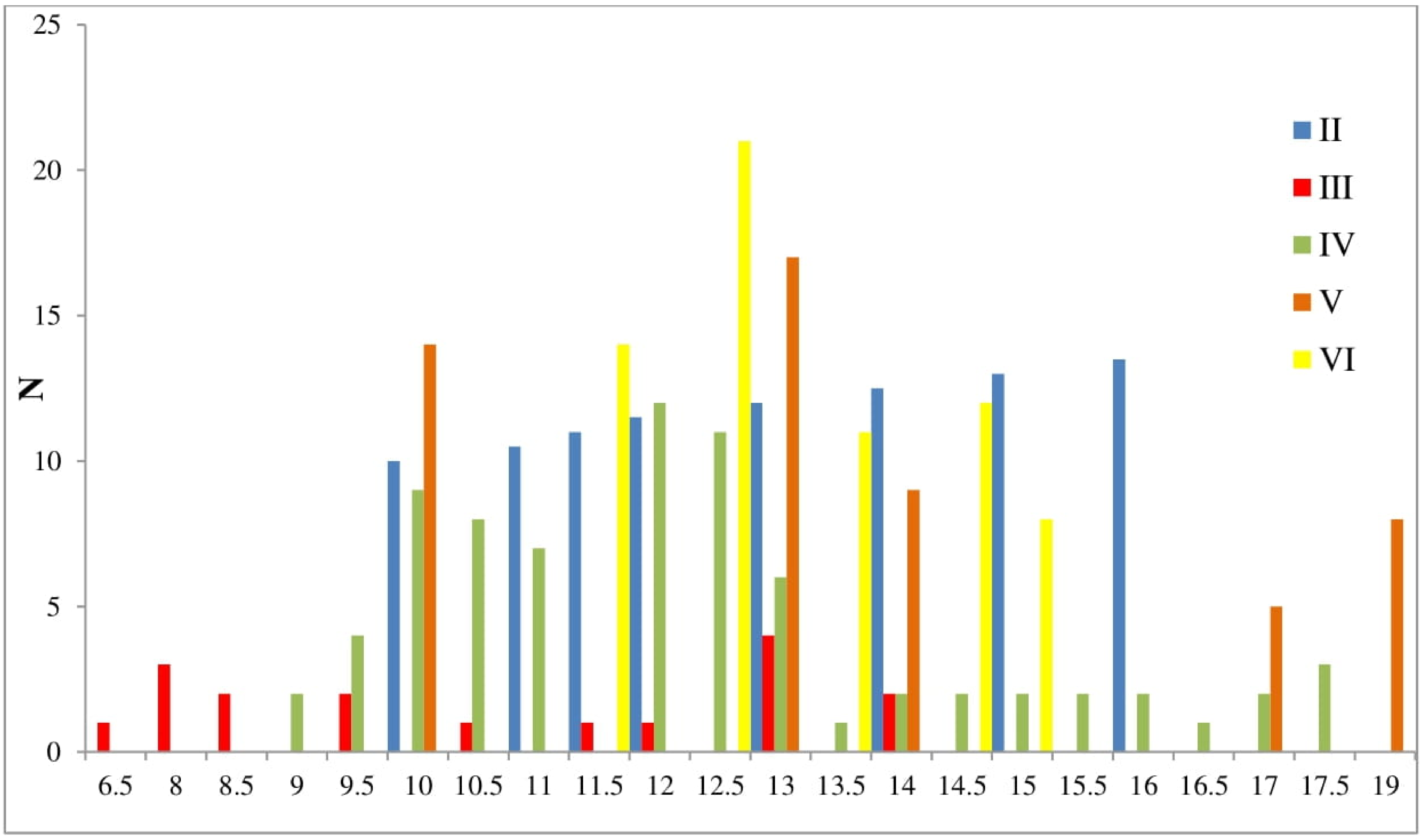

Figure 3.2.1. Histogram of length frequency data of whiting landings in 1th and 2th quarters of 2021.

III.3.3 Age structure of landings

The three readers determined the age of whiting otoliths, and reader 1 read all otoliths twice. Specimens **(n = 226)** were used for age determination. The age structure of the whiting is represented by six age classes, 0,1,2,3,4 and 5 years old **(Figures 3.3.1)**. In April and June, two-year-olds were the highest percentage in catches - three-year-olds were most present in February and March, the highest four-year-olds were seen in June, and in May five-year-olds participated with the highest percentage. The zero-year-olds were absent from the catch in February, May and June.

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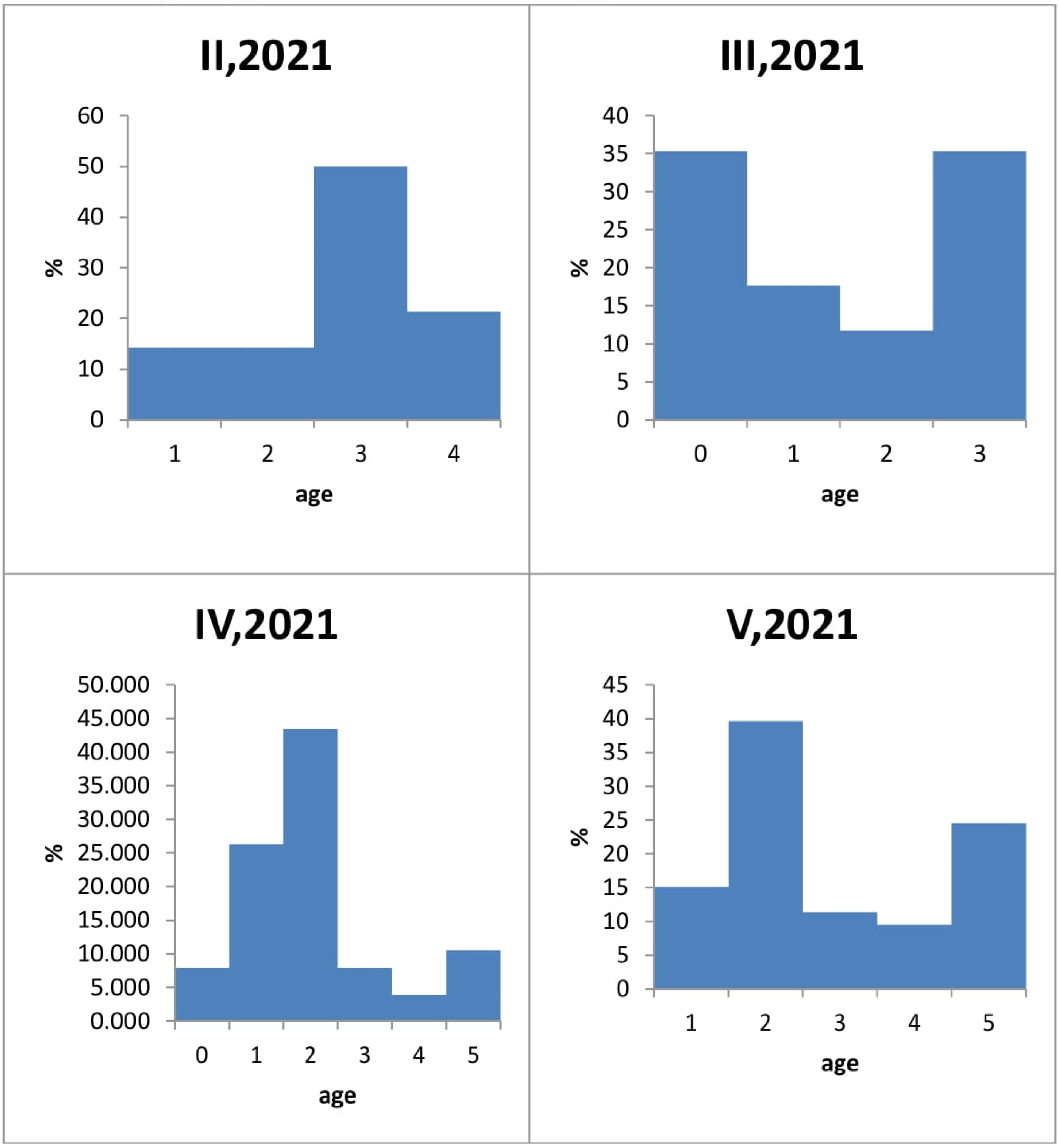


Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

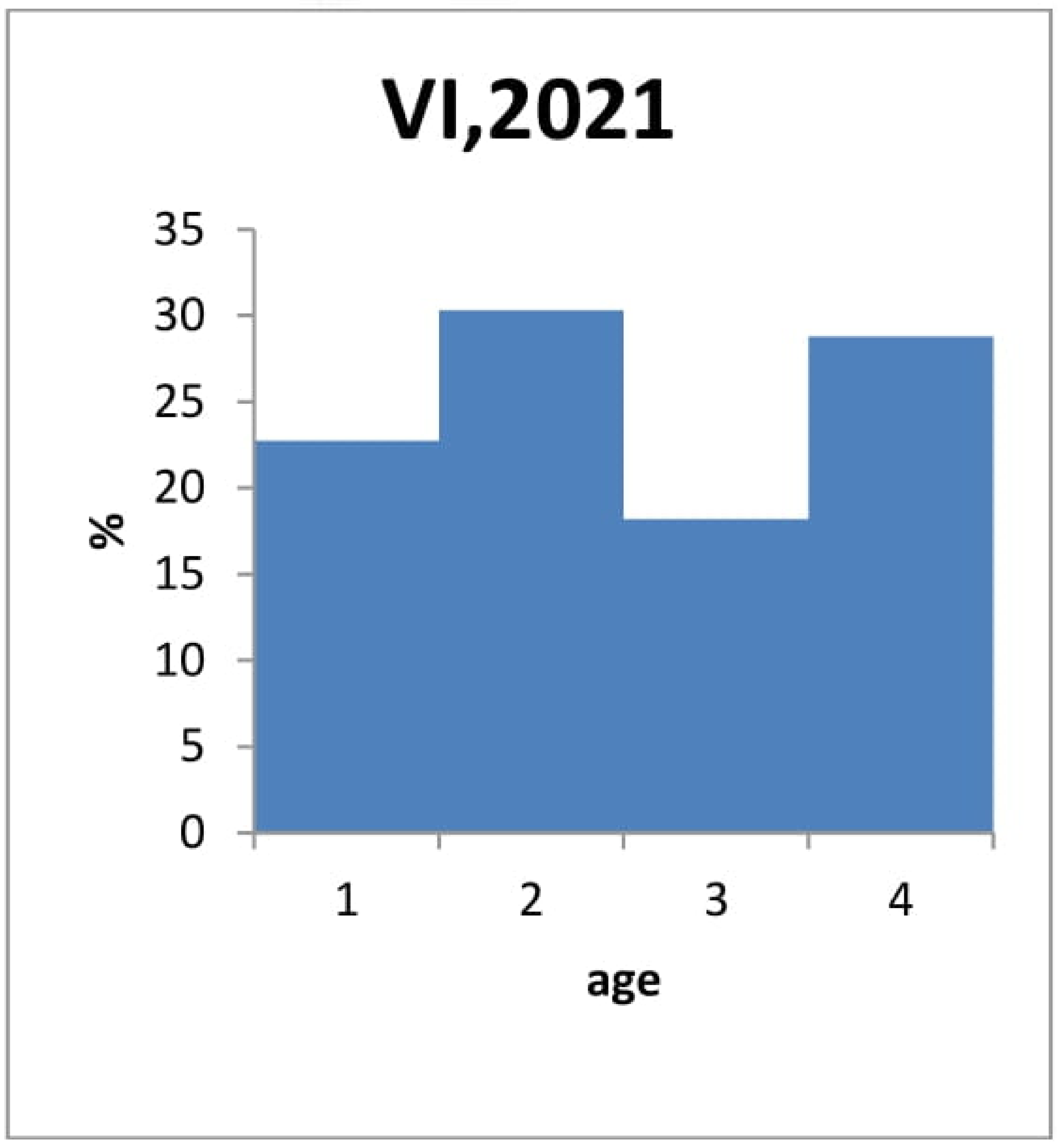


Figure 3.3.1 Age distribution of whiting.

The predominant age in the 1th and 2th quarters was 3-3+ y^{-1}, followed by participation with 25.66% in catches of 2-2+ y^{-1} age groups. Age 1-1+y^{-1} is high 19.47%. A decrease was observed for 0 + y^{-1} (6.64%) .

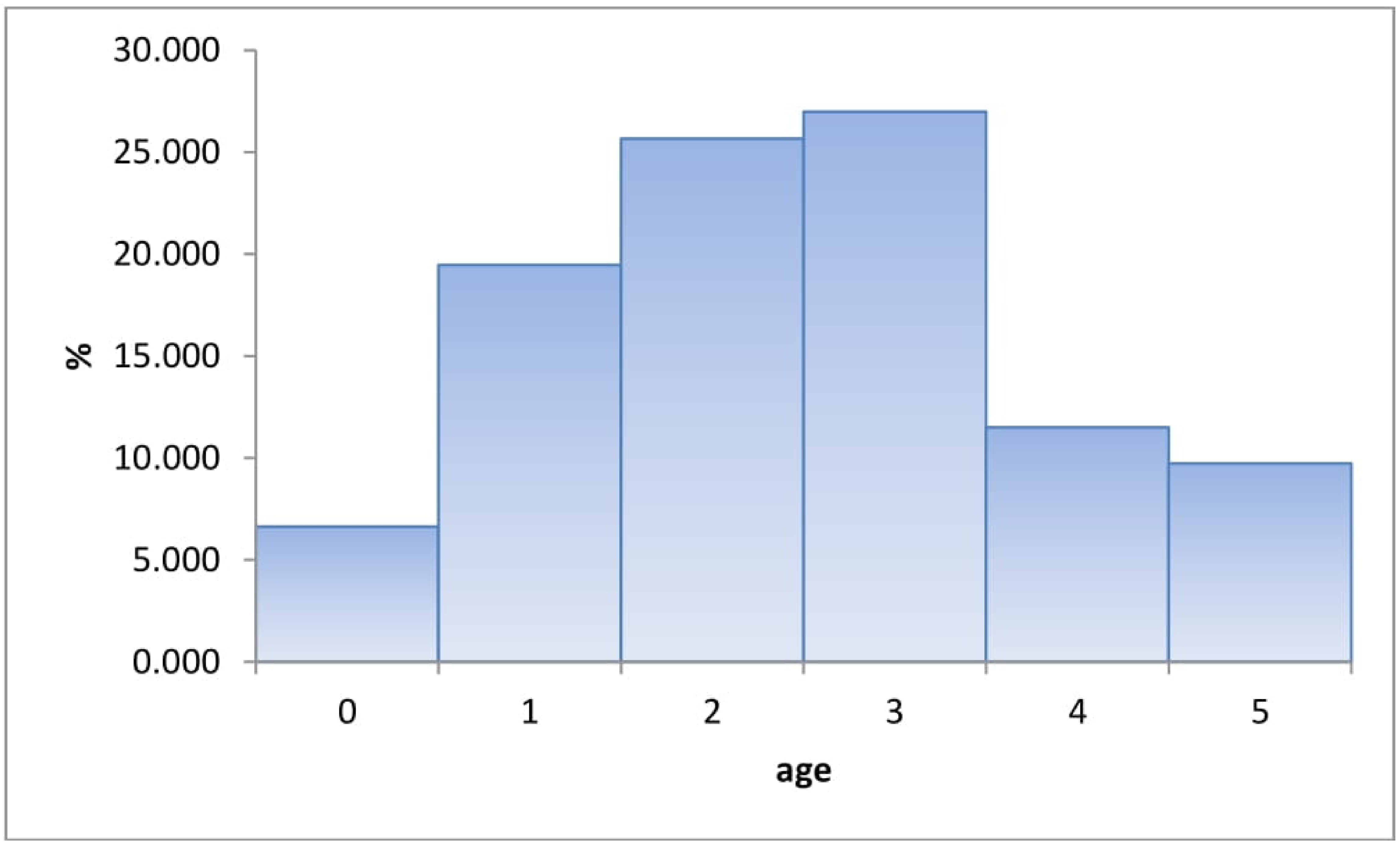


Figure 3.3.2 Age distribution of whiting.

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

II.3.4 Condition factor

The analysis of the conditioning of the whiting shows a variation of the parameter over the different months. In March, the conditioning of the mejida was at the highest level for all age groups, K=0.8085. In February and April, close average status factor values were recorded: 0.747 – 0.737 **(Fig. 3.4.1)**.

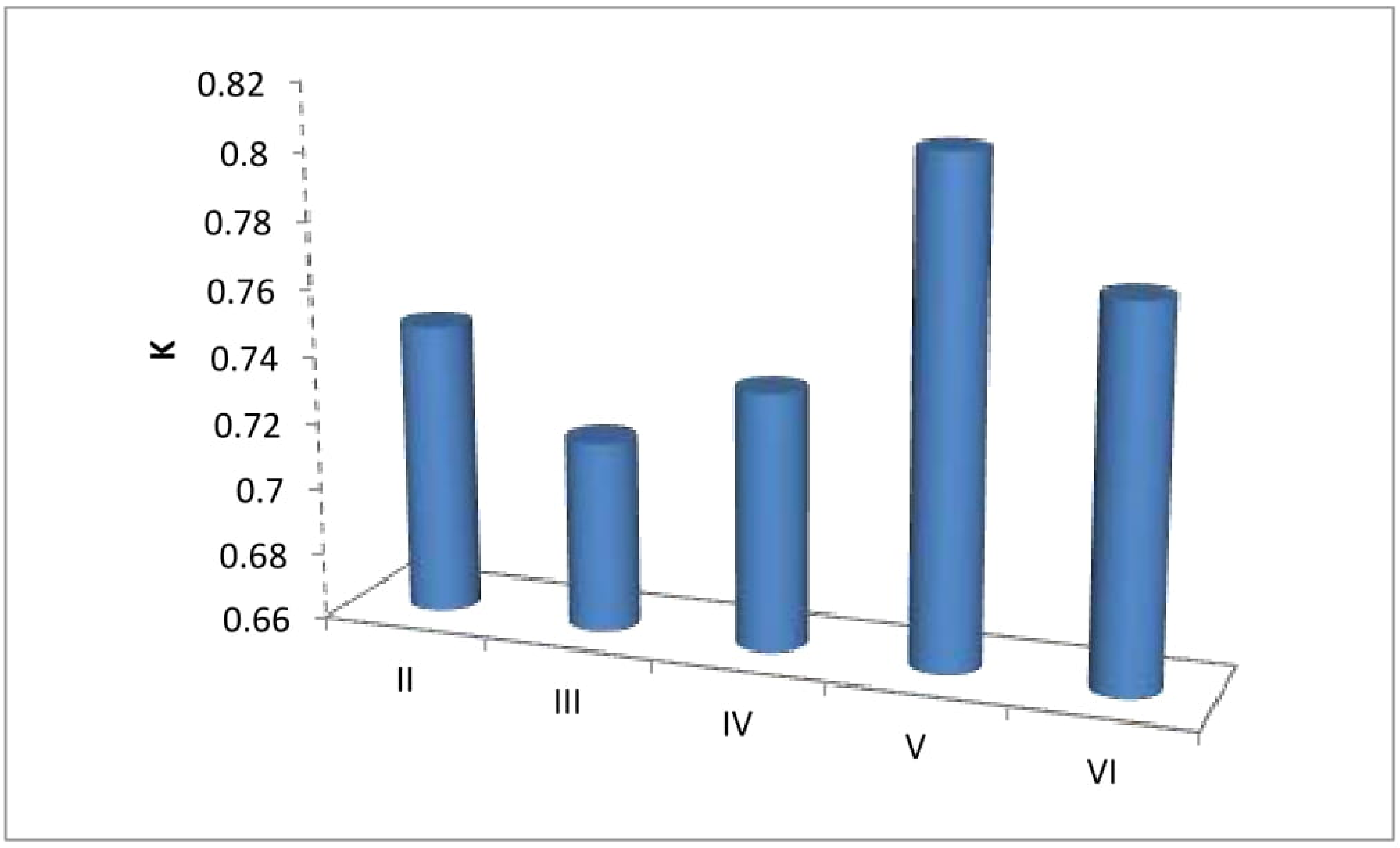


Figure 3.4.1 Mean condition factor of whiting.

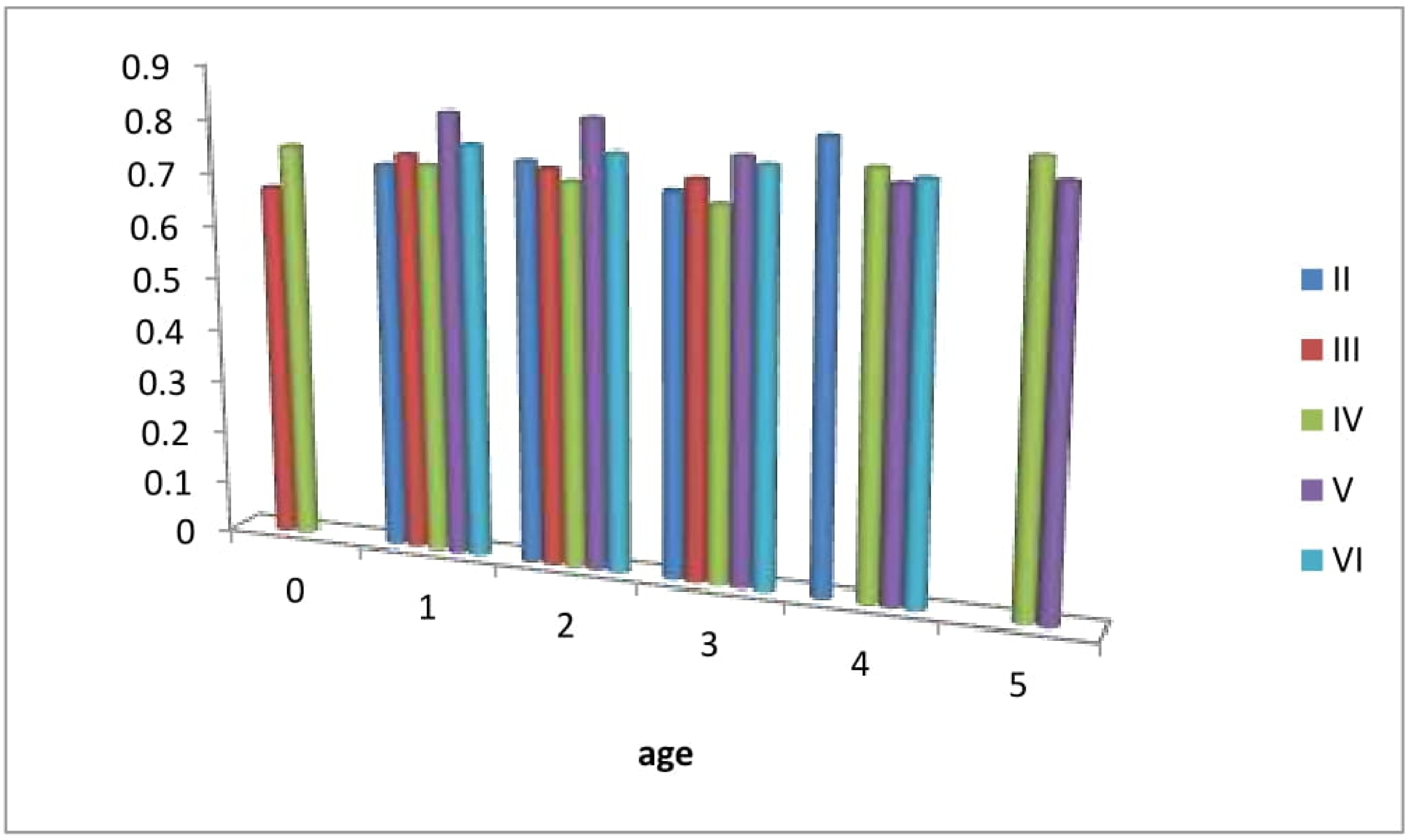


Figure 3.4.2 Mean condition factor of whiting by age goups.

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

III.3.5 Weight structure of whiting

Weight was measured of **226 specimens**. Five-year-old fish showed the highest weight, while zero-year-old fish showed the lowest weight.

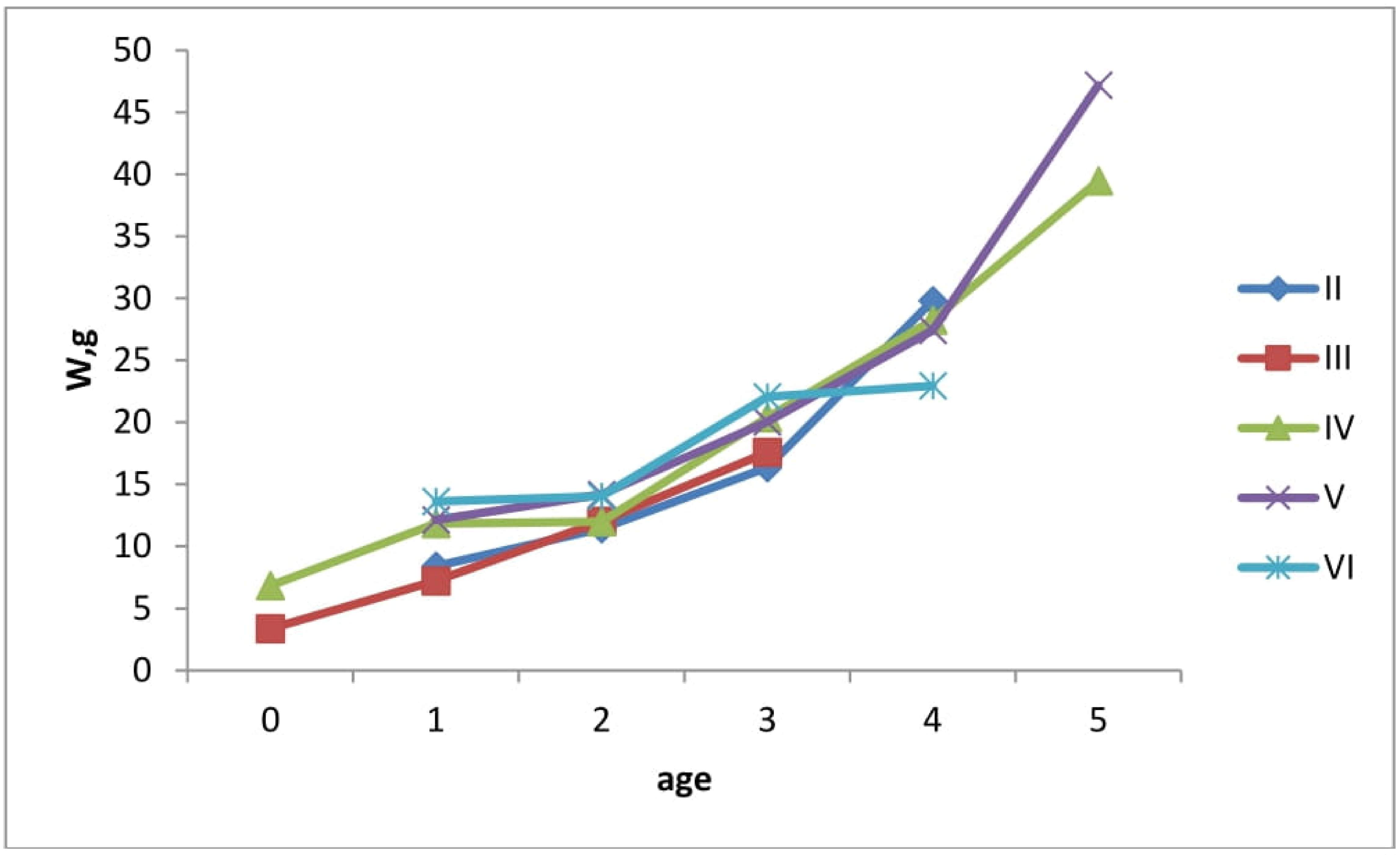
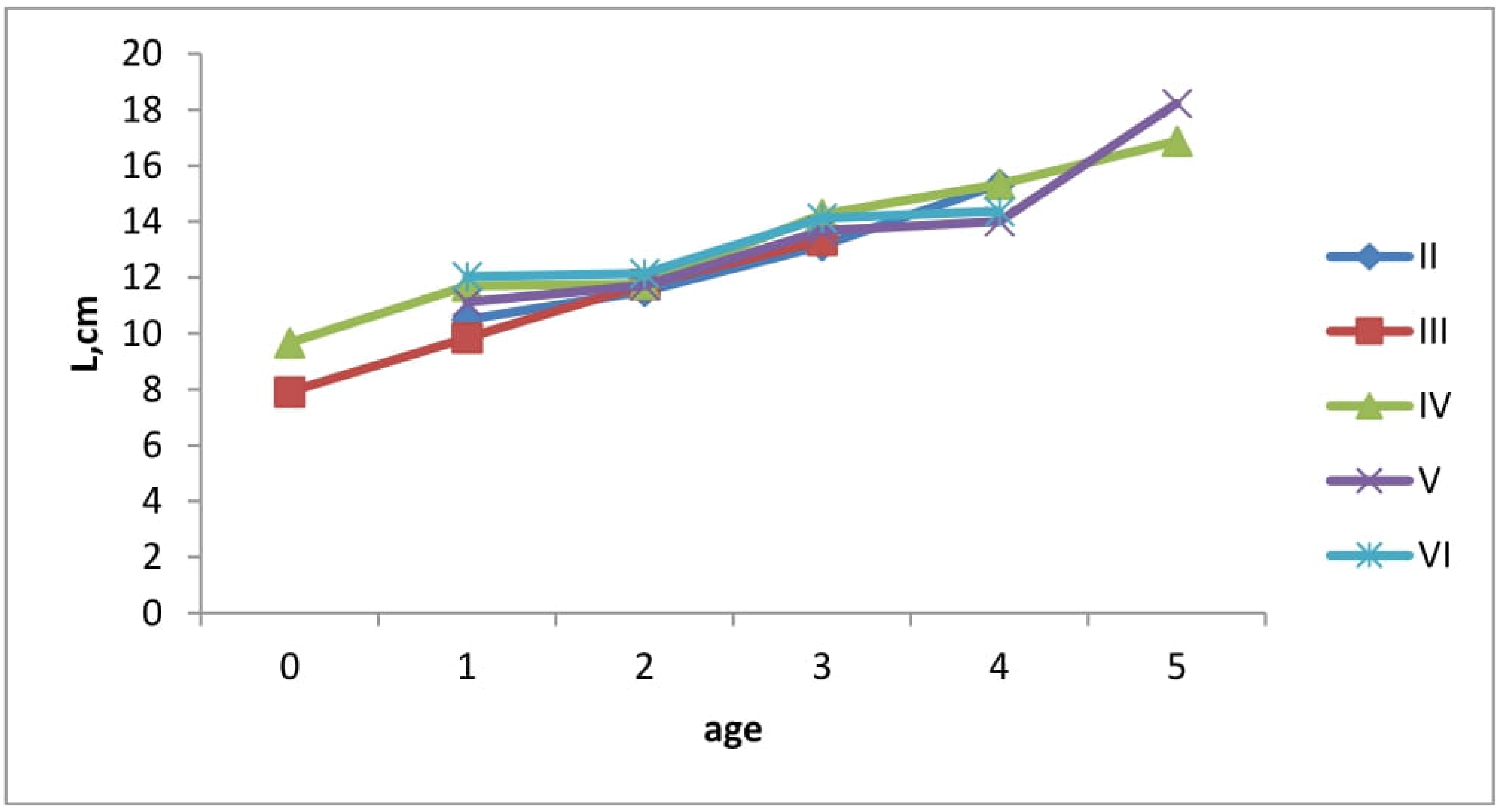


Figure 3.5.1. Weight structure by age group in the 1th and 2th quarters of 2021.

III.3.6 Size structure of whiting by age group

The fish length was measured of **226 specimens**. The analysis of the size structure in annual terms **(Figure 3.6.1)** shows that the average length values by age group vary differently over the study period.



Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

Figure 3.6.1 Length structure by age group.

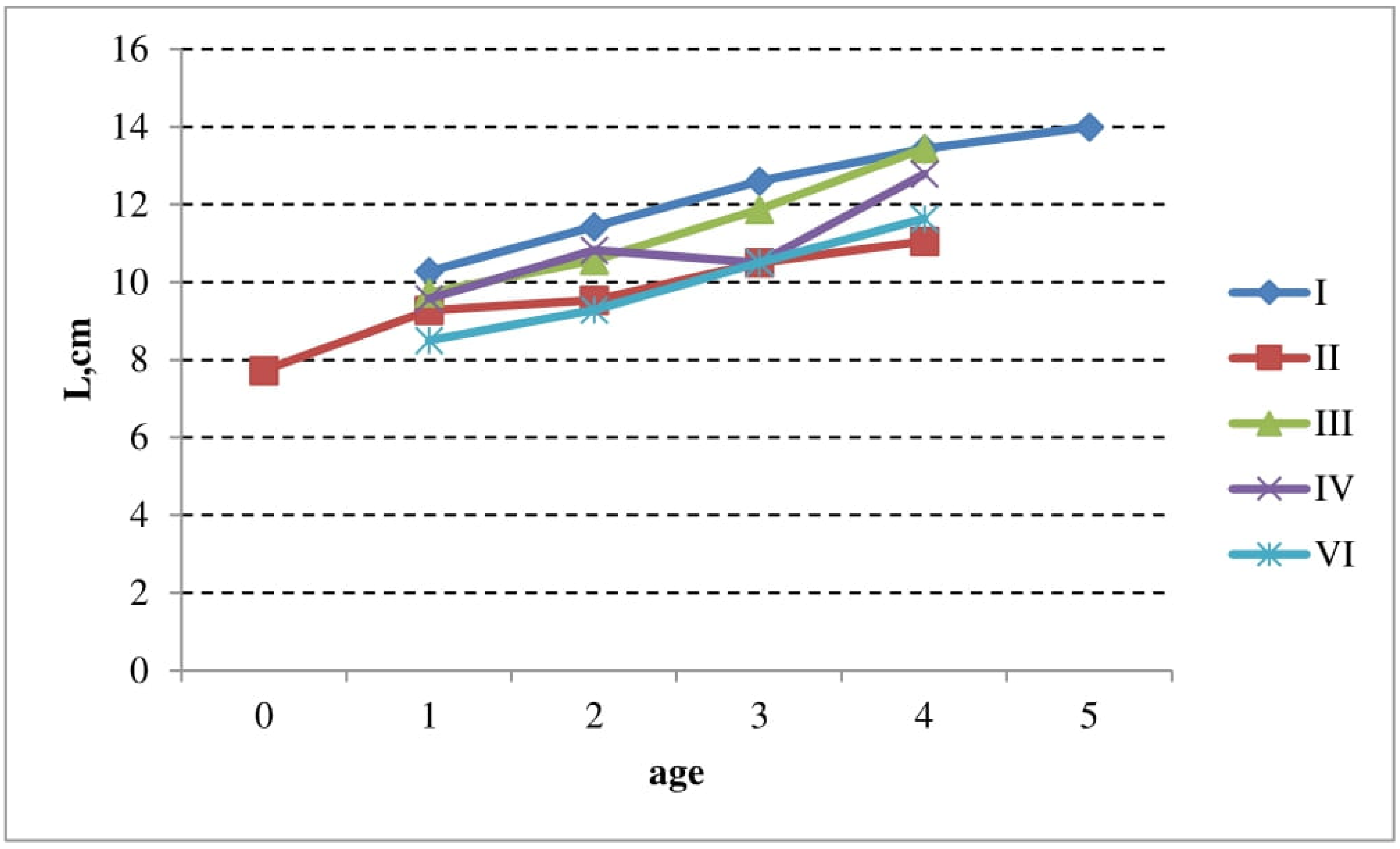


Figure 3.6.1. Length structure by age groups in the 1th and 2th quarters of 2021.

III.3.7 Length- weight relationship

The interrelation between the size (L) and the weight (W) of the sampled specimens is described by the equation: $W = 0.0051*L^{3.1508}$

From the analysis, it follows that the increase in the whiting is allometric ($n \neq 3$).

Table 3.7.1 Length-weight relation parameters.

year	a	n
2021	0.0051	3.1508

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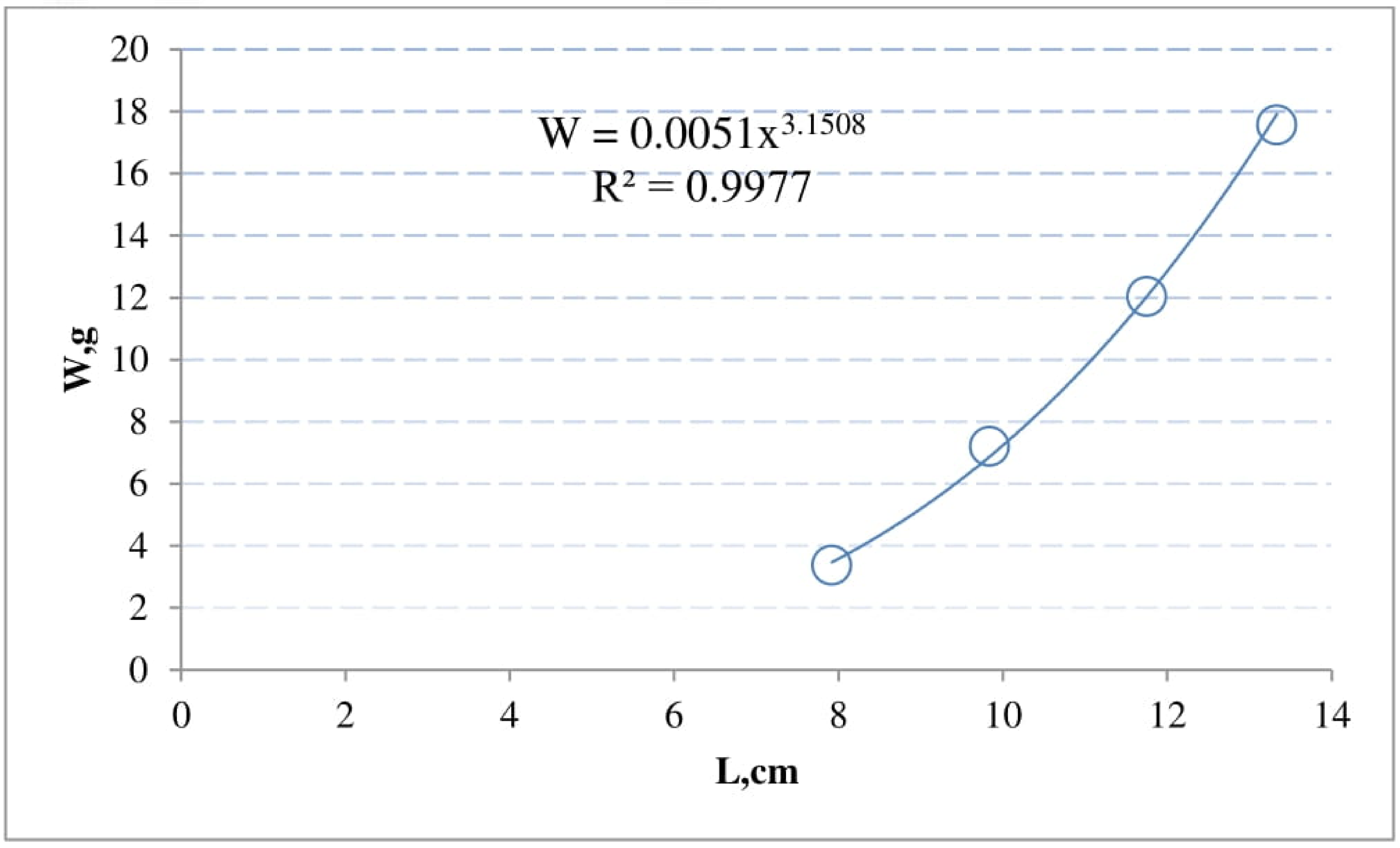


Figure 3.7.1 Length-weight relation

III.3.8 Sex ratio

The sex ratio was determined of **100 samples**. Sex of the determined specimens, 52% was male and 48% was female **(Figure 3.8.1**).

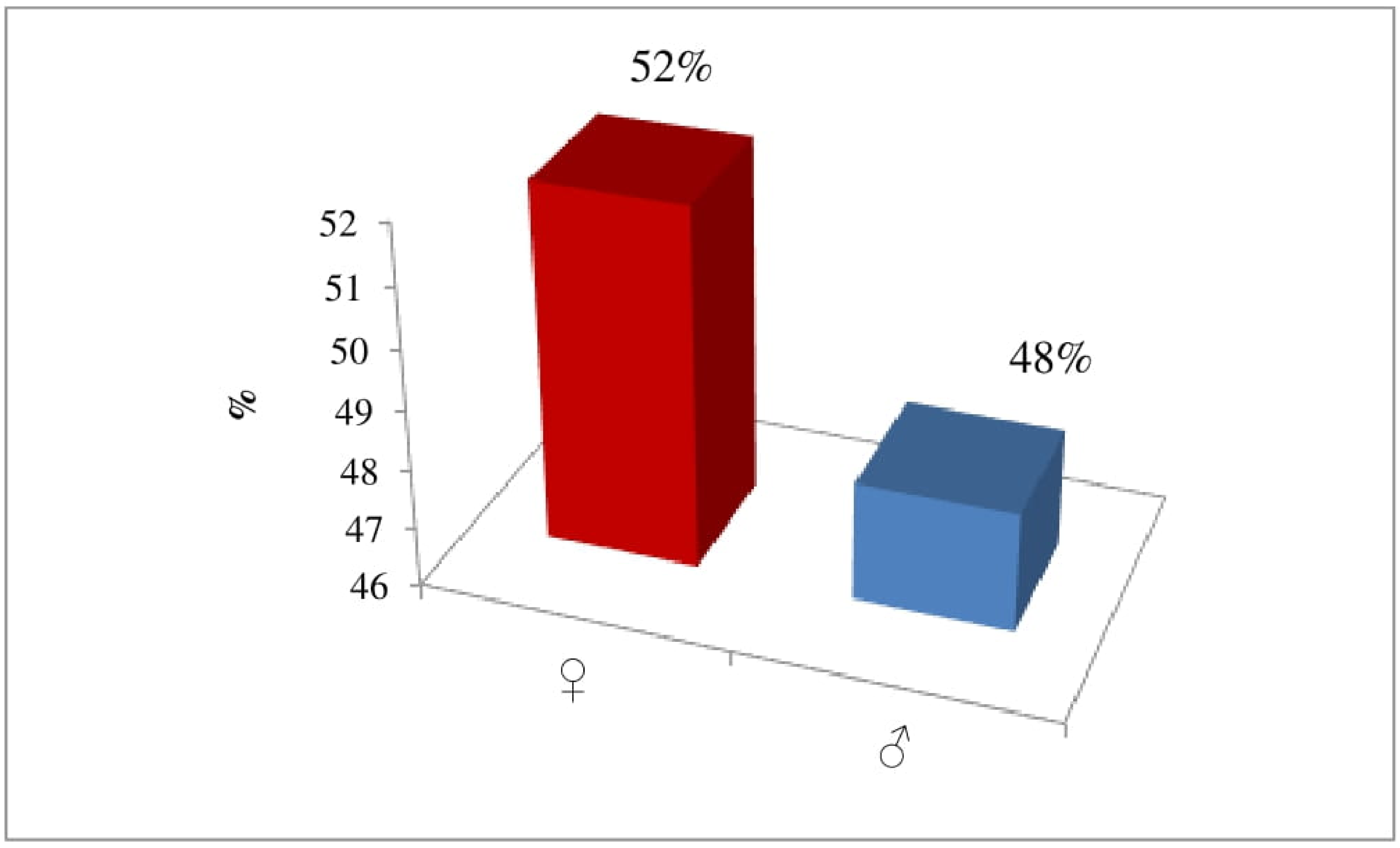


Figure 3.8.1 Sex ratio of whiting (*Merlangius merlangus*) caught in the Bulgarian Black Sea waters.

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

The mean lengths in females by age group were higher, with the exception of two-year specimens, in which males showed close values of lengths **(Figure 3.8.2)**.

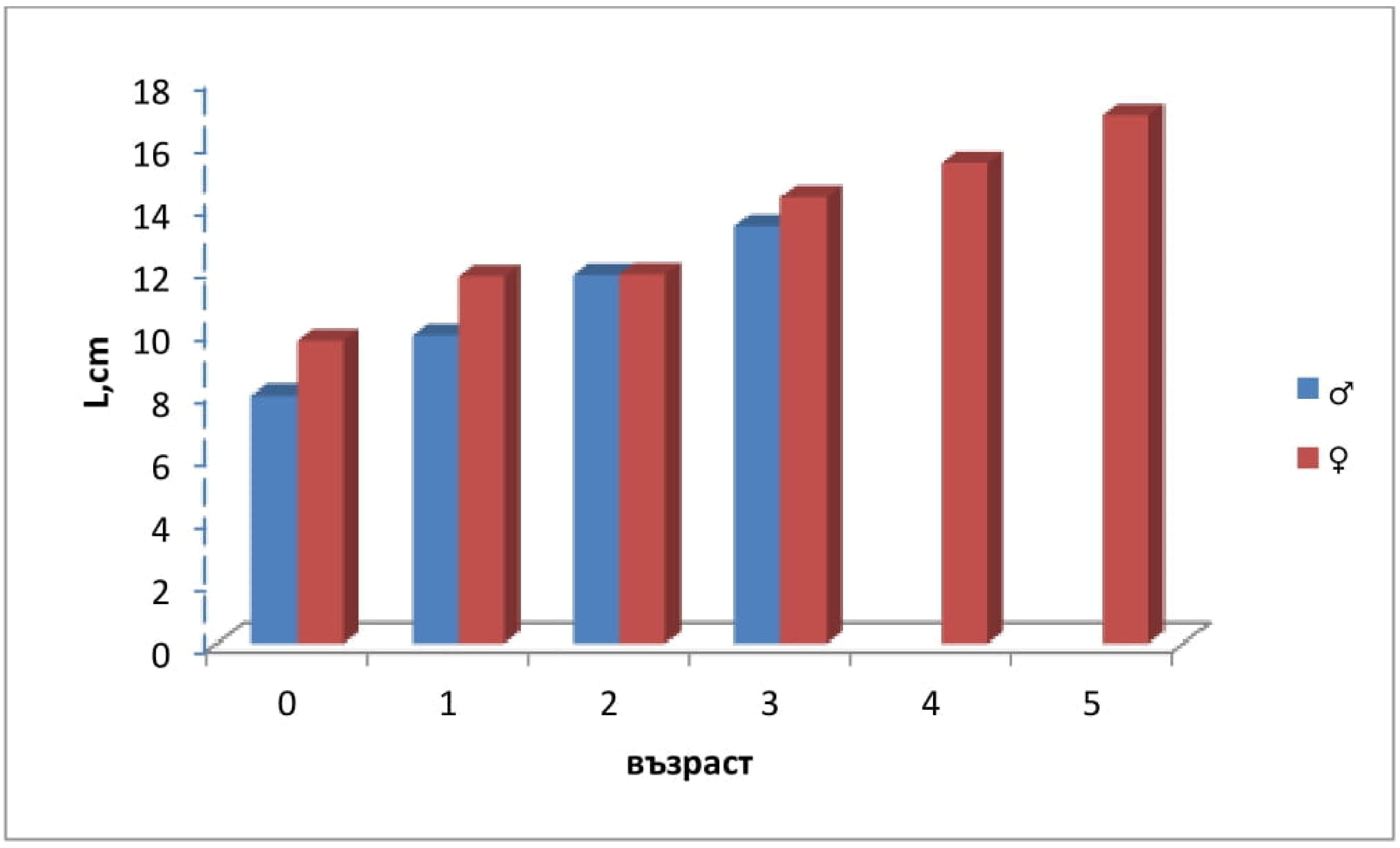


Figure 3.8.2 Sex ratio by size and age of whiting.

III.3.9 Fertility

Fertility was determined on **100 specimens**. Gonado somatic index is highly dependent on the on the sexual glands weights (R^2= 0.9717), which is correlated with the high maturation of females in the late spring and summer spawning processes of whiting **(Figure 3.9.1)**.

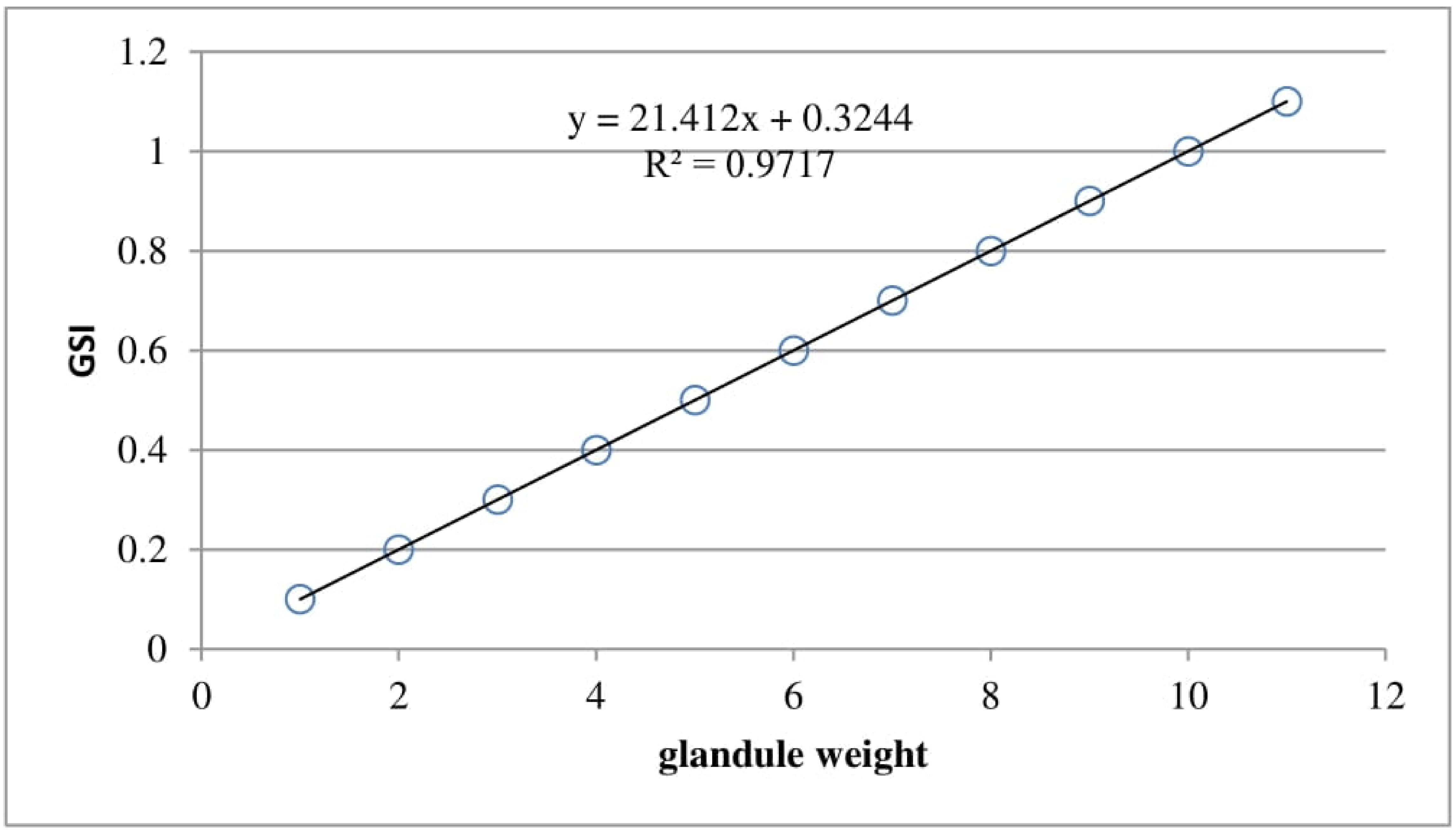


Figure 3.9.1 Glandule weight (g) vs.GSI for whiting.

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

Batch fecundity of whiting from the researched period correlated low with GSI ($R^2 = 0.2301$) **(Figure 3.9.2)**.

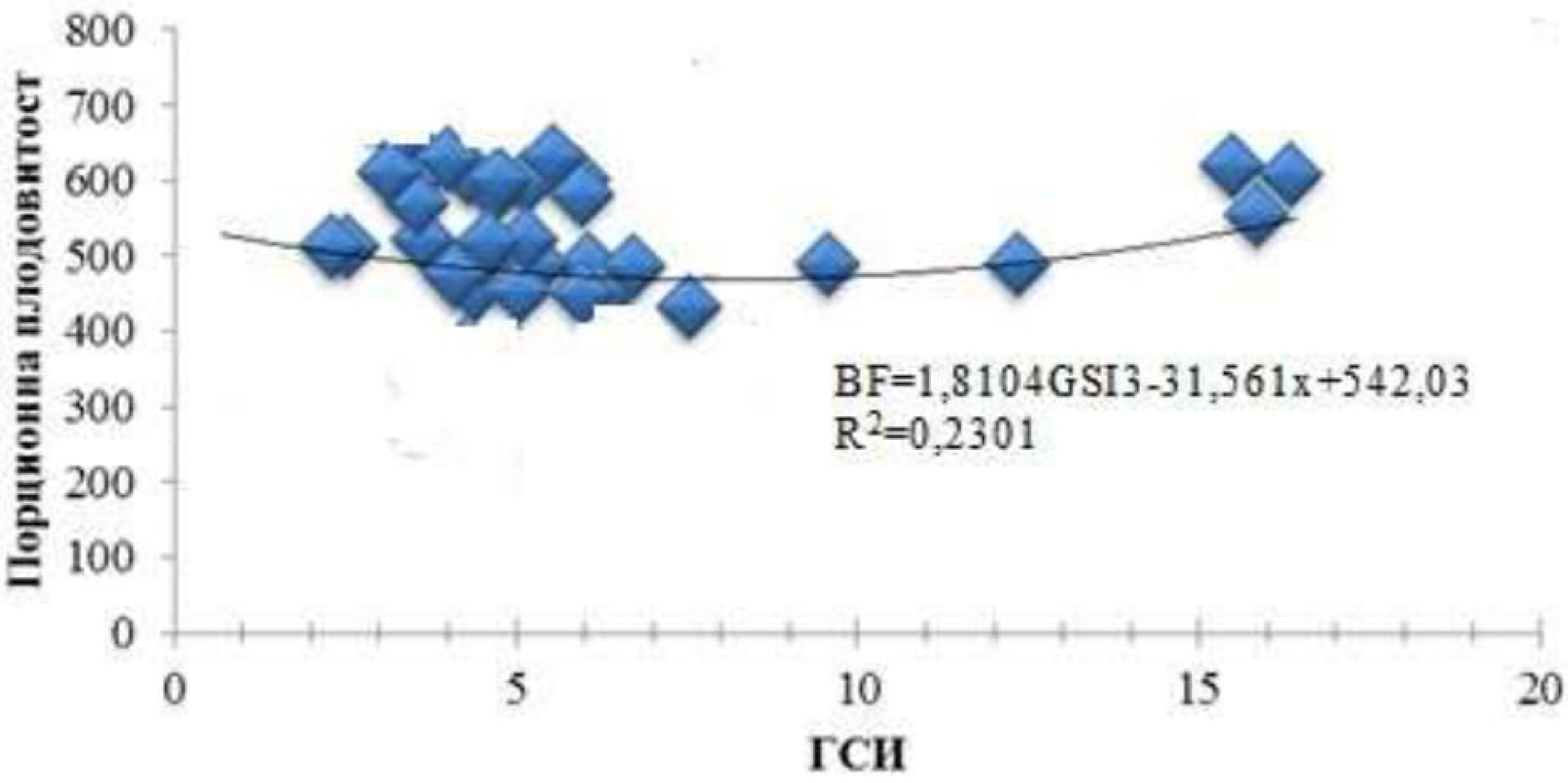
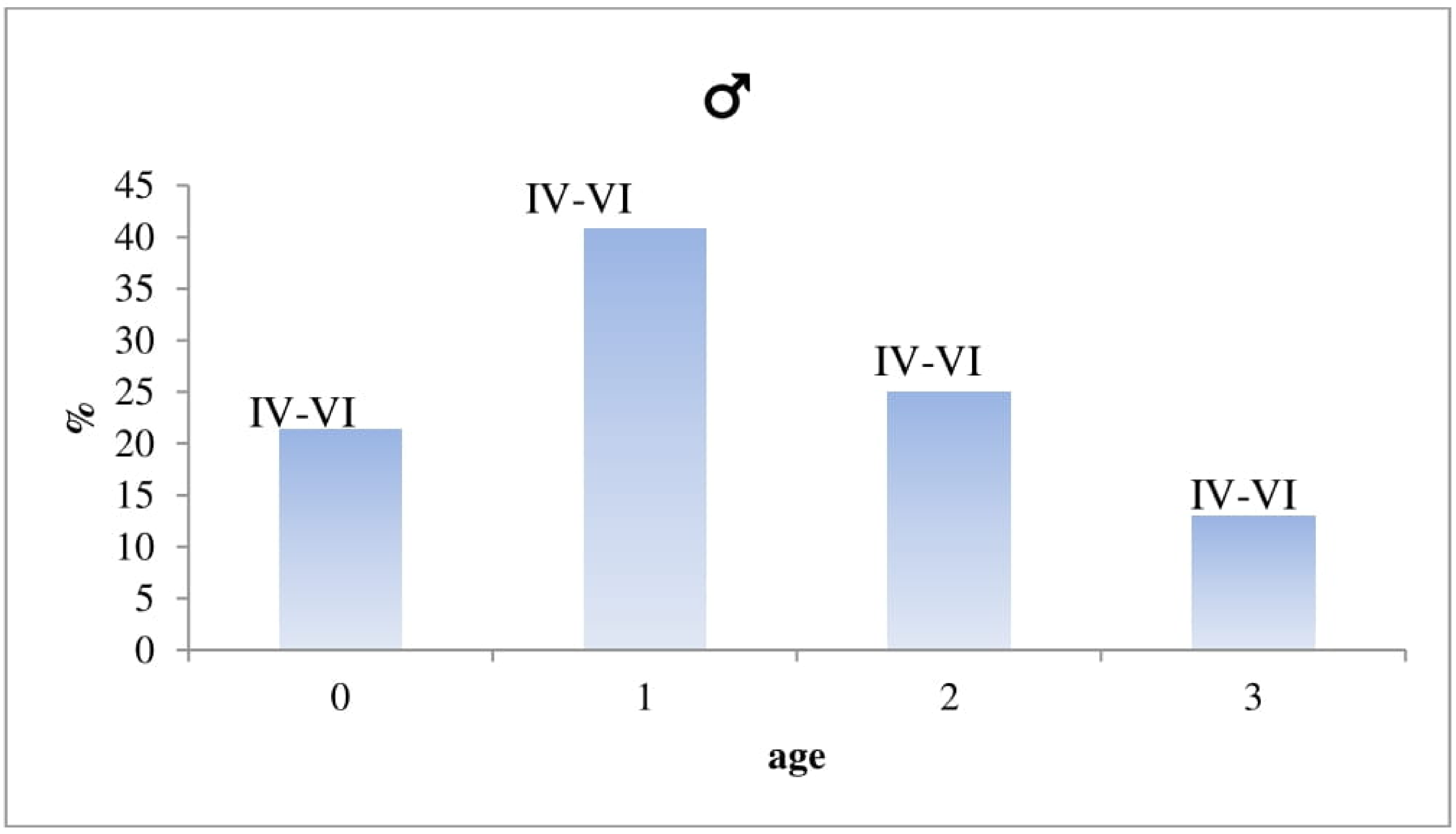


Figure 3.9.2 Batch fecundity vs. GSI for whiting.

II.3.10 Sexual maturity

Sexual maturity was determined on **100 specimens**. During this period it is actively used in sexual products, with 100% of the degree of maturity being IV-VI.



Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

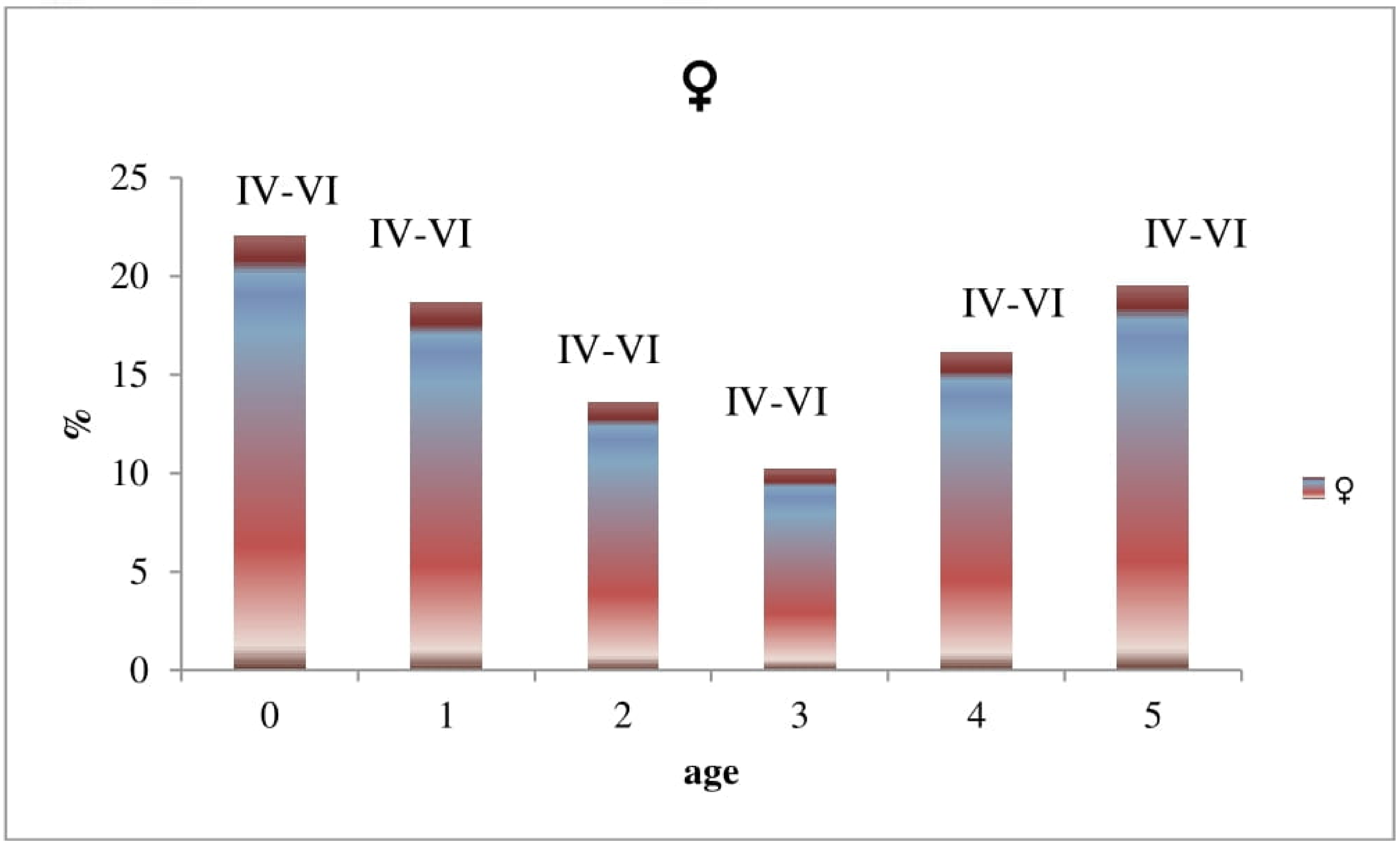


Figure 3.10.1 Sexual maturity by age of whiting - female♀ and male ♂.

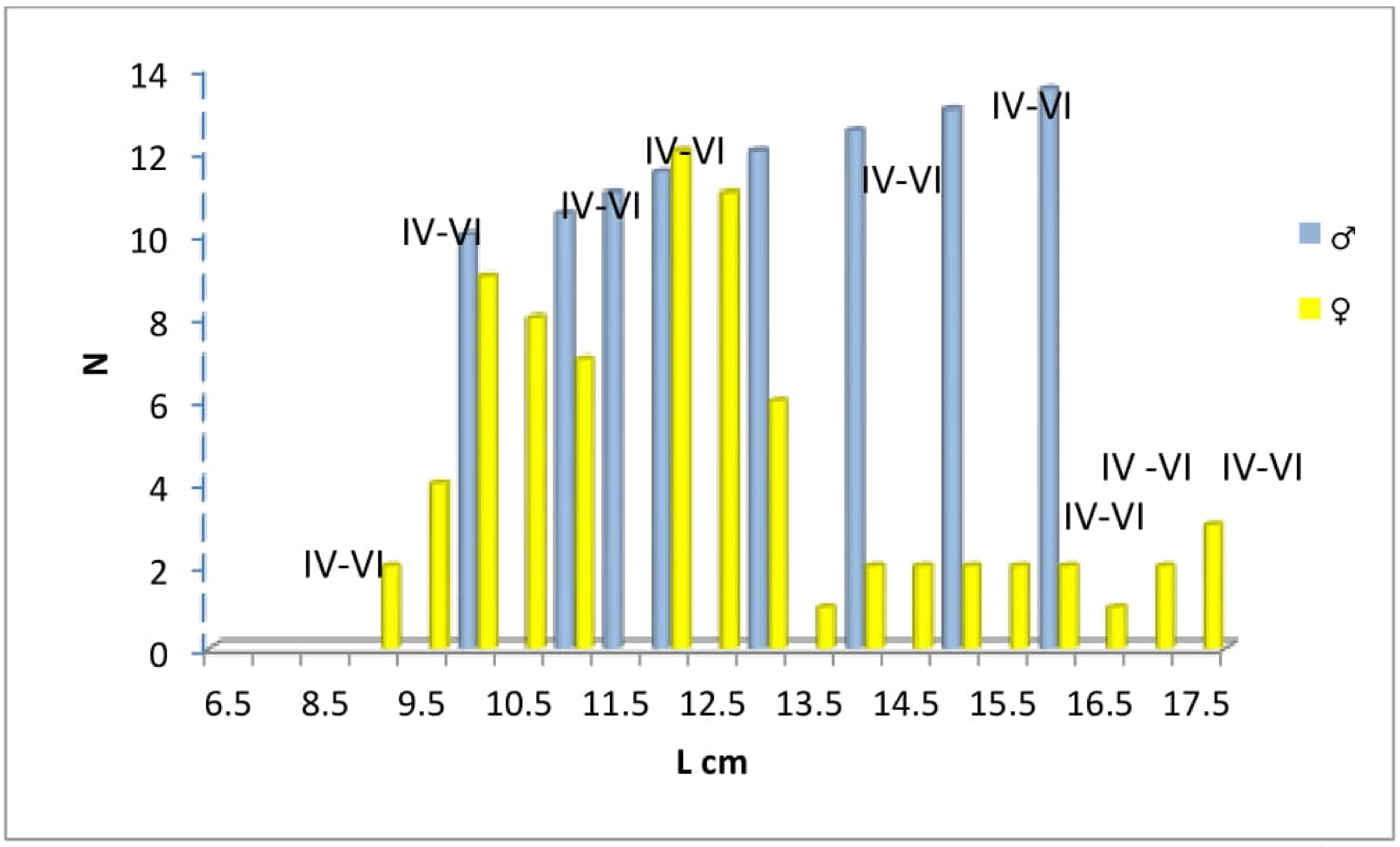


Figure 3.10.2 Sexual maturity along the length of whiting - female ♀ and male ♂.

III.3.11 Catch numbers and biomass by age and length

Monthly catches (in tons) together with mean weights of whiting were used to derive the monthly catch numbers. The share (%) by age groups and catch numbers were used to create catch-at-age matrix for selected months by age groups **(Table 3.11.1)**.

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.", финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

Table 3.11.1 Catch at age (10^{-6}) matrix and biomass (kg) of whiting for selected months.

Catch-at-Age *10^-3 (in thousands)		
Age groups	**1th Quarter**	**2nd Quarter**
0	6,8156	4,0206
1	19,9925	11,7939
2	26,3538	15,5465
3	27,7169	16,3506
4	11,8138	6,9691
5	9,9963	5,8970
∑	102,6888	60,5778
Biomass (kg)		
Age groups	**1th Quarter**	**2nd Quarter**
0	38,1178	22,4863
1	227,6535	134,2966
2	339,9045	200,5153
3	538,8813	317,8950
4	273,5838	161,3916
5	436,3591	257,4154
∑	1854,5000	1094,0000

Monthly catches (in tons) together with mean weights of whiting were used to derive the monthly catch numbers. The share (%) by length groups and catch numbers were used to create catch at length matrix for selected months by age groups **(Table 3.11.2).**

Table 3.11.2 Catch at length (10^{-6}) matrix and biomass (kg) of whiting for selected months.

Catch-at-length *10^-3 (in thousands)		
Length group (cm)	**1th Quarter**	**2nd Quarter**
6,5	0,4544	0,2680
8	1,3631	0,8041
8,5	0,9088	0,5361

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9	0,9088	0,5361
9,5	0,9088	0,5361
10	8,6331	5,0928
10,5	4,5438	2,6804
11	4,0894	2,4124
11,5	10,9050	6,4330
12	6,3613	3,7526
12,5	14,5400	8,5774
13	14,0856	8,3093
13,5	5,4525	3,2165
14	6,8156	4,0206
14,5	6,3613	3,7526
15	5,4525	3,2165
15,5	0,9088	0,5361
16	1,3631	0,8041
16,5	0,4544	0,2680
17	3,1806	1,8763
17,5	1,3631	0,8041
19	3,6350	2,1443
∑	102,6888	60,5778

Biomass (kg)		
Length group (cm)	**1th Quarter**	**2nd Quarter**
6,5	0,8906	0,5254
8	4,5528	2,6858
8,5	3,7531	2,2140
9	4,8845	2,8815
9,5	5,7887	3,4149
10	69,3422	40,9061
10,5	37,4314	22,0814
11	40,0441	23,6227
11,5	123,9581	73,1249
12	79,3566	46,8138
12,5	215,5283	127,1437
13	264,3463	155,9422
13,5	105,6740	62,3388
14	146,2088	86,2510
14,5	148,2126	87,4330
15	140,5291	82,9004
15,5	27,6396	16,3051
16	44,3924	26,1878
16,5	16,9028	9,9712

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17	131,6279	77,6495
17,5	57,3240	33,8163
19	186,1120	109,7905
∑	1854,5000	1094,0000

The biomass was higher in the first quarter (January-March) of the study period (**Figure 3.11.1).**

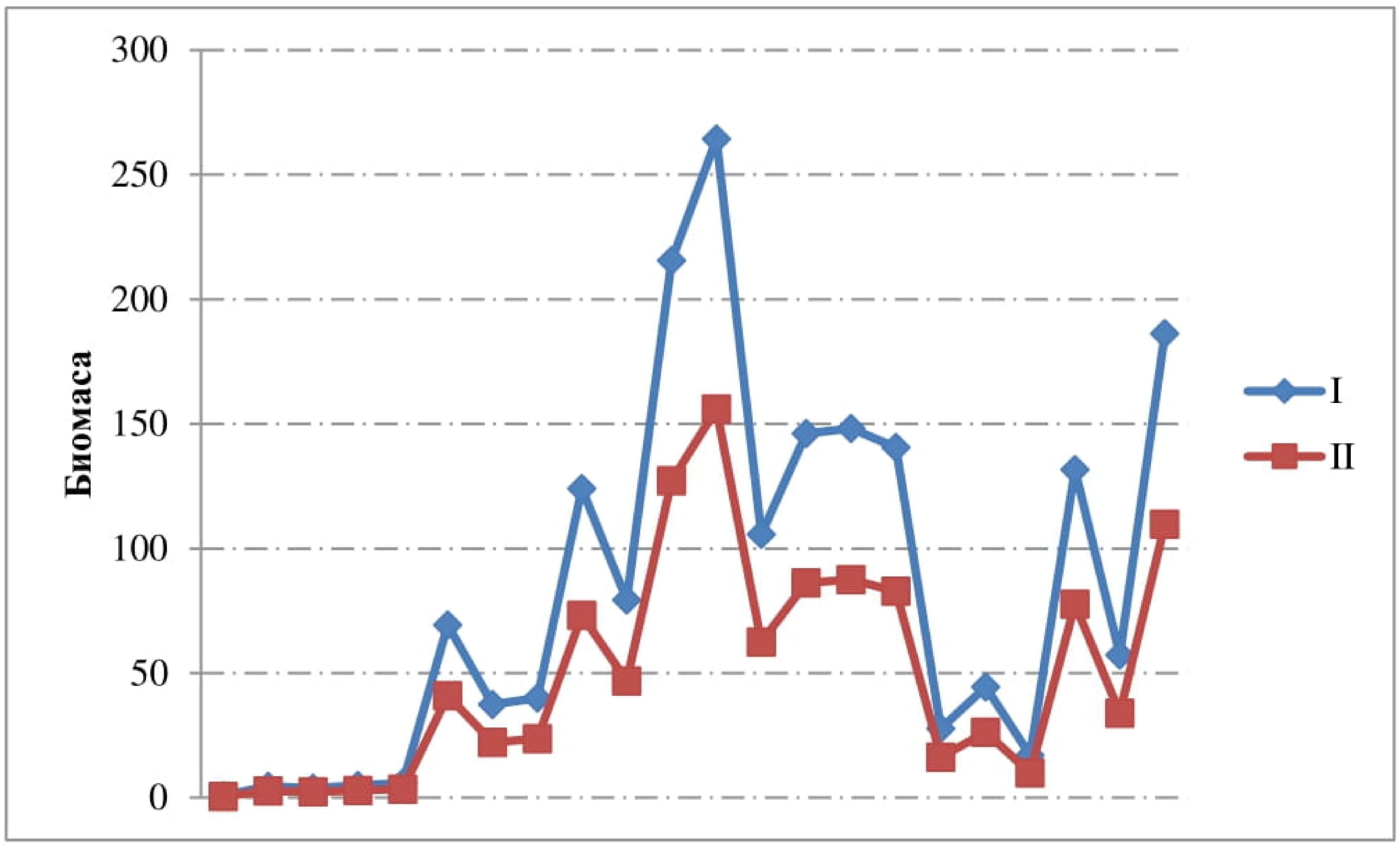

Figure 3.11.1 Biomass dynamics for 1st and 2nd quarter, 2021.

III.3.12 Coefficient of variation of length

na

III.3.13 Conclusions and recommendations

The analysis of the biological parameters of the whiting makes it possible to draw the following **conclusions**:

1) In the catches of the Bulgarian aquatoria on the Black Sea in the 1st and 2nd quarters of 2021, the size composition is represented by individuals with body length from 6.5 cm to 19.0 cm. In the study period, preponderance have size groups of 12.5 cm.

2) The age structure of the whiting is represented by six age classes– 0- 5 years old.The predominant age in the 1th and 2th quarters was 3-3+ y^{-1}, followed by participation with 25.66% in catches of 2-2+ y-1 age groups. Age 1-1+y^{-1} is high with an advocacy rate of 19.47%. A decrease was observed for 0 + y^{-1} (6.64%) .

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.", финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

3) The analysis of the conditioning of the whiting shows a variation of the parameter over the different months.

4) The relationship between the size (L) and the weight (W) of the specimens examined is described by the equation: $W = 0.0051*L^{3.1508}$.

5) Female (♀) specimens prevailed by 52%, followed by males (♂) by (48%).

6) The average lengths in females by age group are higher, with the exception of two-year-old specimens where close values are observed.

7) Gonado- somatic index is highly dependent on the weight of the gonads ($R^2 = 0.9717$), which is associated with the high maturation rate of females in late spring and summer and the breeding process of the species.

8) Active maturation of sex products has been observed and in 100% the maturity rate is IV-VI.

9) The biomass of the whiting is higher in the first quarter (January - March) of the study period.

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IV. Biological monitoring of red mullet (*Mullus barbatus*) landings

IV.1 Objectives

Red mullet is one of the most important fish species fished and consumed traditionally in the Black Sea countries. Multi annual biological monitoring on the landings provides the so called "Fishery dependant" information. The aim of this study is to collect and to analyze dynamics in length and weight age distribution as well as to determinate condition of the red mullet species using the so-called condition factor. The condition factor is also a useful index for monitoring of feeding intensity, age, and growth rates in fish. It is strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to assess the status of the aquatic ecosystem in which fish live. Biological information on species collected each month thus analyzed and compared for previous periods could be used then for estimation of growth parameters. These indicators are with very high importance of species. Robust and informative long-term information is of crucial importance for fisheries stock assessment, fisheries management and decision making process as a whole.

IV.2 Sampling

IV.2.1 Geographic area coverage

Data of present analysis were collected from landing ports of Bulgarian Black Sea coast. During first 6 months of 2021, **4 samples with 320 specimens** were collected and processed.

IV.2.2 Sampling period

Monthly sampling was carried out as investigated area includes the Bulgarian Black Sea coast.

Data	Harbour	F/V	Catch/kg
26.2.2021	Nesebar	BAHARI	11
14.3.2021	Nesebar	ISHTAR	10
8.4.2021	Varna	TRIGONA	2
26.6.2021	Balchik	SVETI ILIYA	12

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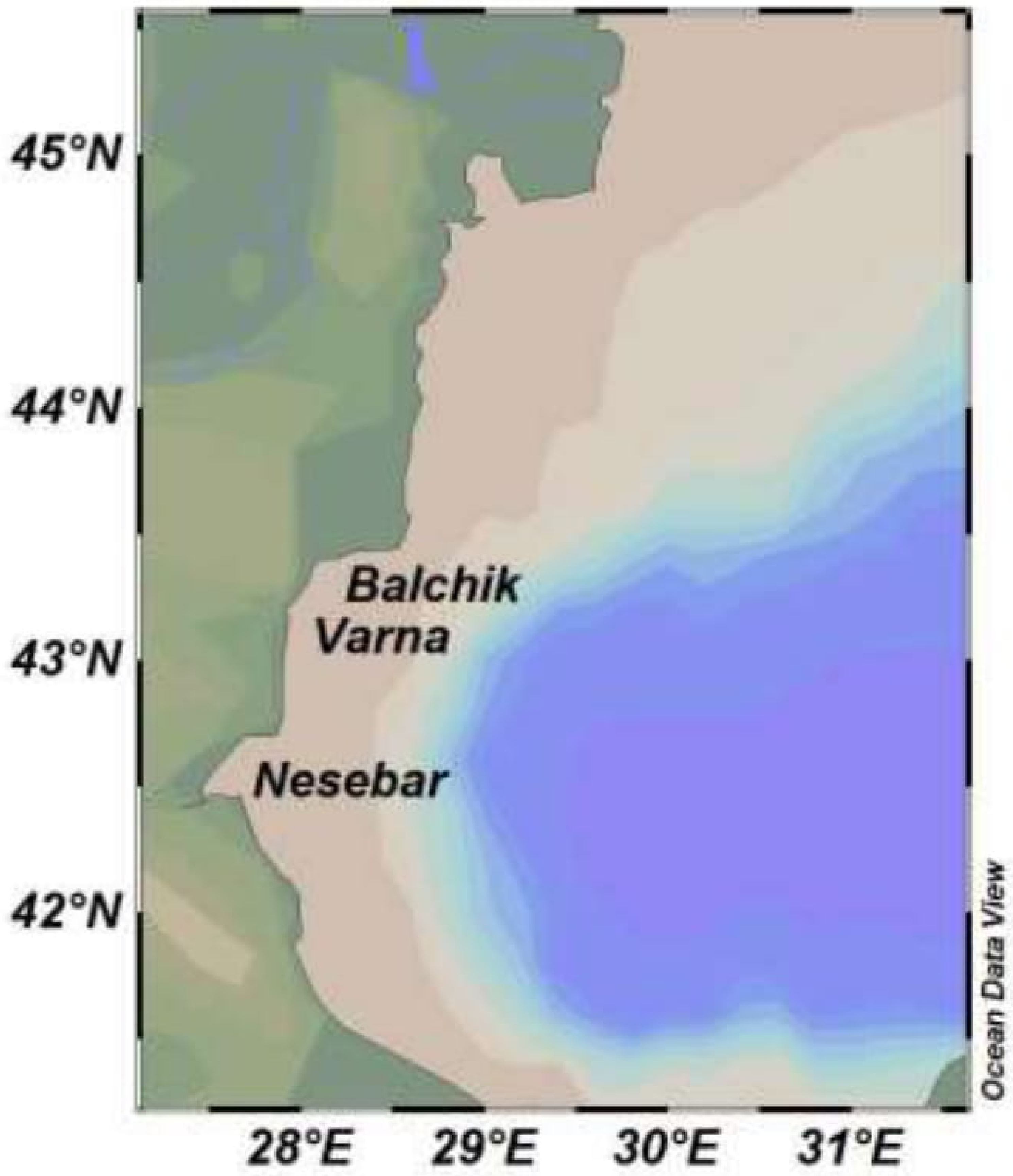

Figure 2.2.1 Research area and plan of the sampling ports of Bulgarian Black Sea coast.

IV.2.3 Statistical analysis of data

See section statistical analysis of sprat.

IV.3 Results

IV.3.1 Landings statistics

Official statistics on landings during the period of examination are presented in **Figure 3.1.1.** The catches in January and May were zero. The highest catch was registered in June 2021.

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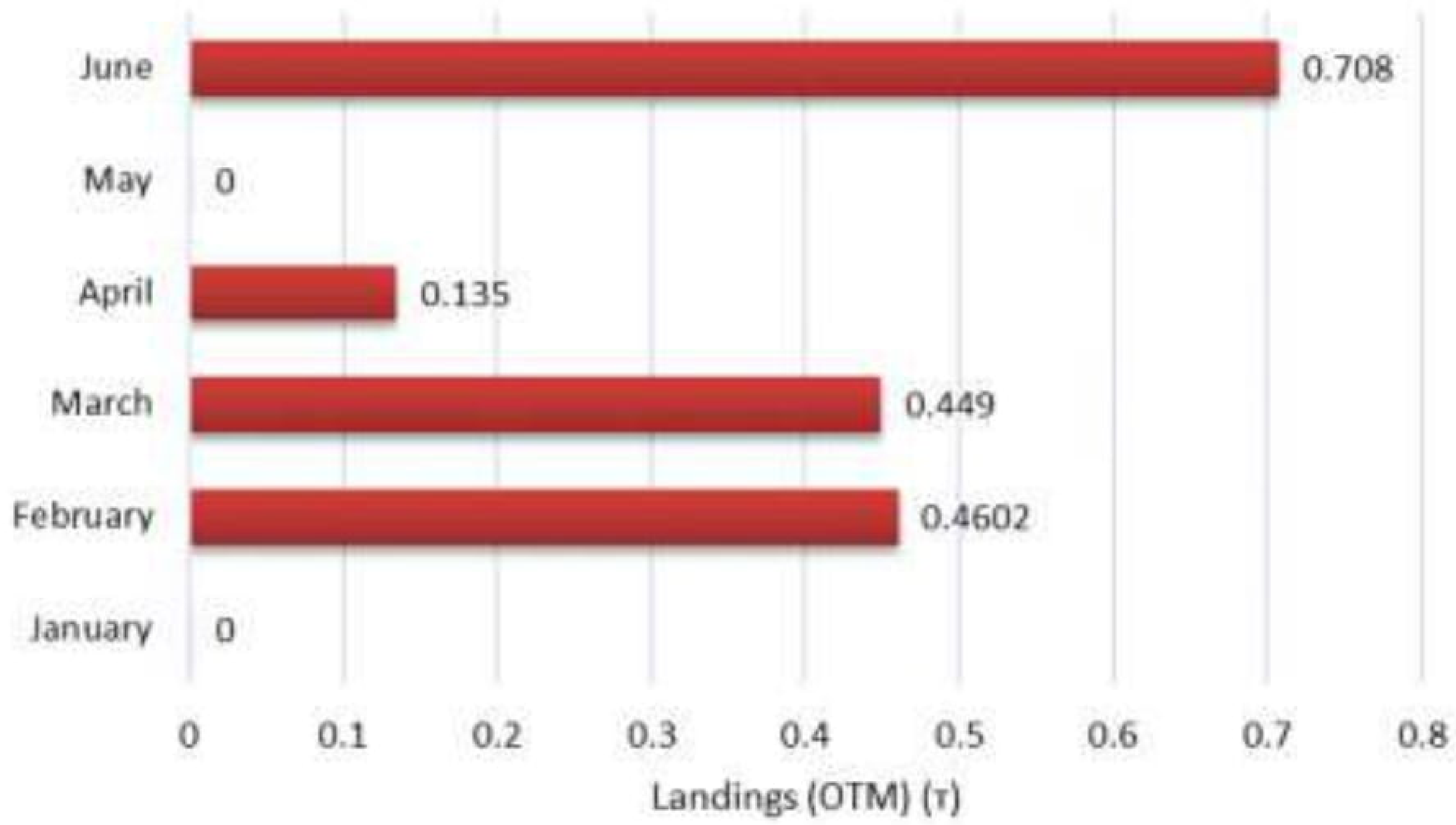

Figure 3.1.1 Landings statistics of red mullet.

IV.3.2 Length structure of landings

The size classes of the mullet during the studied period were in the range of 7 cm to 17.5 cm. The groups in the first quarter prevailed: 9 cm, 11 cm, and in the second 12, 12.5 and 13.5 cm. **(Fig. 3.2.1).**

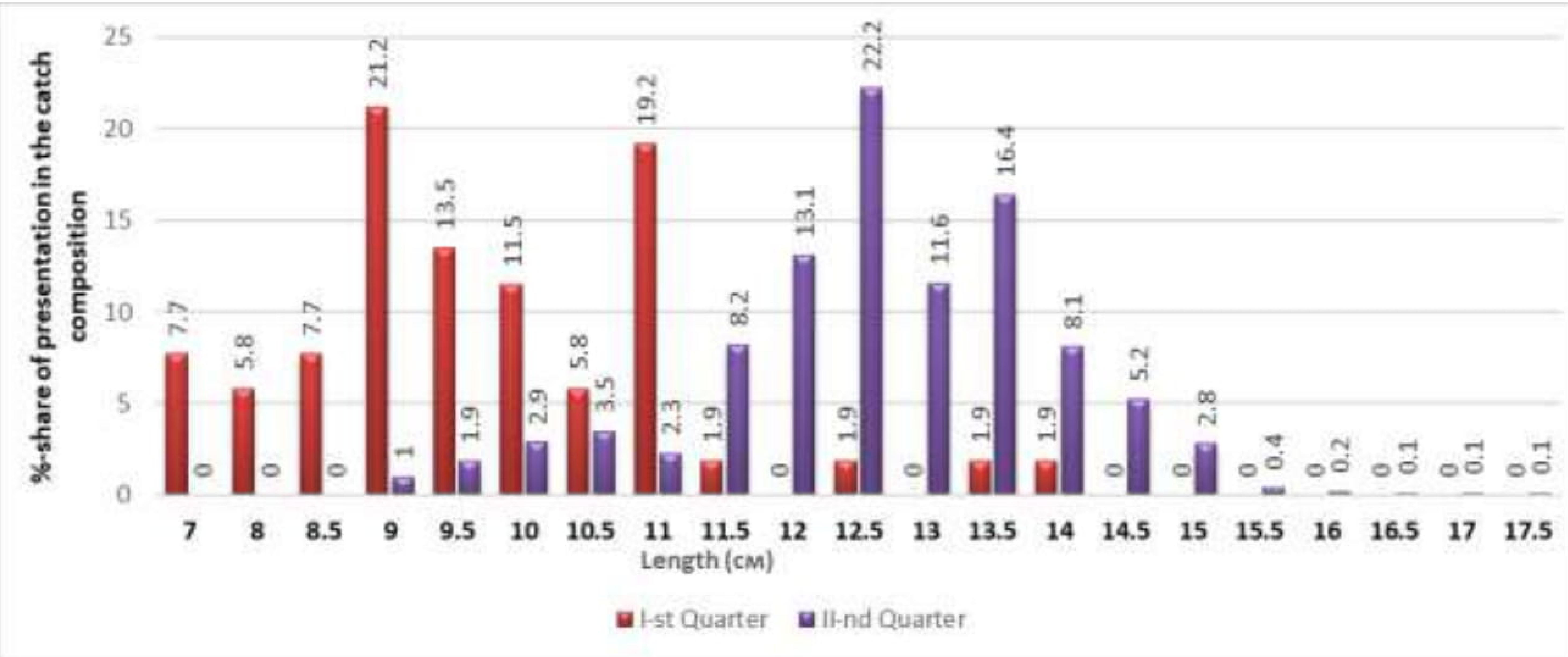

Figure 3.2.1 Length structure of red mullet landings.

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

IV.3.3 Age structure of landings

The three readers determined the age of red mullet otoliths, and reader 1 read all otoliths twice. Specimens **(n = 250)** were used for age determination. The age structure of the red mullet in the first trimester showed highs of 0-0 + year and 1-1 + year individuals. 2-2 + year specimens had about 14% share in catches, and older groups were missing in catches. In the second quarter, recruitnment was almost non-existent in catches (2.7%), 1-1 year's old had a subordinate share (8.8%), 2-2 + years had a share of 51% in total catches, 3-3 + years 33%, 4-4 + years - 0.8%.

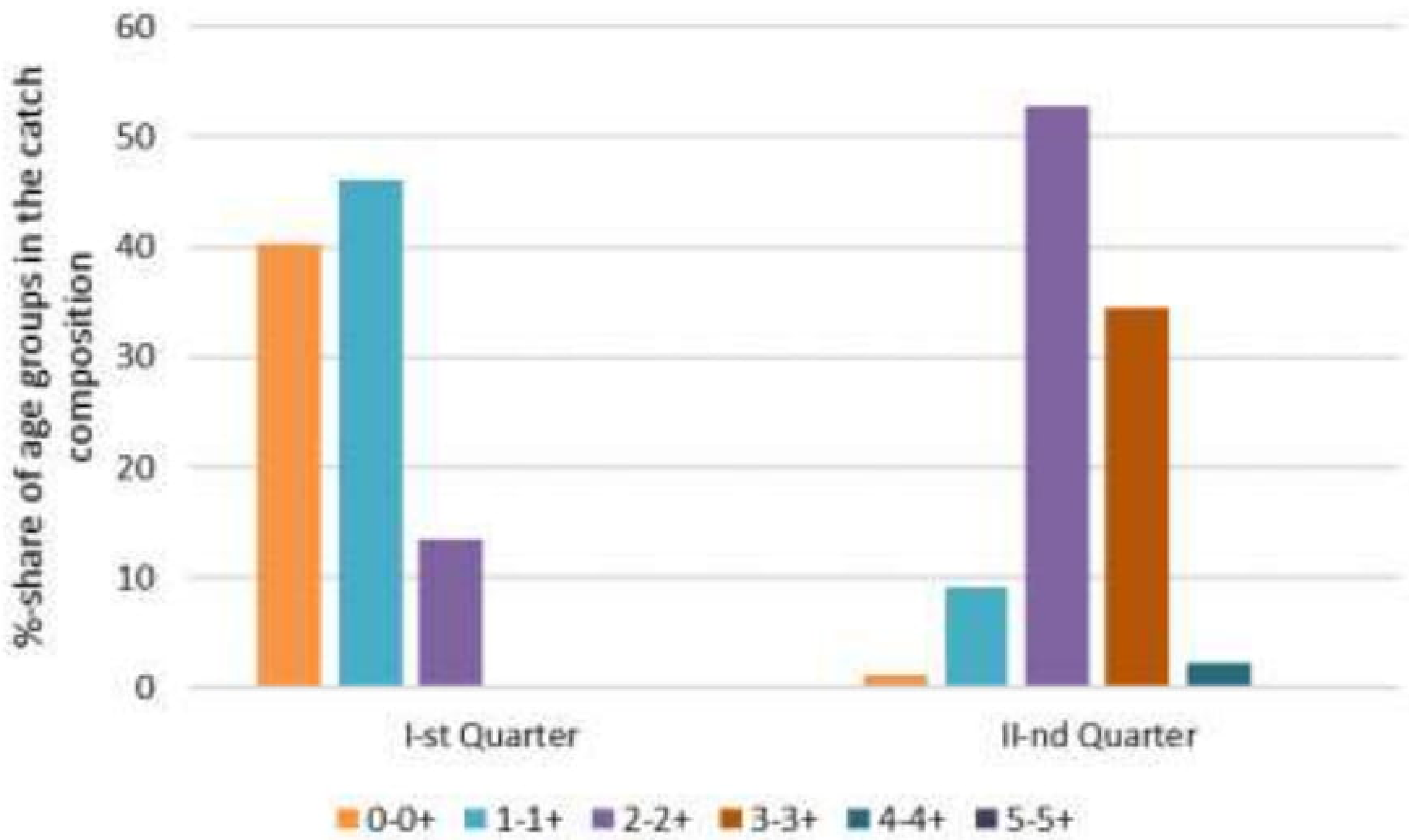

Figure 3.3.1 Share of age groups in 2021.

IV.3.4 Condition factor

The condition of the mullet in the first trimester was lower than the condition in the second trimester.

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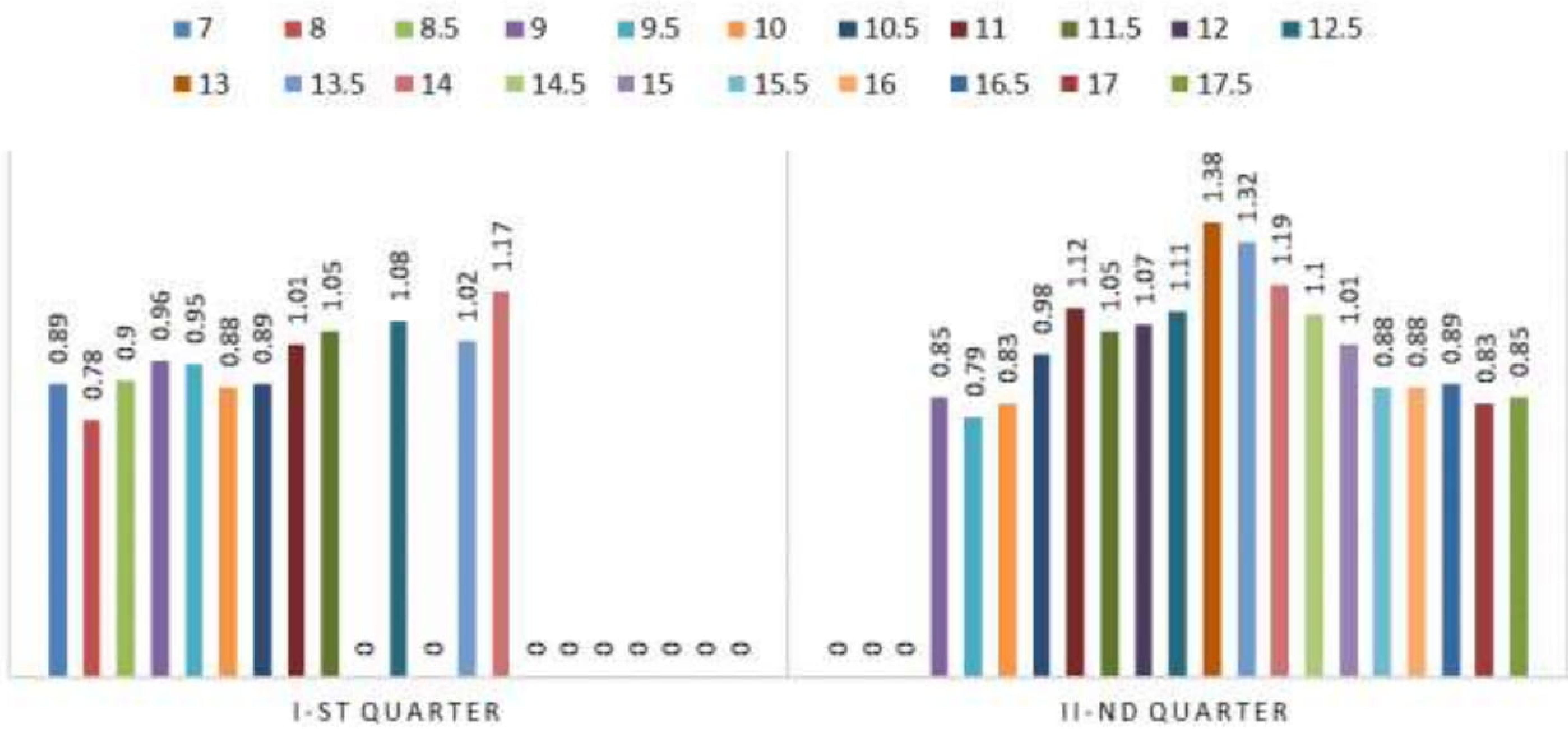

Figure 3.4.1 Fulton condition factor of red mullet by length classes.

The conditioning factor by age groups showed a higher condition of the mullet in the second trimester.

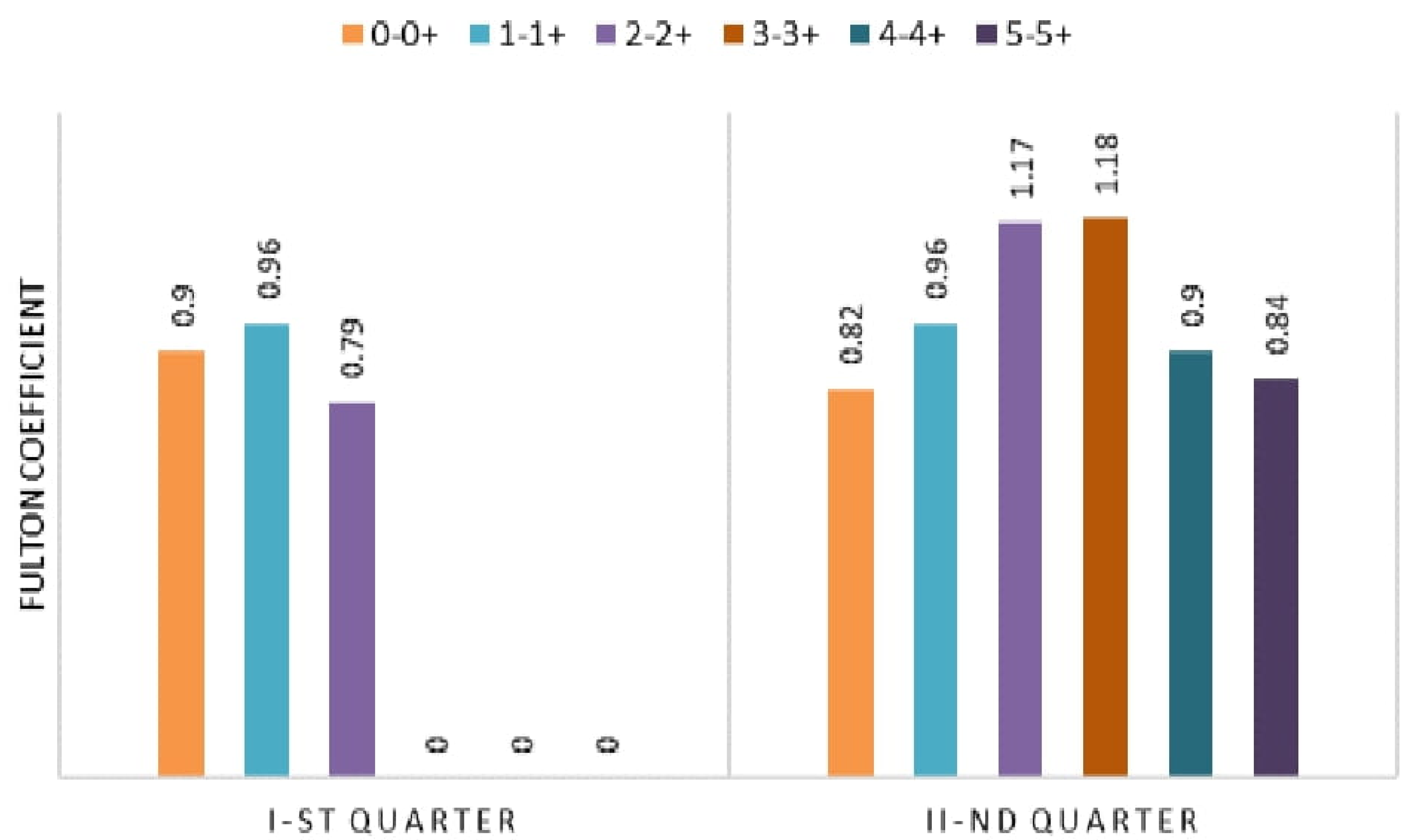

Figure 3.4.2. Fulton condition factor of red mullet by age classes.

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

IV.3.5 Weight structure

Weight was measured of **320 specimens**. The mean weights of the mullet in the first trimester were significantly lower than in the second trimester due to the absence of the older age groups in the first three months.

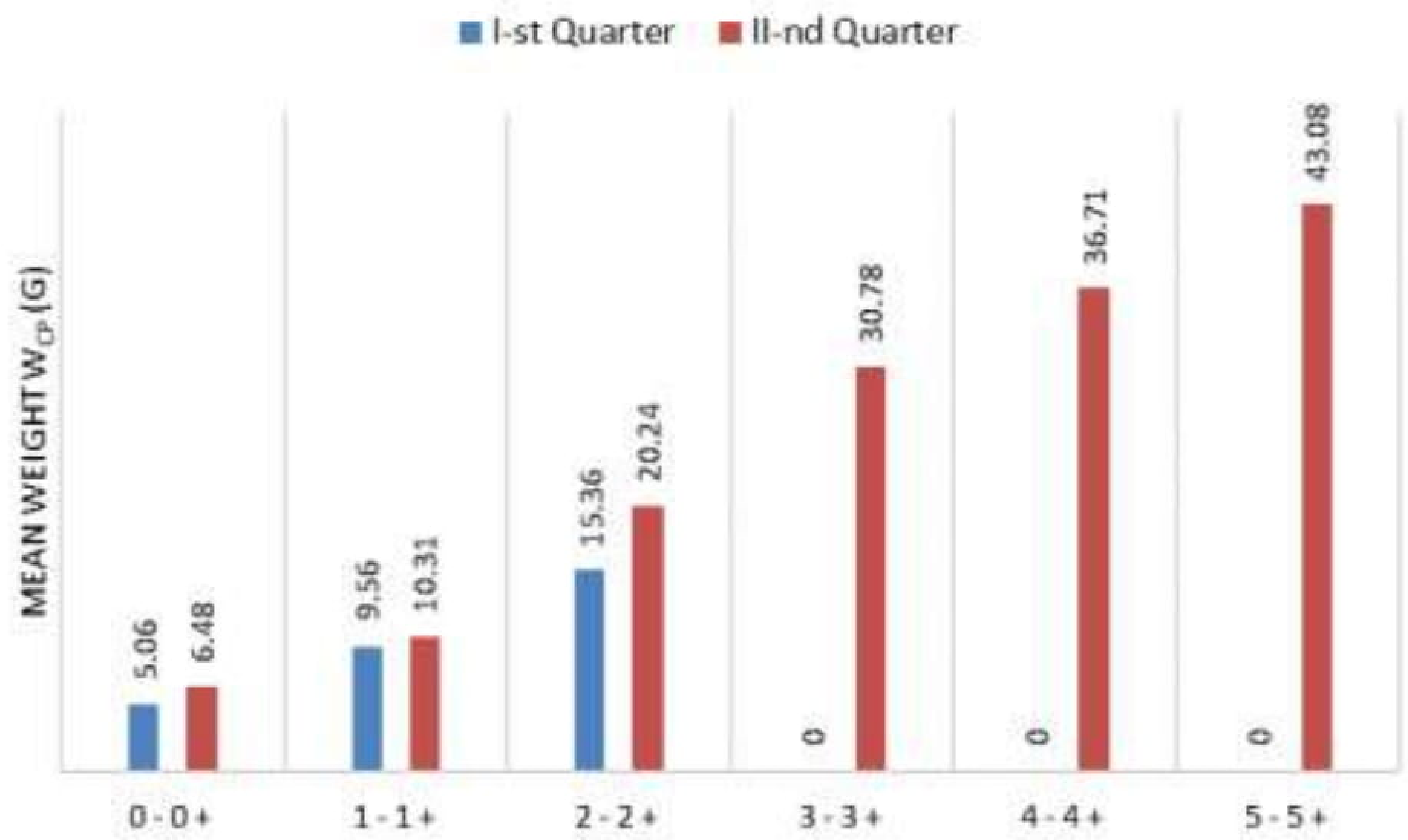

Figure 3.5.1. Weight structure by age group.

IV.3.6 Size structure by age group

The fish length was measured of **320 specimens**. The mean length of the mullet in the first trimester was significantly lower than in the second trimester due to the absence of older age groups in the first three months.

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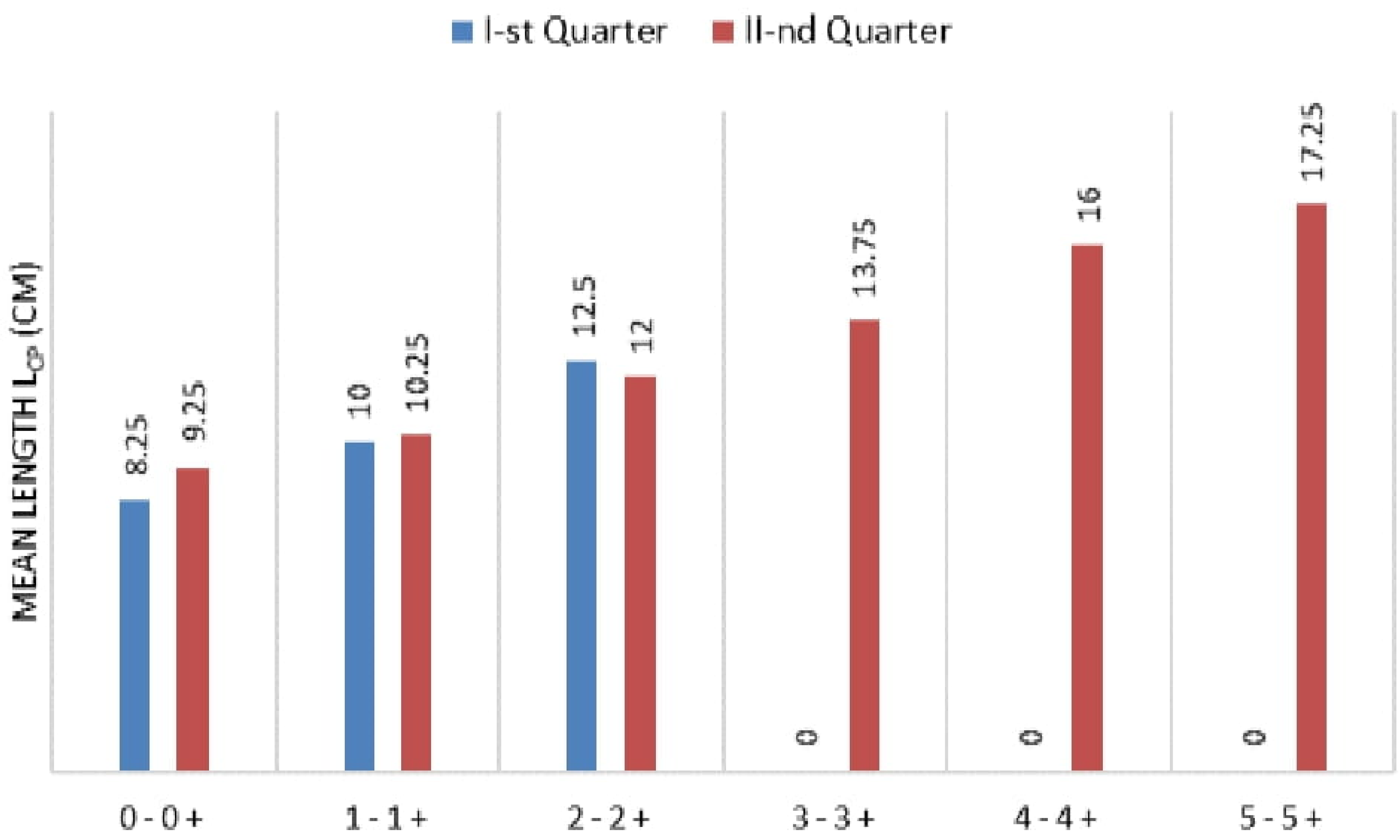

Figure 3.6.1. Length structure by age group**.**

IV.3.7 Length- weight relationship

The length-weight relationship in the first trimester of mullet showed an allometric increase with high determinism ($R^2 = 0,9856$).

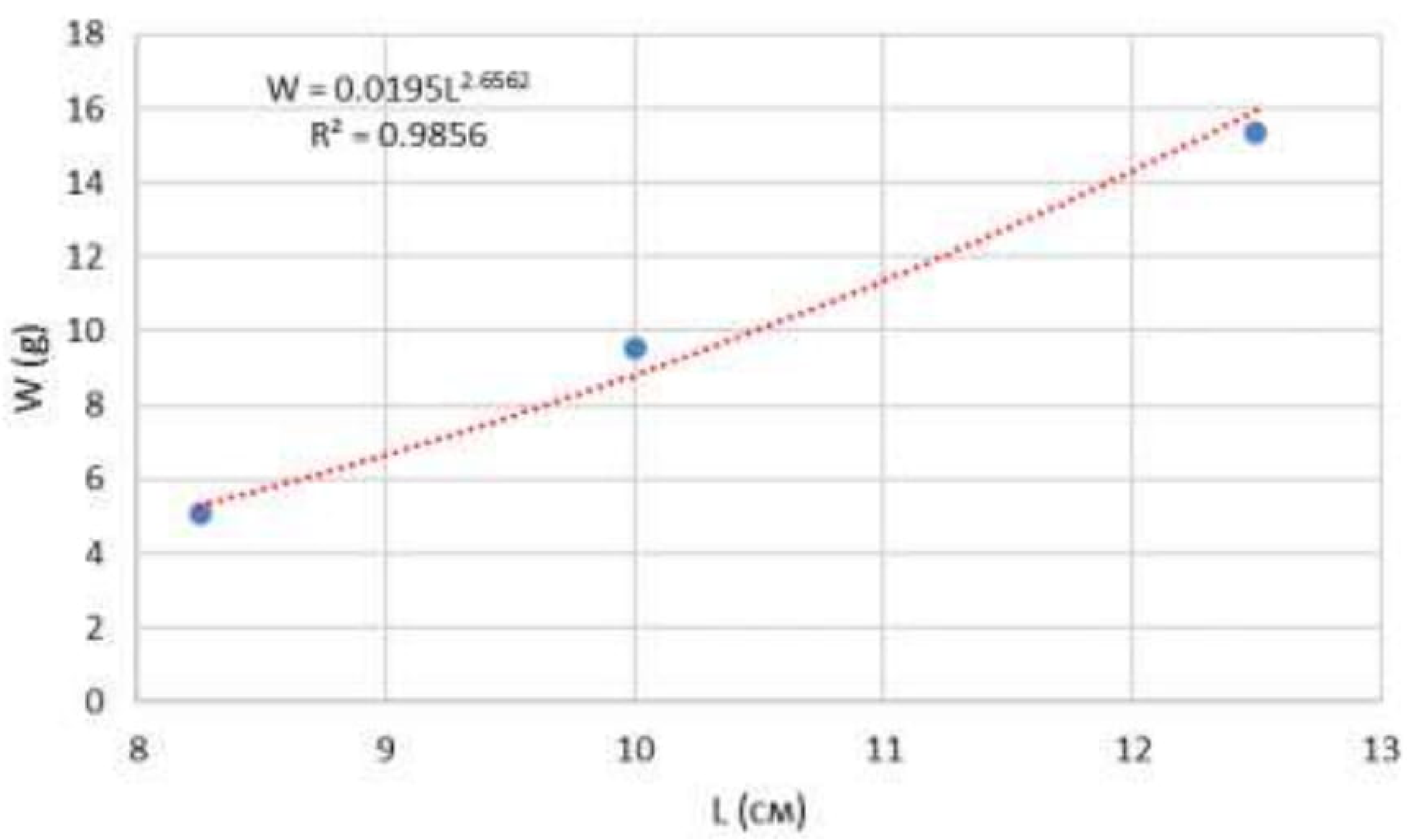

Figure 3.7.1 Length-weight relationship - I quarter of 2021.

The size-weight relationship in the second trimester is described by the logarithmic model showing a very high degree of determinism (R^2 =0.9928).

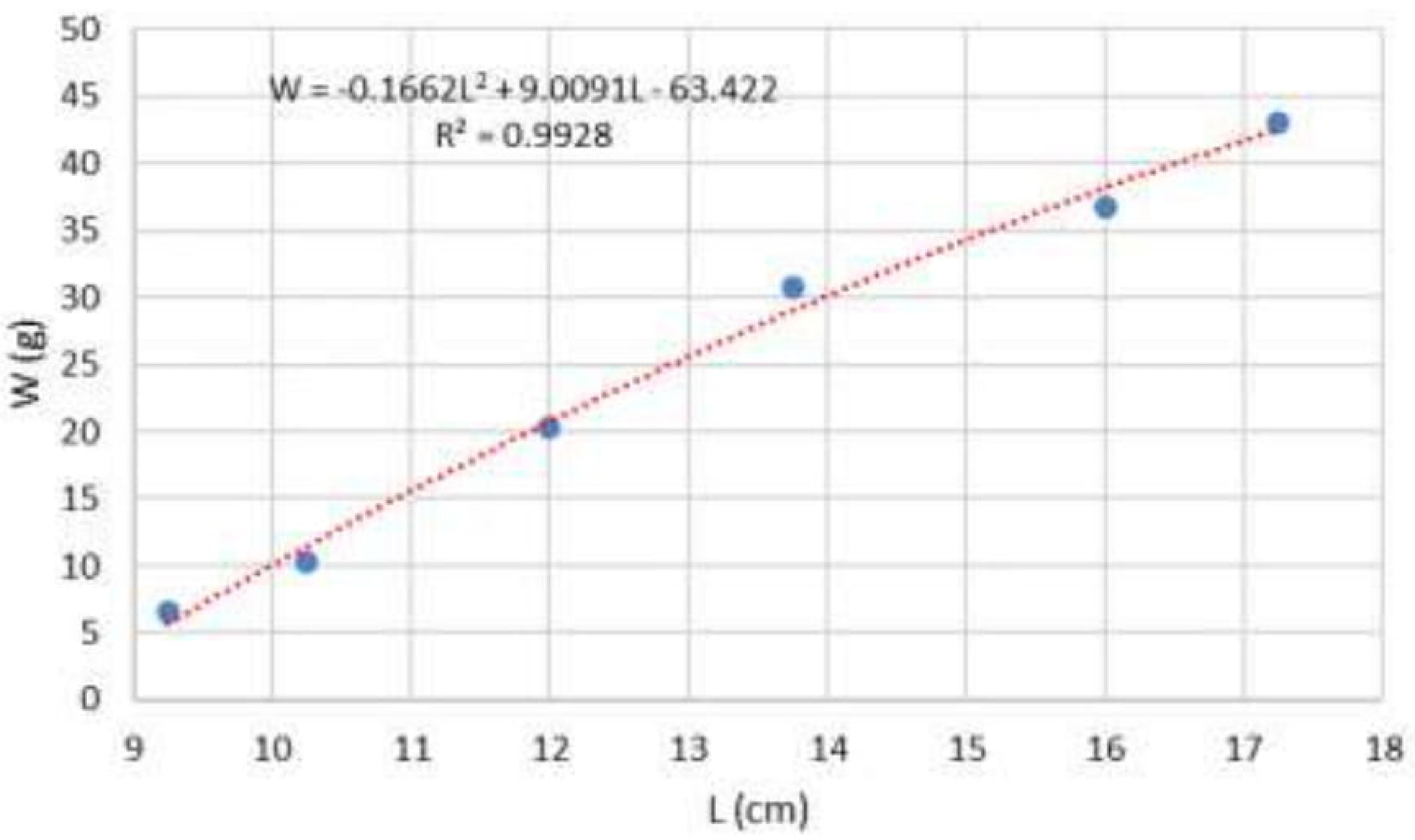

Figure 3.7.2 Length-weight ratio - II quarter of 2021.

IV.3.8 Sex ratio

The sex ratio was determined of **60 samples**. Females (53-55%) predominated in the first and second quarters of 2021. Males were 45-47% in the first and second quarters (**Figure 3.8.1**)

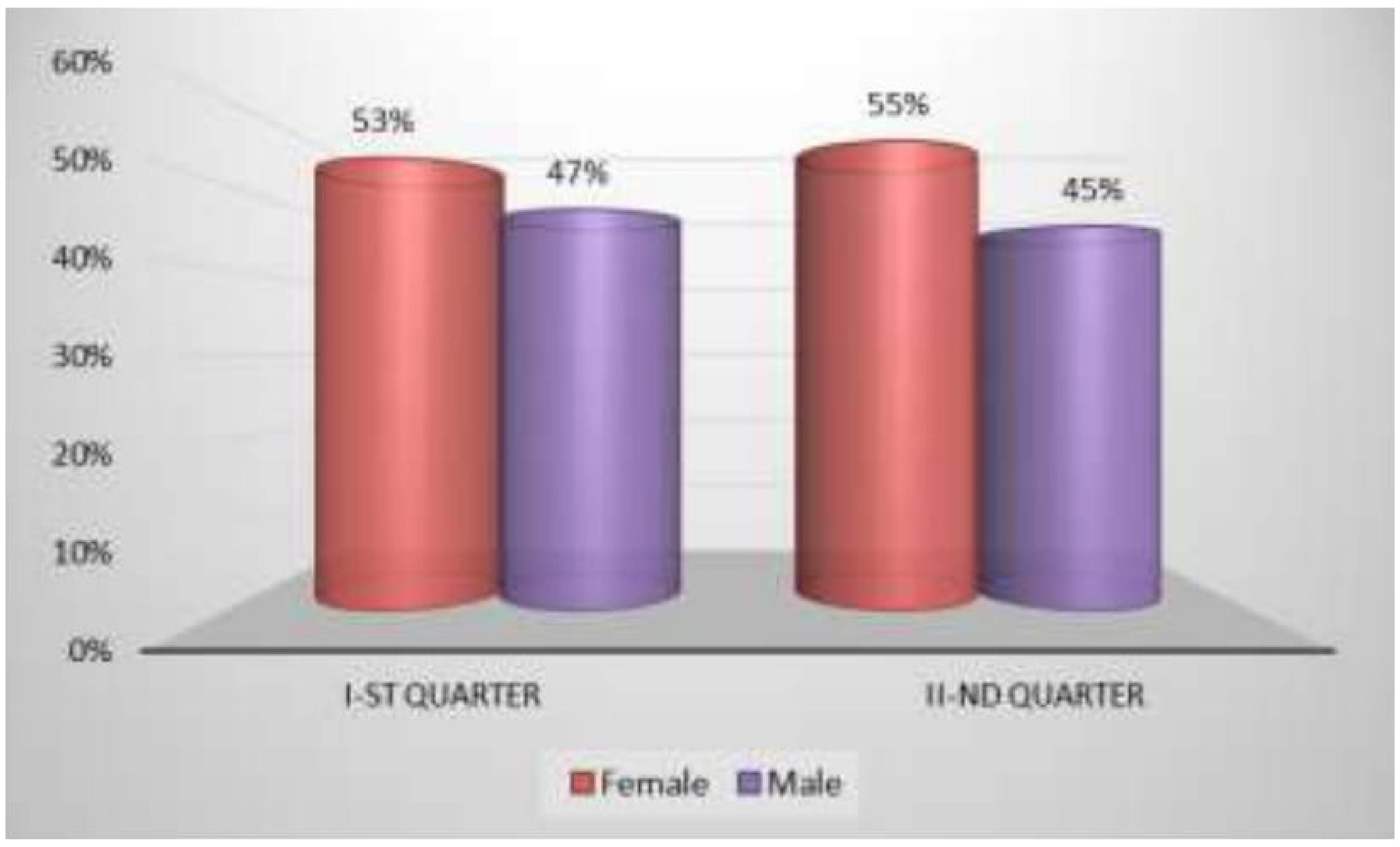

Figure 3.8.1 Sex ratio of red mullet (*Mullus barbatus*) caught in the Bulgarian Black Sea waters.

IV. 3.9 Fecundity

60 specimens were investigated for batch fecundity of red mullet. The portion fertility of the red mullet was examined at the end of June and is expected to increase in the following

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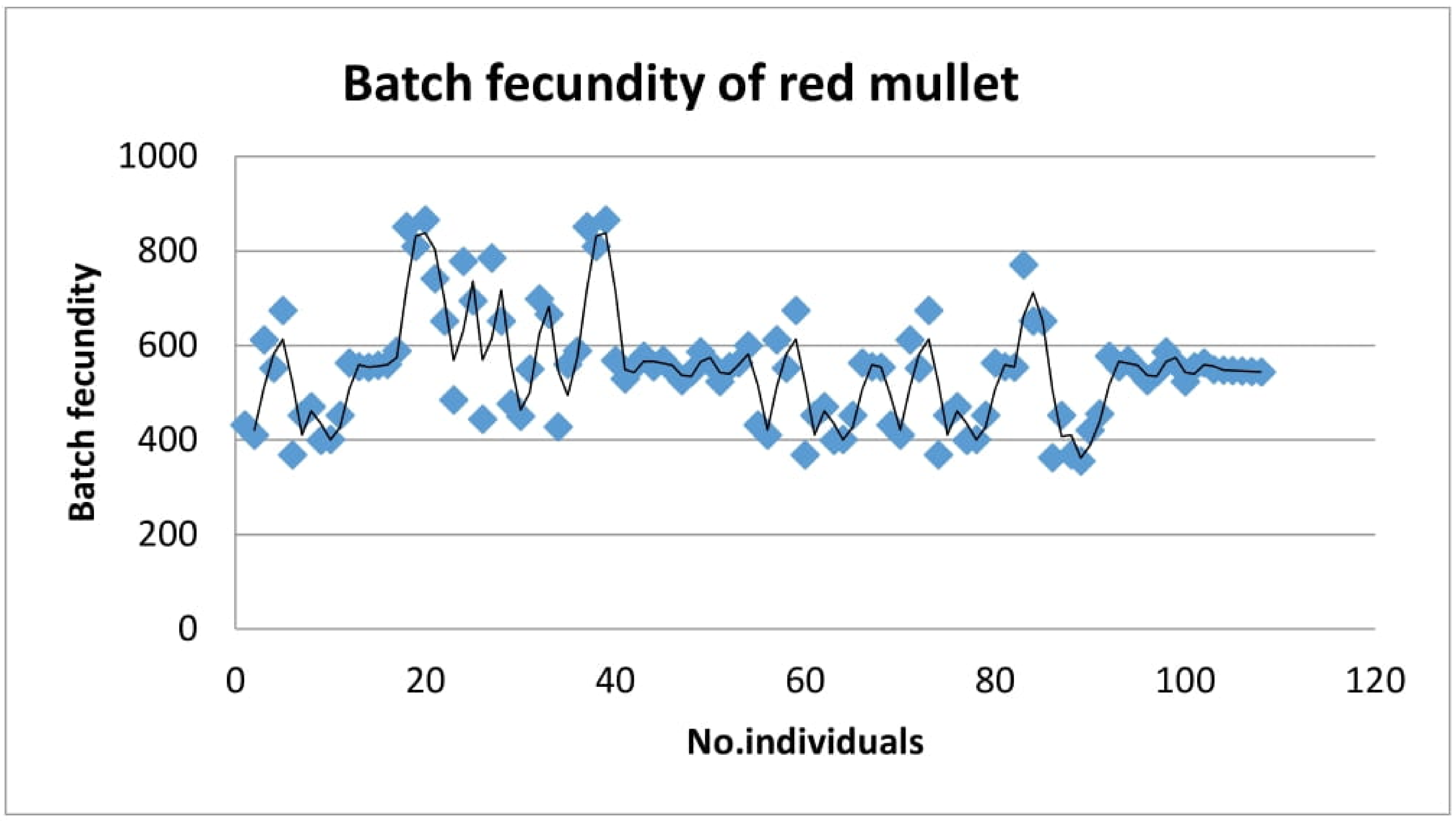
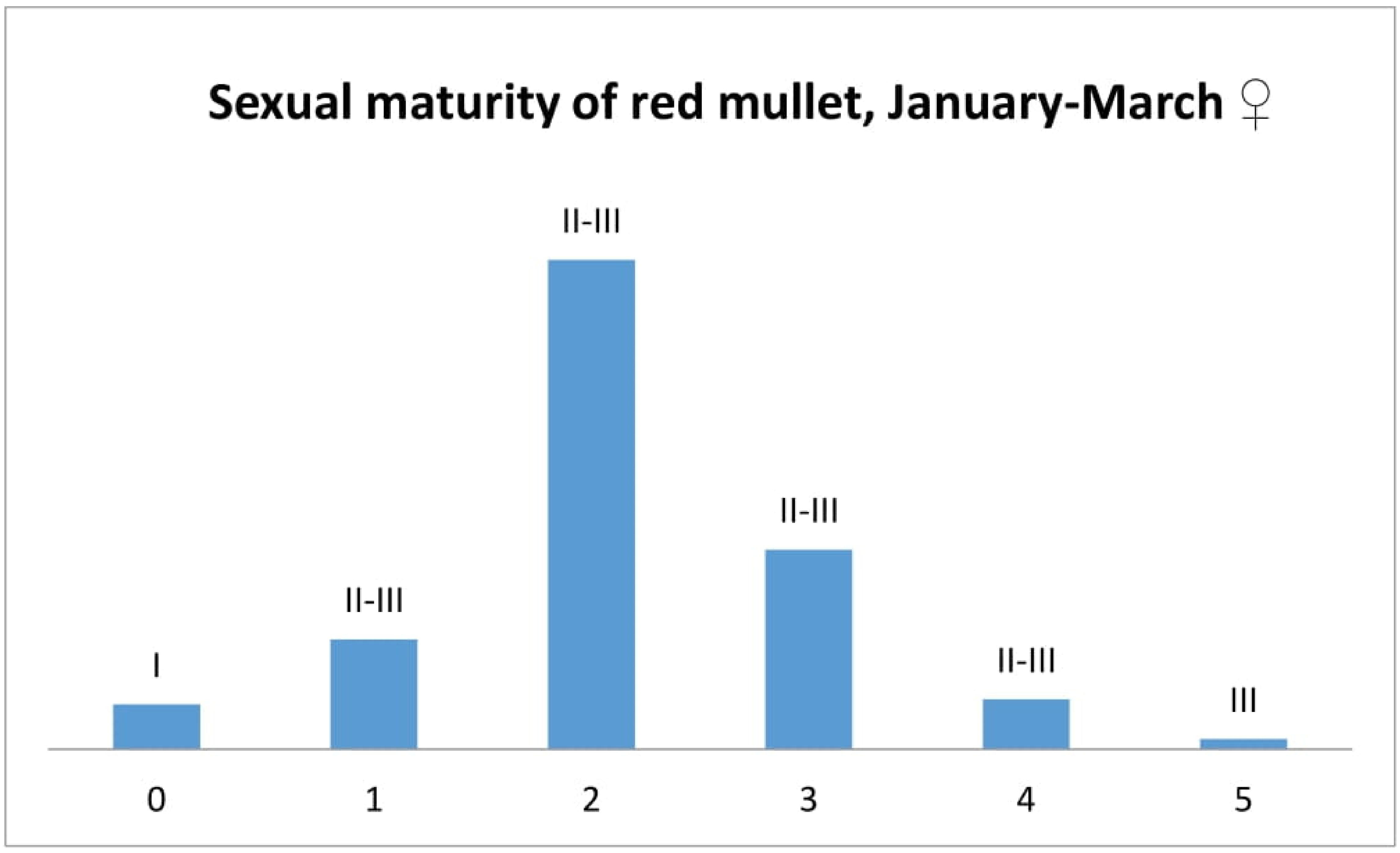
months, which is related to the biology of the species and the active maturation of the sexual products during the warm months of the respective year.



Фигура. 3.9.1 Batch fecundity of red mullet.

IV.3.10 Sexual maturity

60 specimens are used for maturity determination. The red mullet is a summer breeding species. The beginning of the active breeding of the species was registered in March-April.



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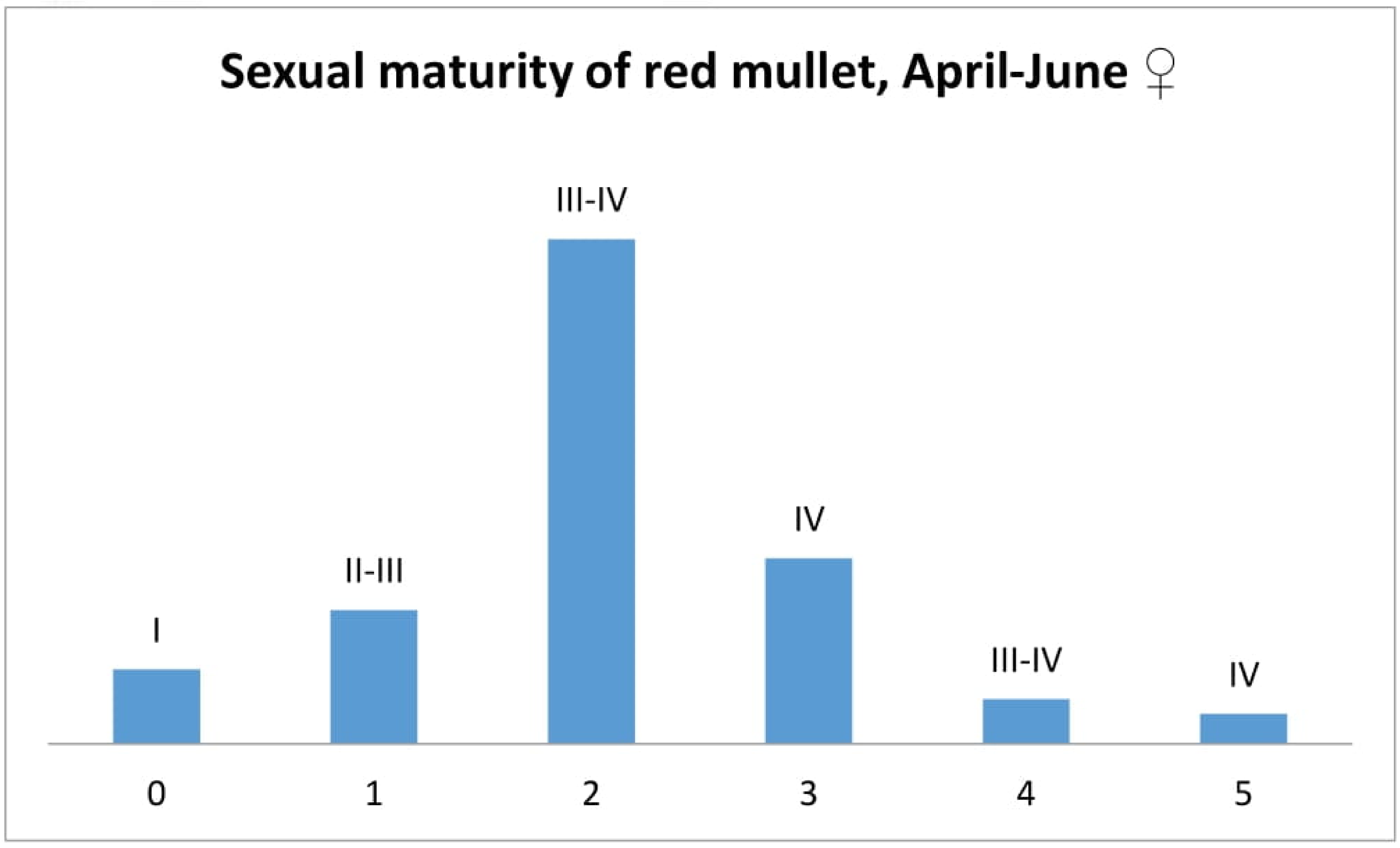
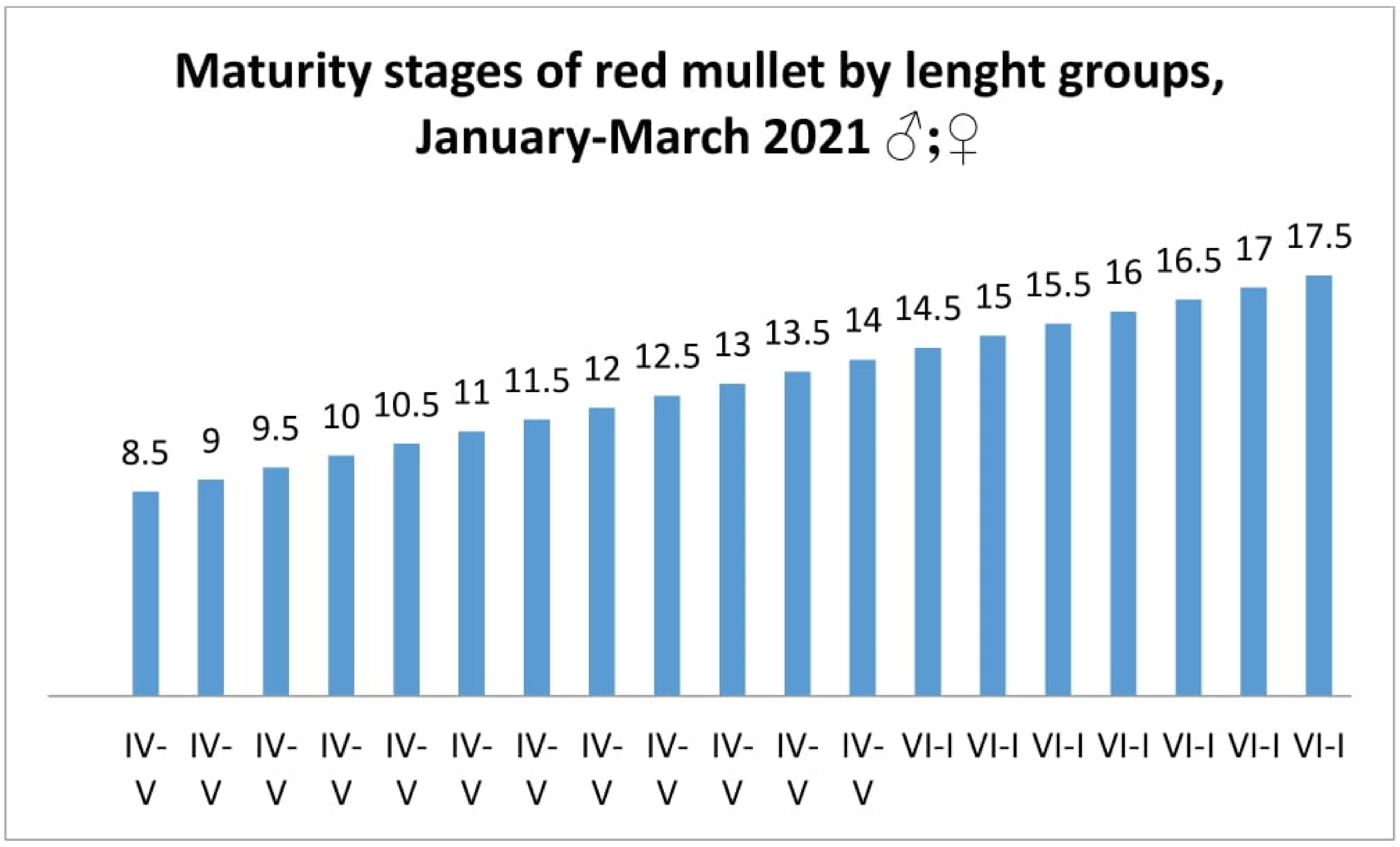


Figure 3.10.1 Sex maturity by age for red mullet.



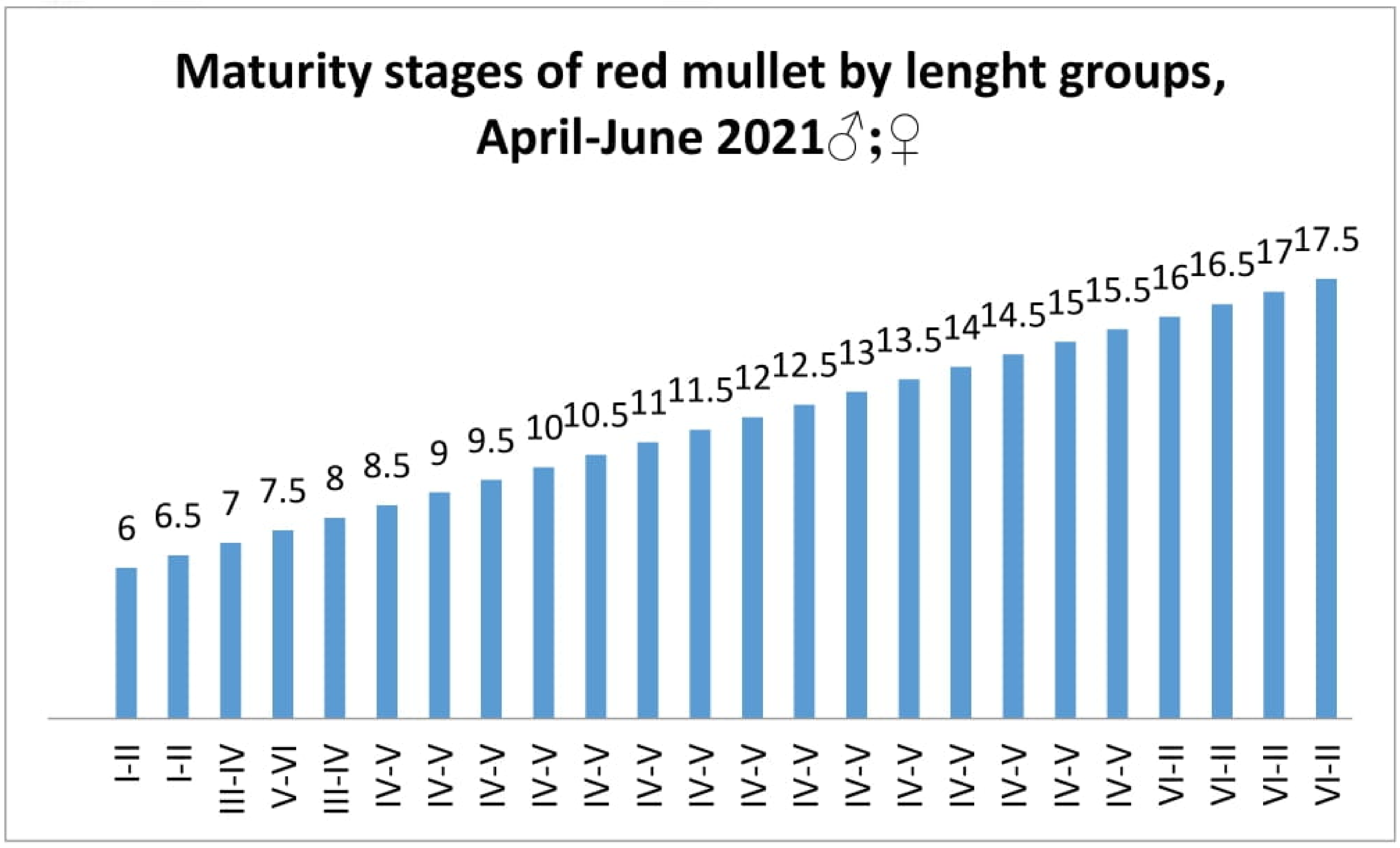


Figure 3.10.2 Sex maturity by age for red mullet.

IV.3.11 Catch numbers and biomass by age and length

Monthly catches (in tons) together with mean weights of red mullet were used to derive the monthly catch numbers. The share (%) by age groups and catch numbers were used to create catch-at-age matrix for selected months by age groups **(Table 3.11.1).**

Table 3.11.1 Catch at lrnght $*10^{-3}$ and Catch at age (10^{-6}) matrix and biomass (kg) of red mullet for selected months, 2021.

Length classes (см)	Catch in numbers *10-3			Biomass (kg)		
	I-st quarter	II-nd quarter	Total	I-st quarter	II-nd quarter	Total
7.5	21.65	0.00	**21.65**	69.94	0.00	**69.94**
8	13.42	0.00	**13.42**	52.45	0.00	**52.45**
8.5	13.15	0.00	**13.15**	69.94	0.00	**69.94**
9	27.70	1.31	**29.01**	192.33	8.19	**200.52**
9.5	15.09	2.30	**17.39**	122.39	16.02	**138.41**
10	12.12	2.90	**15.02**	104.91	24.56	**129.47**
10.5	5.14	2.57	**7.70**	52.45	29.55	**82.00**
11	12.95	1.31	**14.26**	174.85	19.58	**194.43**
11.5	1.09	4.29	**5.39**	17.48	68.71	**86.19**
12	0.00	5.89	**5.89**	0.00	110.36	**110.36**
12.5	0.83	8.56	**9.39**	17.48	186.90	**204.38**

13	0.00	3.22	**3.22**	0.00	97.54	**97.54**
13.5	0.70	4.26	**4.96**	17.48	138.13	**155.61**
14	0.55	2.08	**2.62**	17.48	68.00	**85.48**
14.5	0.00	1.32	**1.32**	0.00	44.14	**44.14**
15	0.00	0.69	**0.69**	0.00	23.50	**23.50**
15.5	0.00	0.11	**0.11**	0.00	3.56	**3.56**
16	0.00	0.05	**0.05**	0.00	1.78	**1.78**
16.5	0.00	0.02	**0.02**	0.00	0.71	**0.71**
17	0.00	0.03	**0.03**	0.00	1.07	**1.07**
17.5	0.00	0.02	**0.02**	0.00	0.71	**0.71**
Age groups (yr)	**Catch in numbers *10-3**			**Biomass (kg)**		
	I-st quarter	**II-nd quarter**	**Total**	**I-st quarter**	**II-nd quarter**	**Total**
0-0+	72.53	1.43	**73.96**	367.18	9.26	**376.43**
1-1+	43.89	7.49	**51.38**	419.63	77.25	**496.88**
2-2+	7.97	21.98	**29.95**	122.39	445.00	**567.39**
3-3+	0.00	9.44	**9.44**	0.00	290.49	**290.49**
4-4+	0.00	0.53	**0.53**	0.00	19.58	**19.58**
5-5+	0.00	0.03	**0.03**	0.00	1.42	**1.42**

IV.3.12 Coefficient of variation of length

na

IV. 3.13 Conclusions

1) Catches of mullet were missing in January and May 2021 with OTM. Maximum catch was recorded in June 2021 (0.708 tonnes).

2) The size classes of the red mullet during the studied period were in the range of 7 cm to 17.5 cm. The groups in the first quarter prevailed: 9 cm, 11 cm, and in the second 12, 12.5 and 13.5 cm.

3) The age structure of the red mullet in the first trimester showed highs of 0-0 + year and 1-1 + year individuals. 2-2 + year specimens had about 14% share in catches, and senior groups were missing in catches.

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4) In the second quarter, recruitment was almost non-existent in catches (2.7%), 1-1+ olds had a subordinate share (8.8%), 2-2 + year's had a share of 51% in total catch, 3-3 + year 33%, 4-4 + year - 0.8%.

5) The conditioning factor by age groups showed a higher condition of the red mullet in the second trimester, probably related to the active maturation of sexual products and an increase in individual weight.

6) The mean weights of the red mullet in the first trimester were significantly lower than in the second trimester due to the absence of the older age groups in the first three months.

7) The length-weight relationship in the first trimester of mullet showed an allometric increase with high determinism (R^2 = 0.9856).

8) In the first and second quarters of 2021, females predominated (53-55%), while males accounted for 45-47% in the first and second quarters.

9) The portion fertility of the red mullet was examined at the end of June and is expected to increase in the following months, which is related to the biology of the species and the active maturation of the sexual products during the warm months of the respective year.

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V. Biological monitoring of anchovy (*Engraulis encrasicolus*)

V.1 Objectives

Anchovy (*Engraulis encrasicolus*) is a pelagic sea fish of importance for fishing in the Black Sea. The purpose of this study is to collect and analyze the dynamics of length, weight and age distribution, as well as to determine the condition of the observed species using the so-called Ricker factor . Biological information on a species is collected every month and thus analysed and compared with previous periods and can then be used to assess growth parameters. These indicators are of very high importance for species. Long-term information is crucial for assessing fish stocks, fisheries management and the decision-making process as a whole.

V.2 Sampling

V.2.1 Geographic area coverage

The data from this analysis are collected directly from the discharges in the ports from the Bulgarian Black Sea coast. In the 1nd and 2nd quarters of 2021, **5 samples containing 313 specimens** were collected and processed.

V.2.2 Sampling period

Date	Sampling ports	Fishing vessel	Catch/kg
21.1.2021	Sozopol	FV 26	1170
11.2.2021	Nesebar	NIKO	1240
5.3.2021	Sozopol	BALNOBOR	2000
19.4.2021	Sozopol	MEDUZA 3	1740
29.6.2021	Pomorie	EGEO	700

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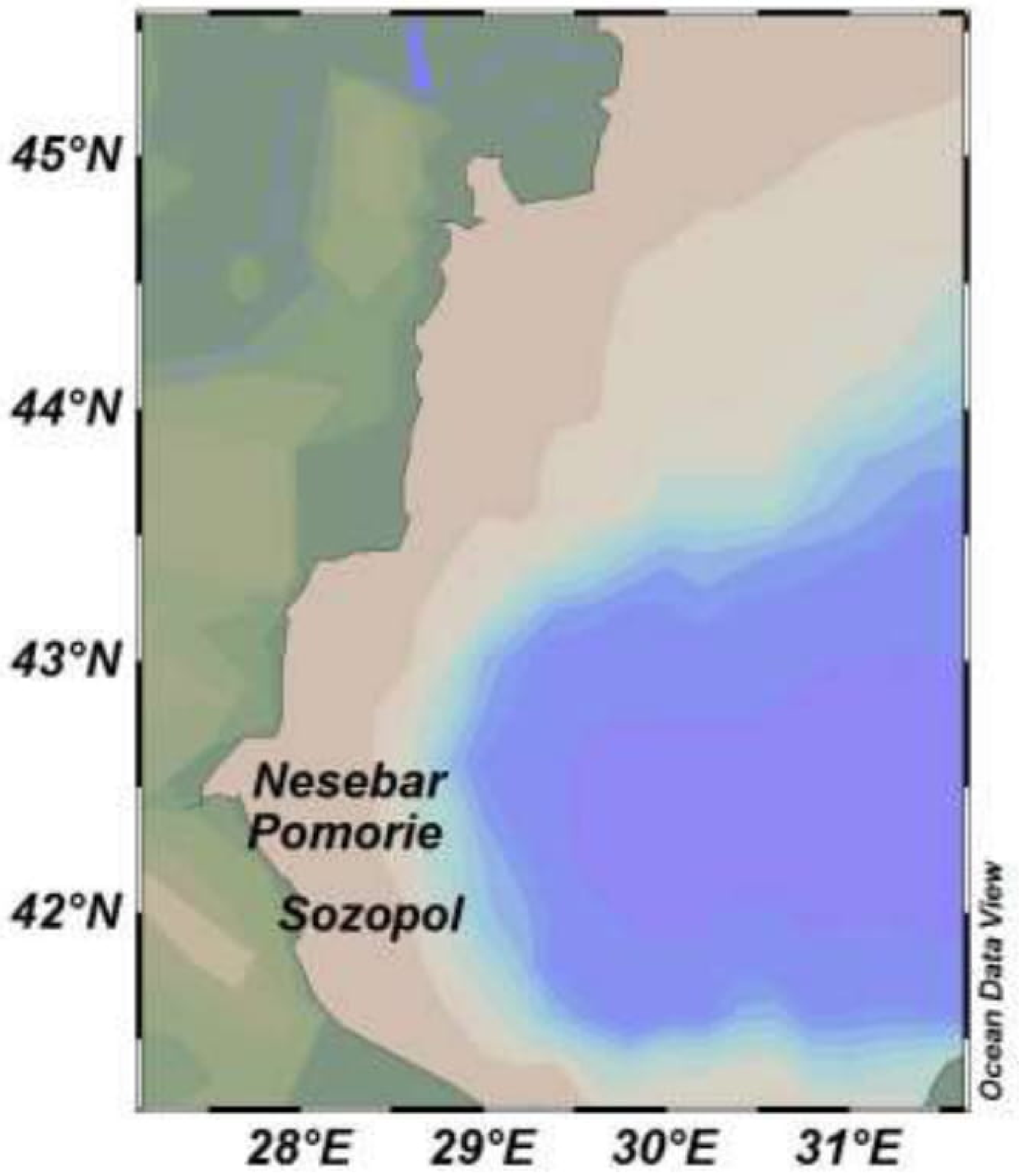

Figure 2.2.1 Research area and plan of the sampling ports of Bulgarian Black Sea coast.

V.2.3 Statistical analysis of data

See section statistical analysis of sprat.

V.3 Results

V.3.1 Landings statistics

According to official catch statistics large catches were taken in February (**Figure 3.1.1**).

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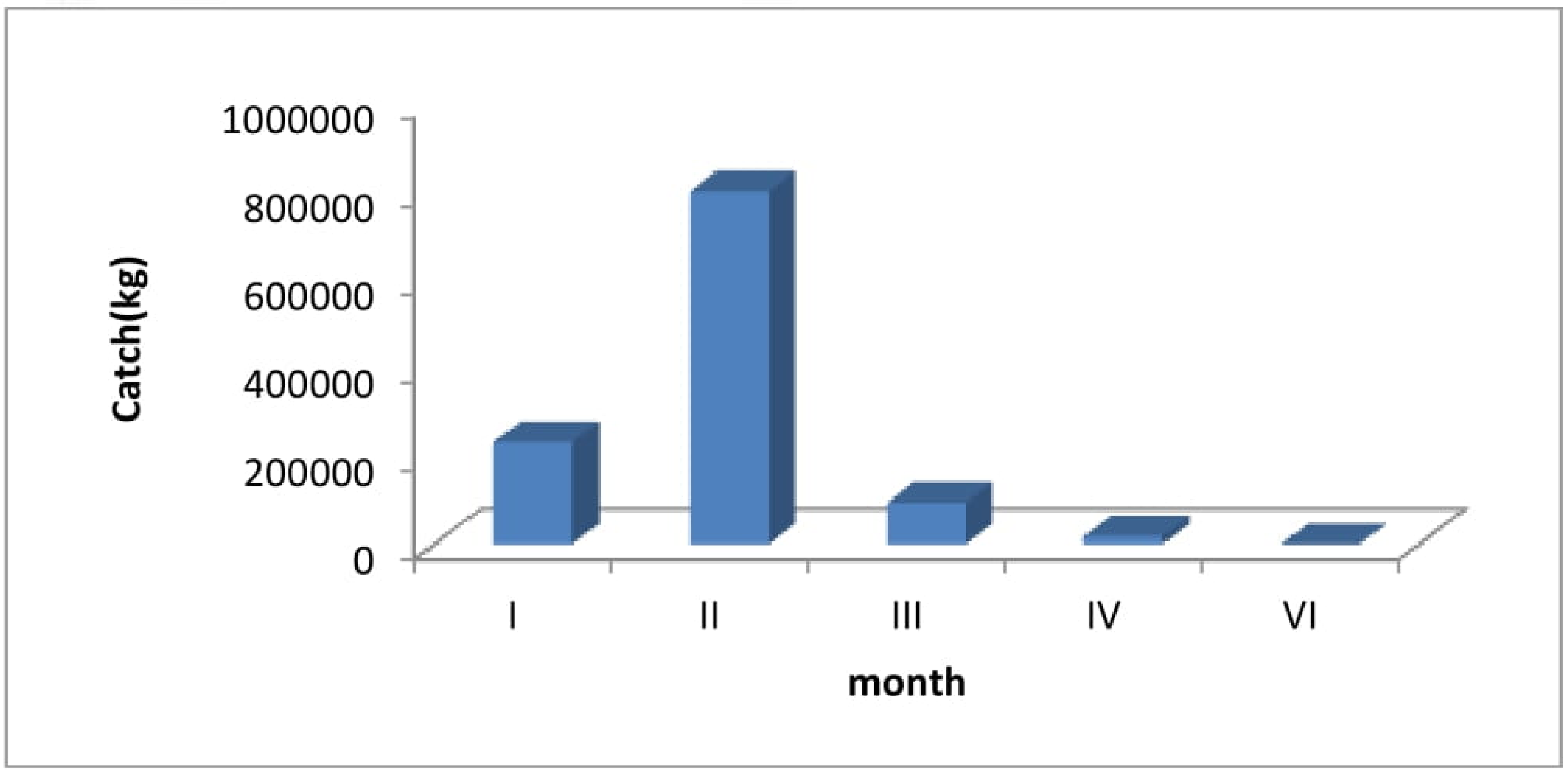

Figure 3.1.1 Landings statistics of anchovy.

V.3.2 Length structure of landings

In the catches of the Bulgarian aquaria of the Black Sea during the research period of 2021, the size composition is presented by individuals with a body length from 6.0 cm to 12.5 cm. During individual months the variation order is interrupted and absent from it or poorly represented individuals of certain sizes.

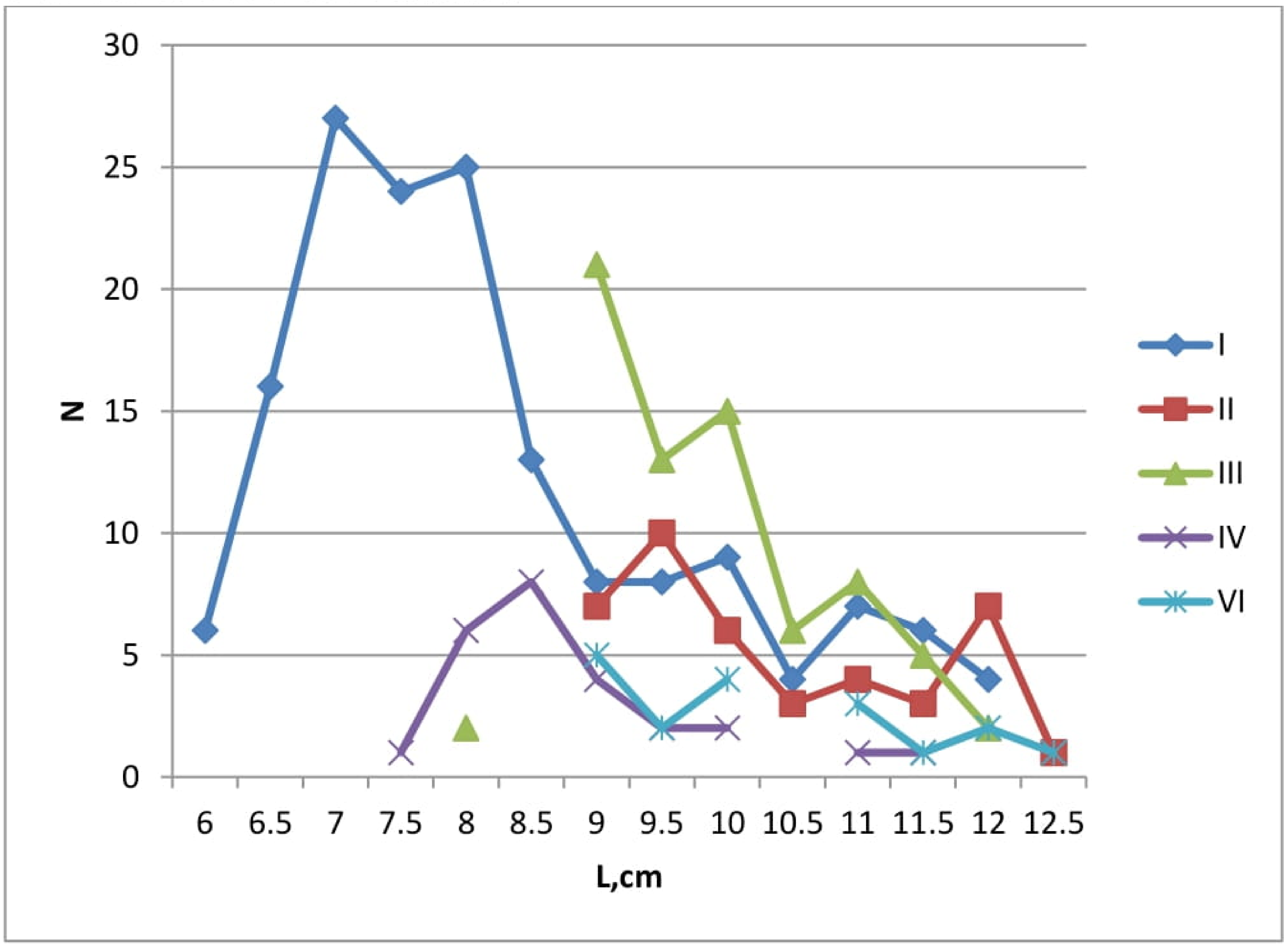

Figure 3.2.1 Frequency of anchovy length from landings
Note: In May, there were no recorded catches of anchovy with OTM

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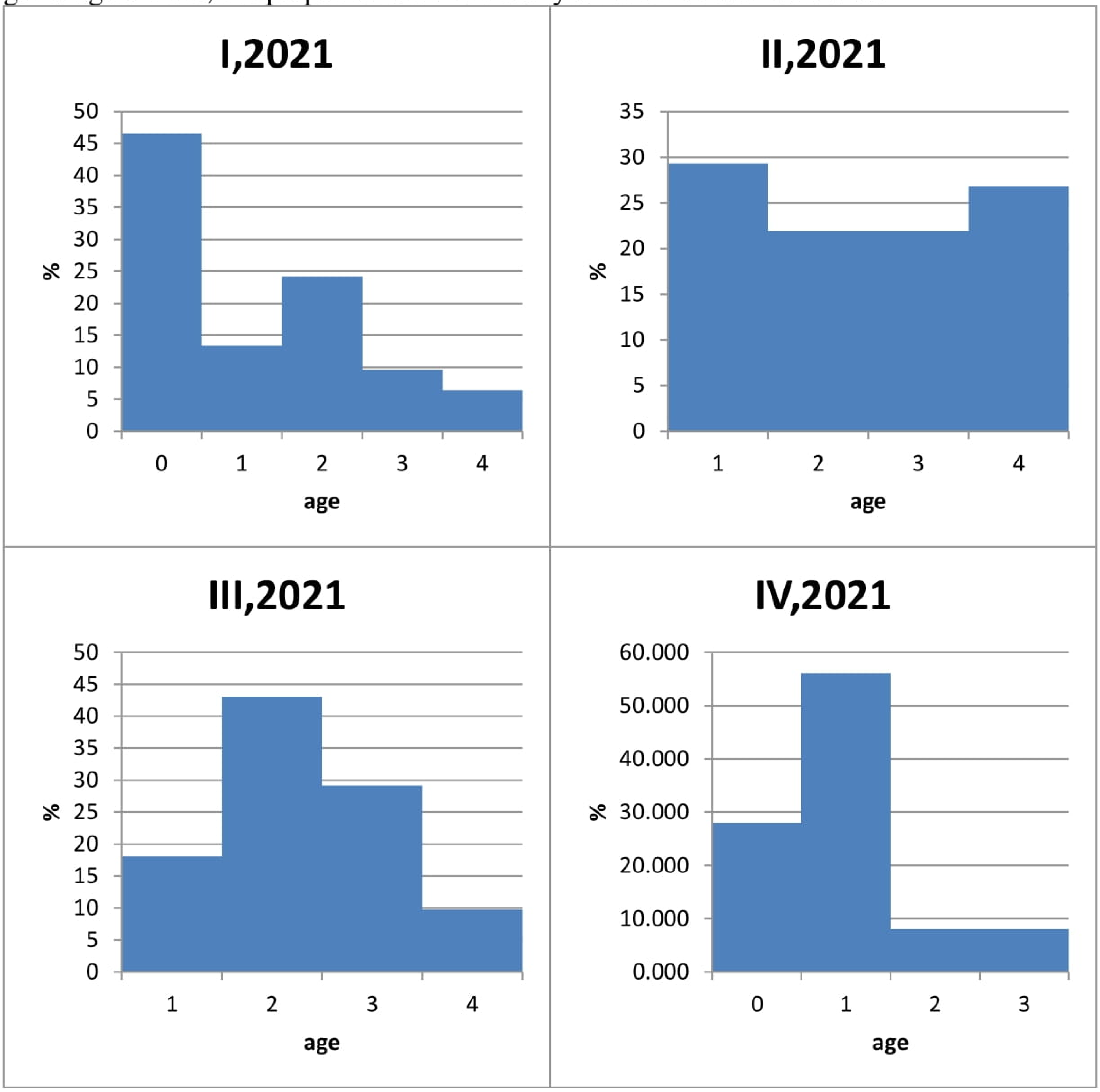
V.3.3 Age structure of landings

Samples (**n = 313**) were used to determine age. In January, 2021 the share of 0+ annual specimens was high (46.50%), and the presence of two-year-olds reached ~24.20%. In February, one and four-year-olds were presented with the highest percentage in catches as two - and three-year-olds showed almost equal distribution. In March, two-year-old fish made up ~43.05% of catches. In April, the importance of annuals reaching ~ 56.00%, (**Figure 3.3.1**) is growing. In June, the preponderance of three-year-old fish was observed.



Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

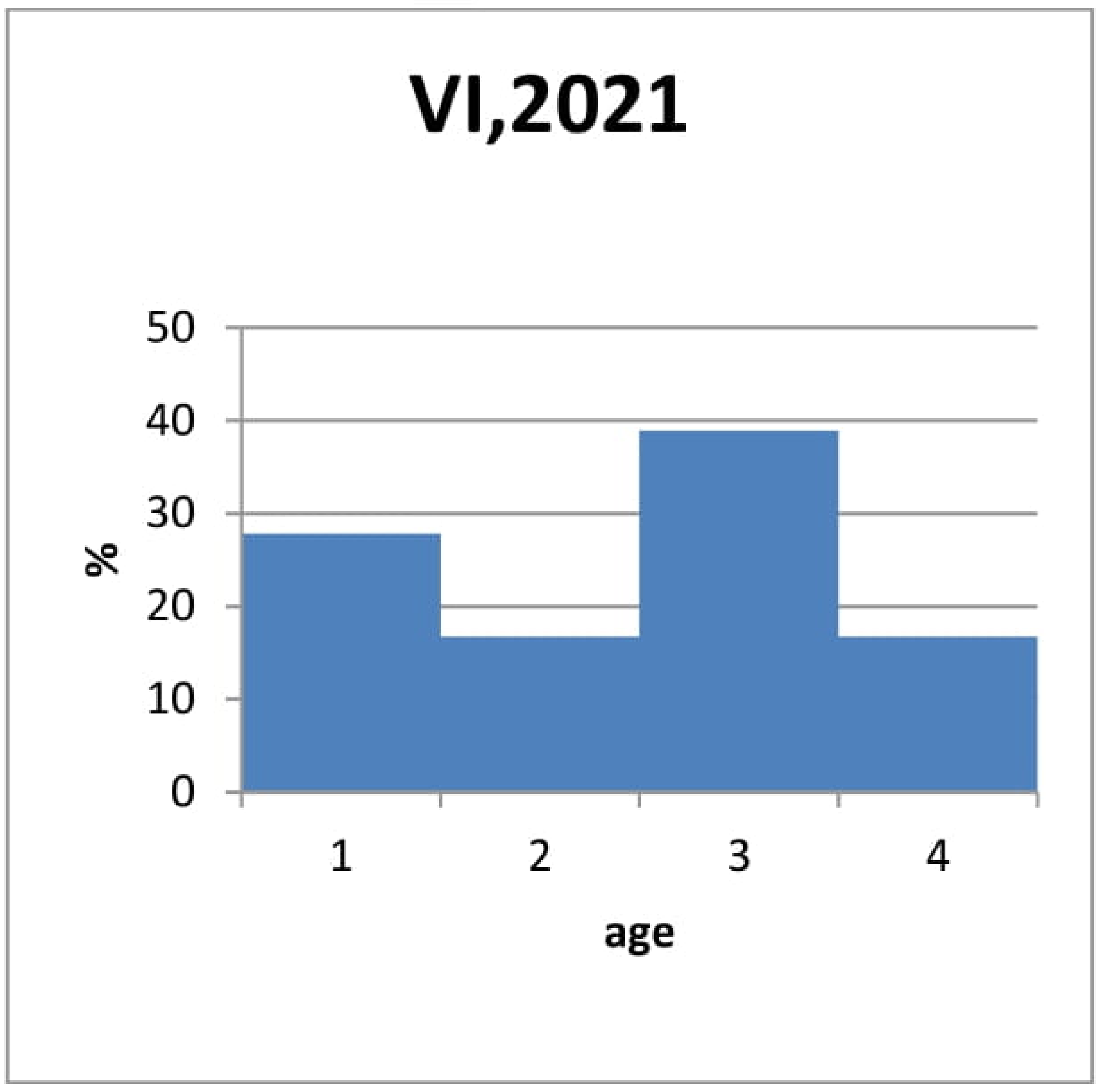


Figure 3.3.1 Age distribution of anchovy (%).

During the study period, the results of 1st and 2nd 2021 **(Figure 3.3.2)** showed the highest participation of two and zero-year-old fish, with lower participation of four-year-olds and no anchovy specimens of the most senior age groups (five and six-year-olds) recorded.

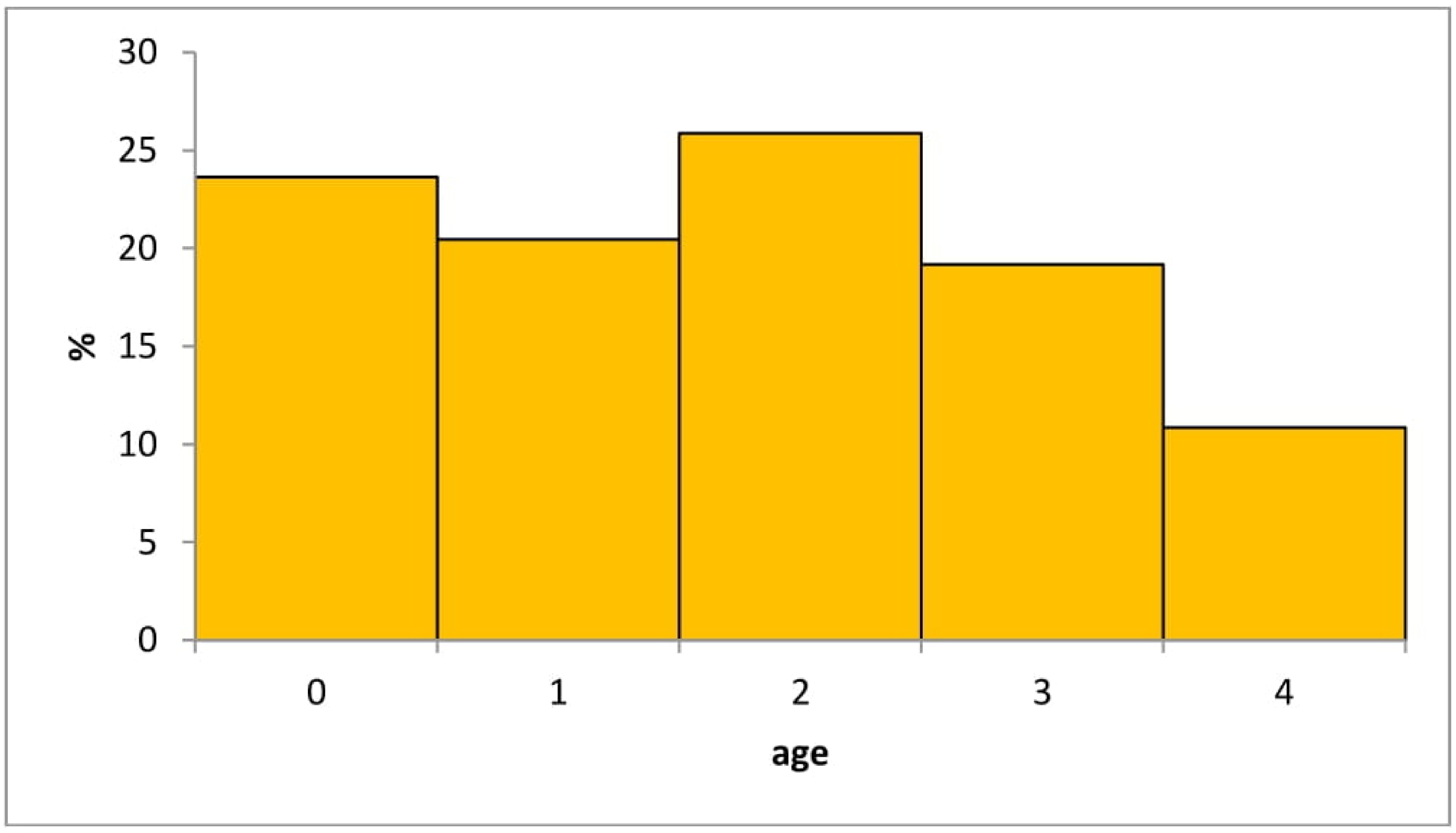


Figure 3.3.2 Age distribution of anchovy in 1st and 2nd quarters, 2021.

V.3.4 Condition factor

In January, the condition factor showed the highest values and decreased in the remaining months.

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

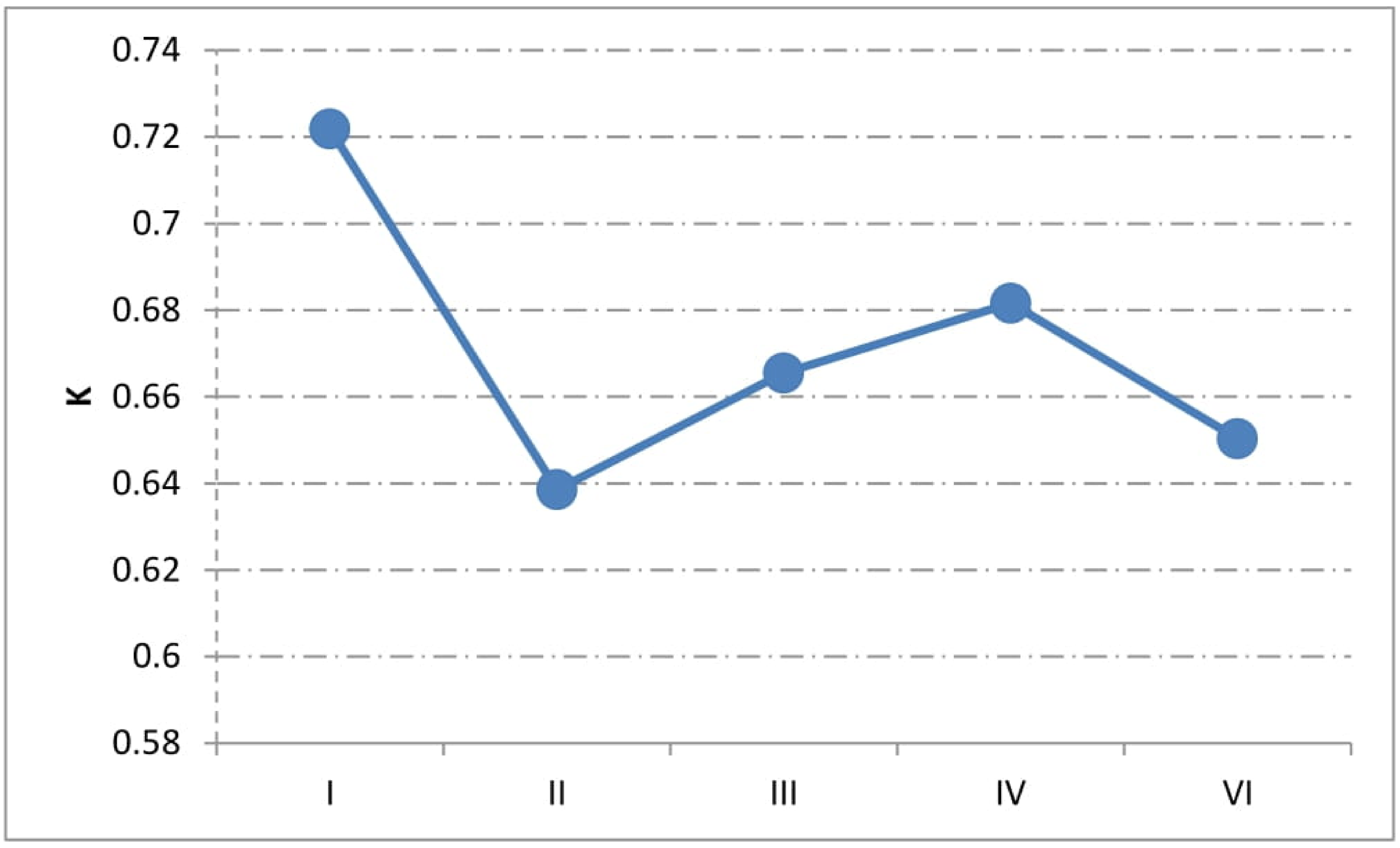


Figure 3.4.1 Average anchovy conditioning values by month.

V.3.5 Weight structure

The weight was measured at **313 samples**. The weight structure analysis shows that the average weights by age group vary by range. The highest weight showed the four-year-old fish: 9.46g (January), 10.82g, (February) 10.01g (March) and 11.51g in June.

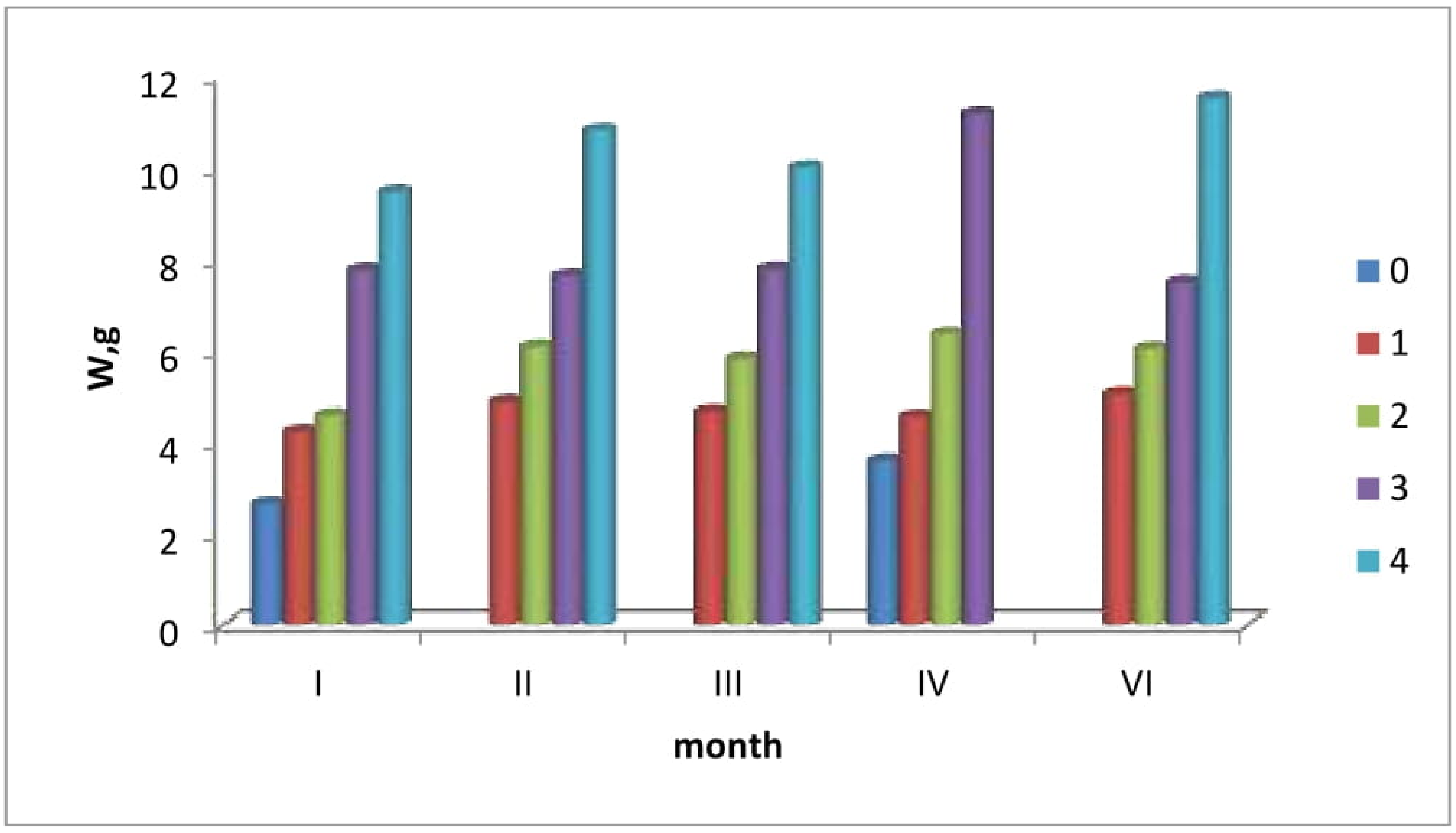


Figure 3.5.1 Average anchovy weights in the 1th and 2nd quarters.

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.", финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

V.3.6 Size structure by age group

The length of the fish was measured at **313 specimens**. As the age increases, the linear dimensions increase steadily. The average length of the anchovy during the study period is as follows: is 8.24 cm (January), 10.25 cm (February), 9.87 cm (March), 8.89 cm (April), 10.27cm (June).

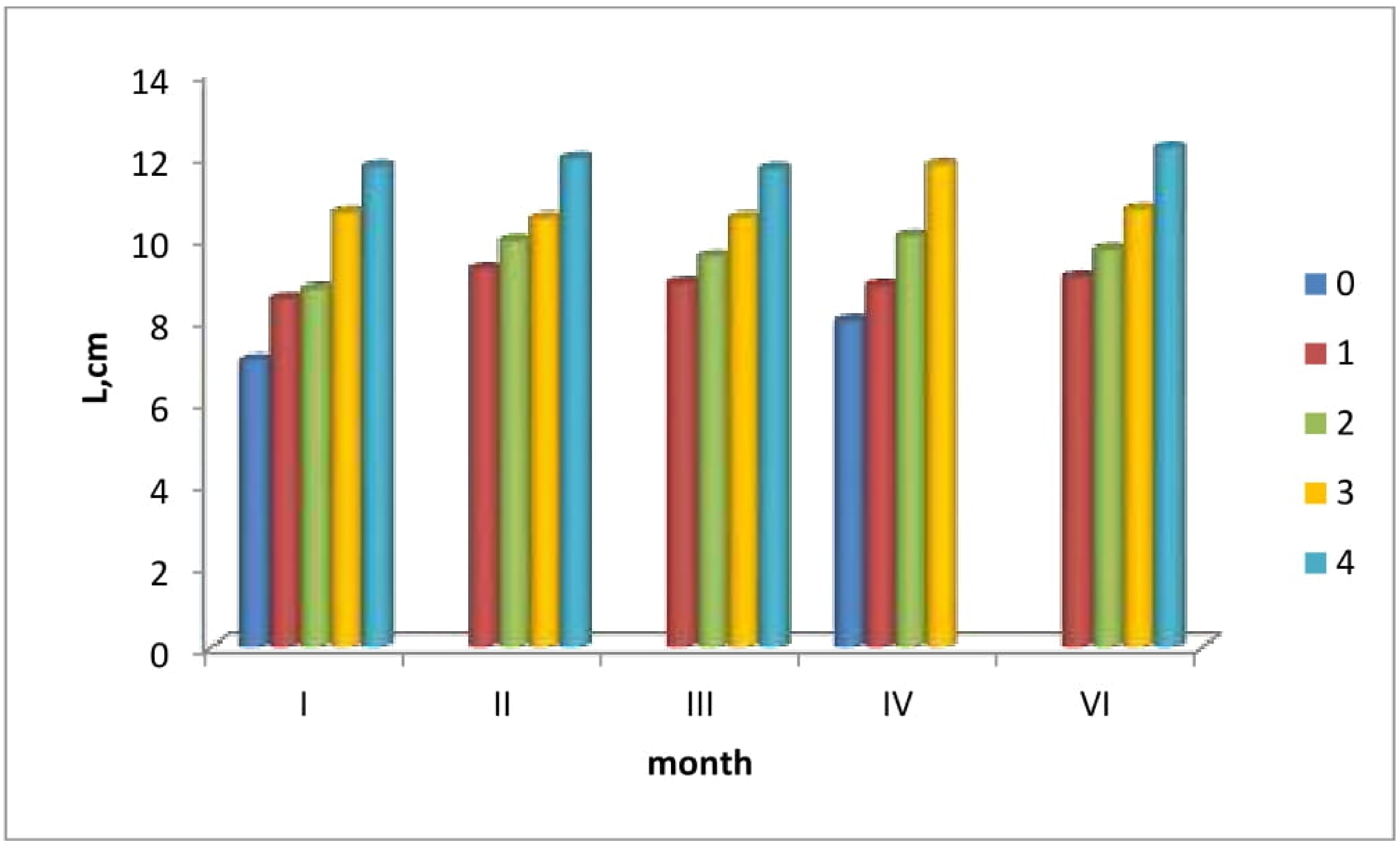


Figure 3.6.1 Average anchovy lengths in the 1th and 2nd quarters.

V.3.7 Length- weight relationship

The interrelation between the size (L) and the weight (W) of the sampled specimens is described by the equation: $W = 0.0207*L^{2.8986}$
From the analysis, it follows that the increase in the whiting is allometric ($n \neq 3$).

Table 3.7.1 Length-weight relation parameters.

year	a	n
2021	0.0207	2.8986

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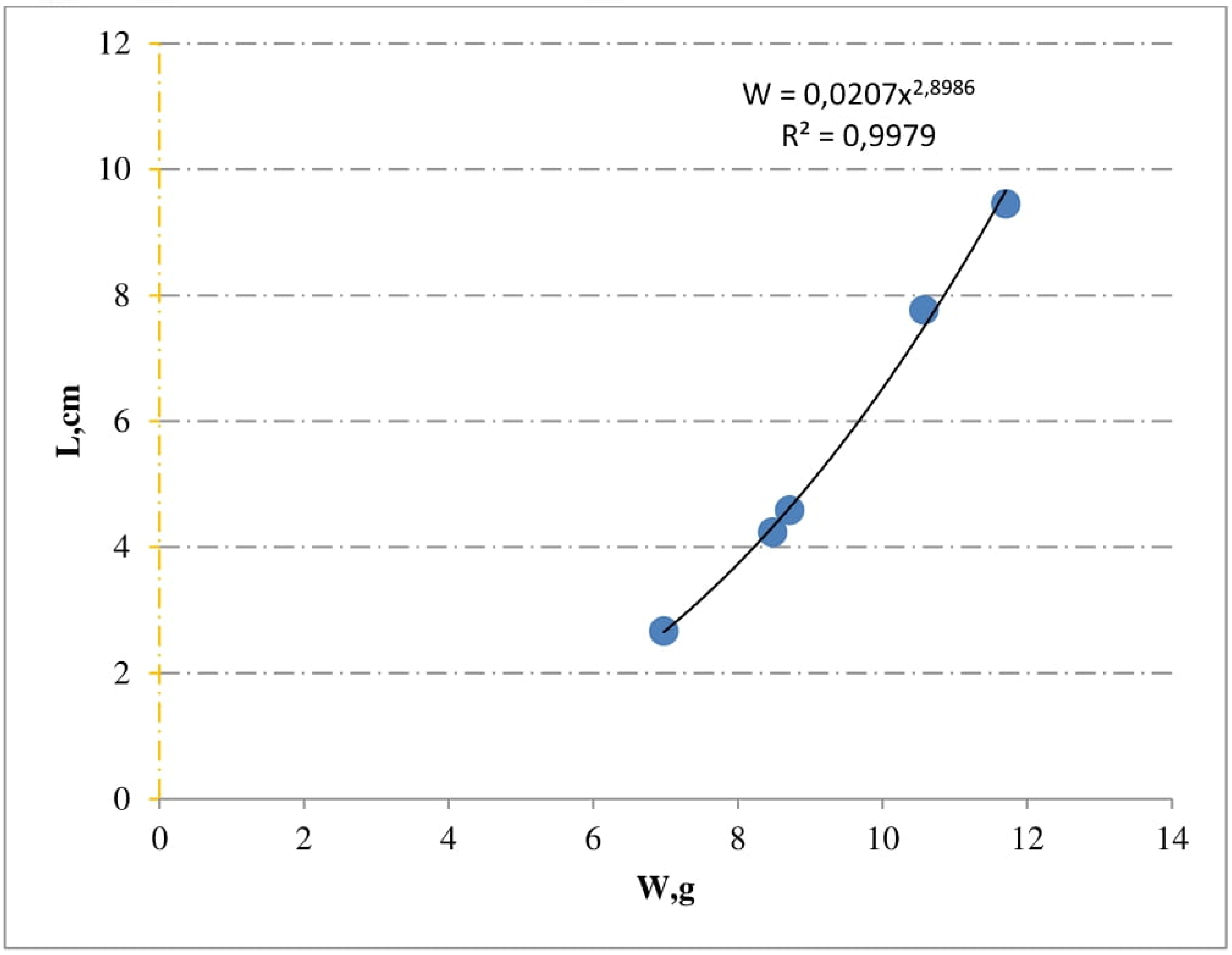

Figure 3.7.1 Linear regression of the ratio size (L)-weight(W) of the anchovy.

V.3.8 Sex ratio

The sex ratio was determined of **250 samples**. Sex of the determined specimens, 36% was male (♂)) and 64% was female (♀) **(Figure 3.8.1).**

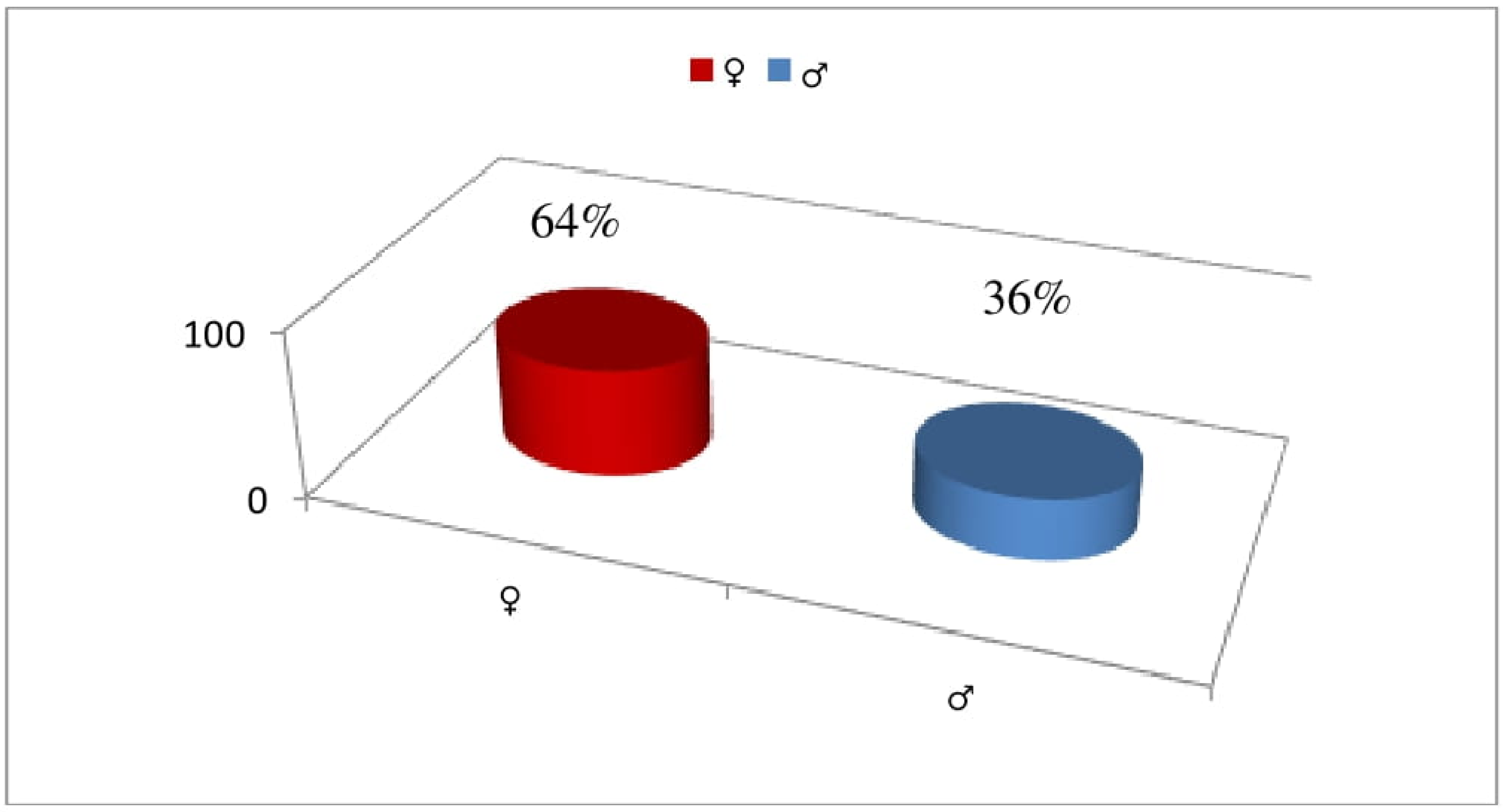

Figure 3.8.1 Sex ratio of anchovy.

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

The mean lengths in females♀ are higher.

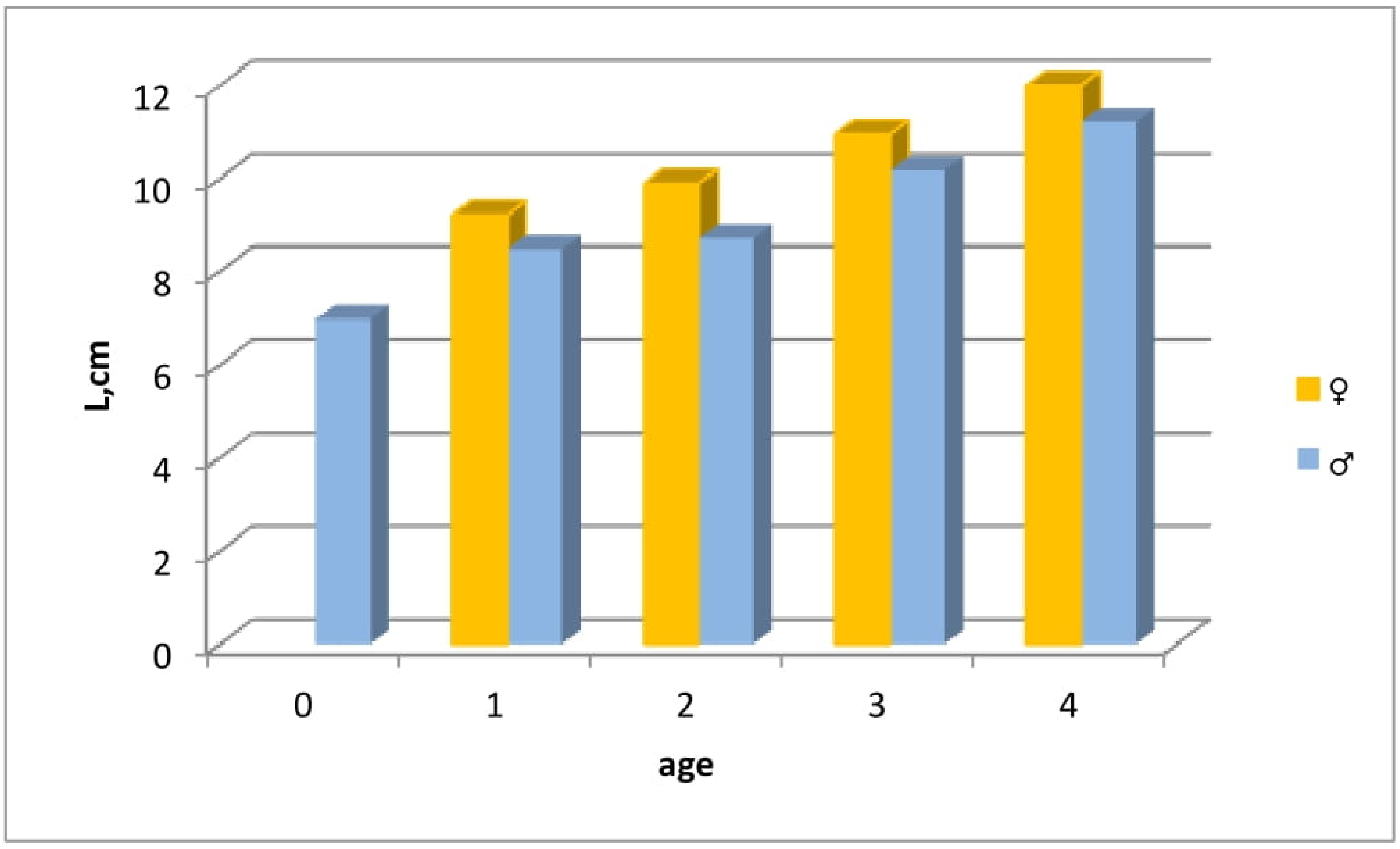

Figure 3.8.2 Sex ratio by size and age of anchovy.

V.3.9 Fertility

Fertility was determined on **100 specimens**. The gonado-somatic index is highly dependent on the weight of the gonads ($R^2 = 0.9822$), which is associated with the high maturation rate of females in late spring and summer and the breeding process of the anchovy (**Figure. 3.9.1**).

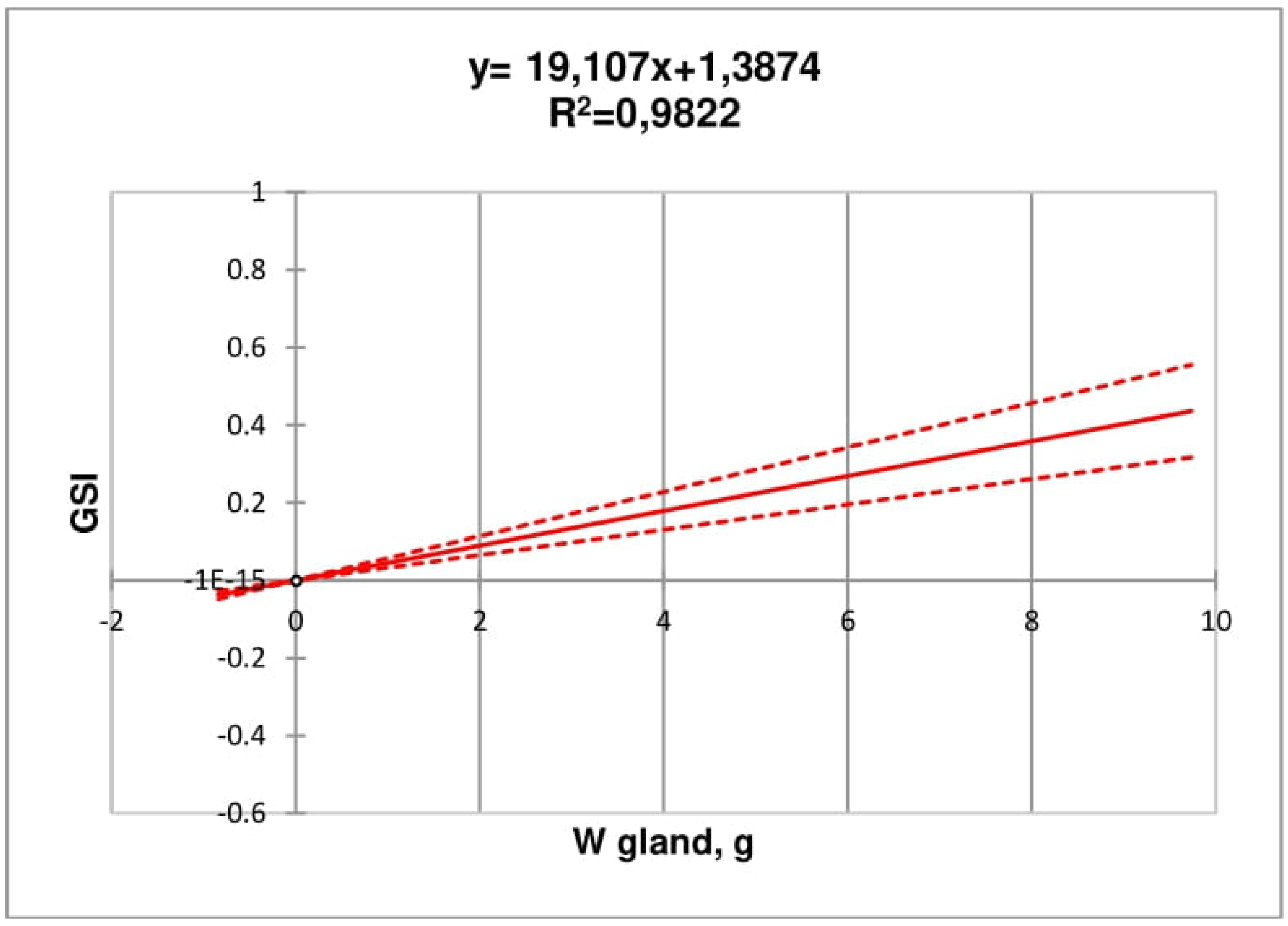

Figure. 3.9.1 Dependence of the weight of the gland on the gonadosomatic index (GSI).

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

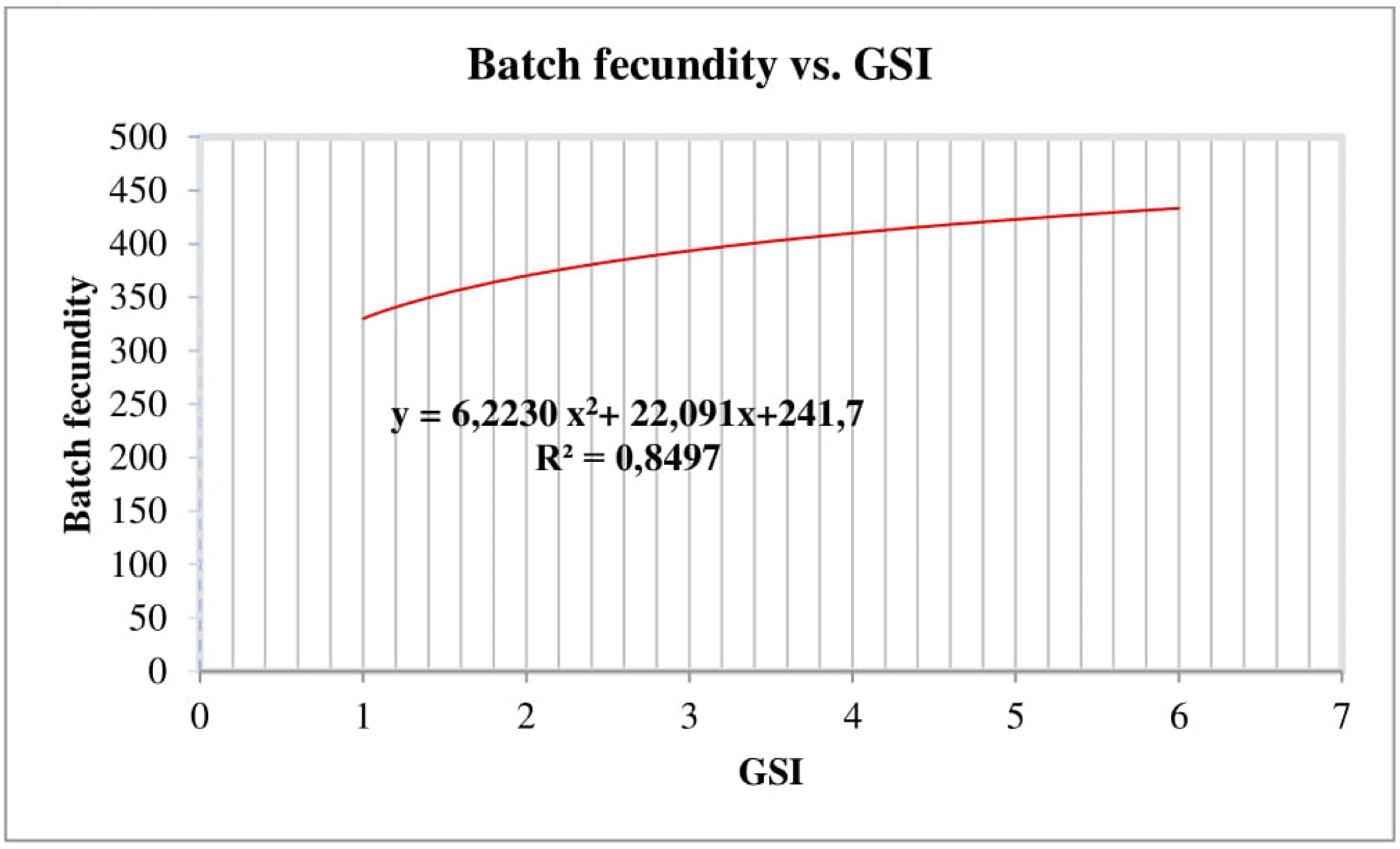

Figure 3.9.2 Batch fecundity vs. GSI for anchovy.

V.3.10 Sexual maturity

250 specimens have been assigned sexual maturity. All specimens studied showed a rate of running gonads **(V-III).** The beginning of the active breeding of the anchovy was registered in June. In June, we observed mass mature sex products in over 100% of the females studied.

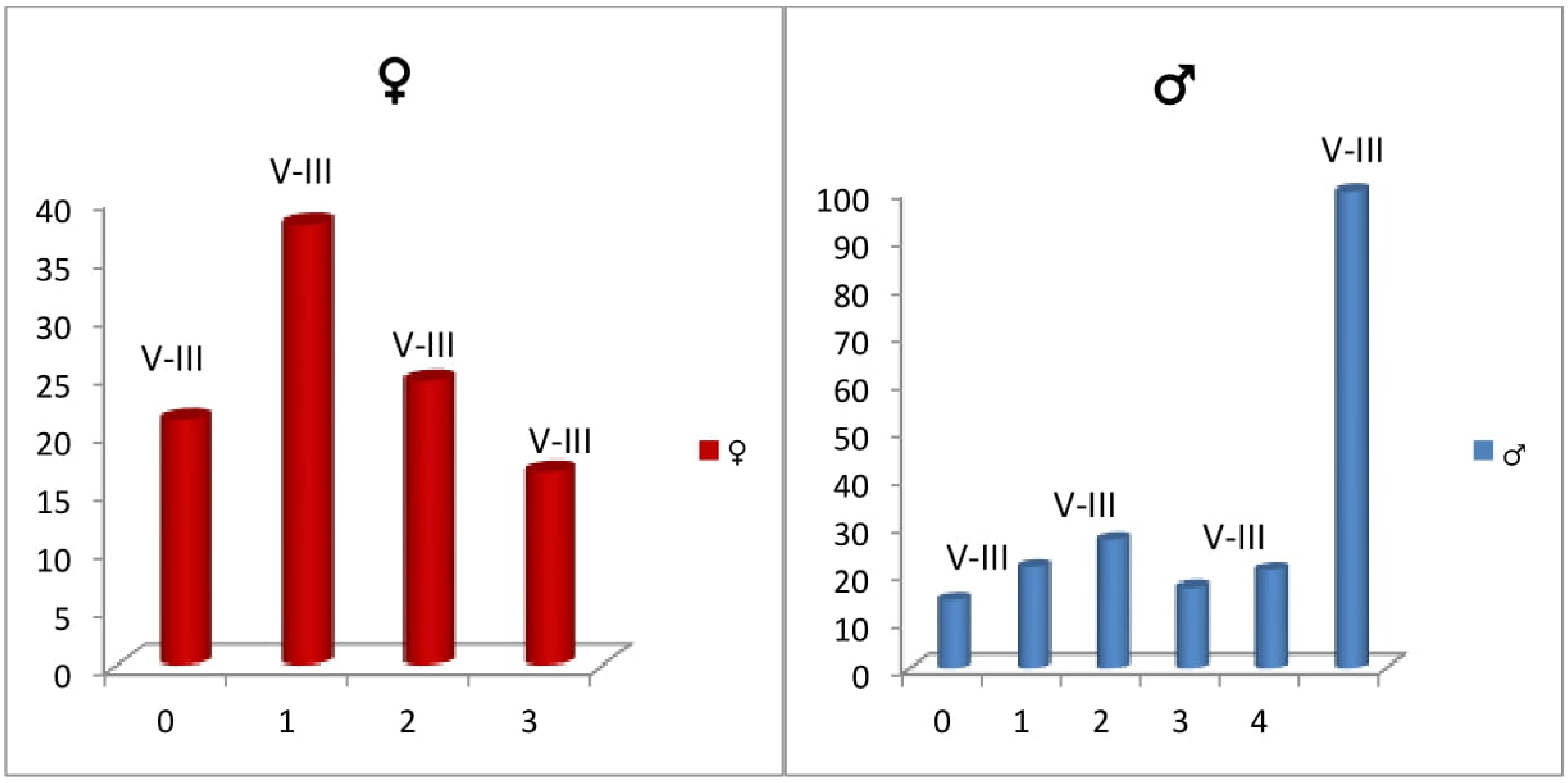

Figure 3.10.1 Sexual maturity by age of anchovies-female ♀ and male ♂.

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

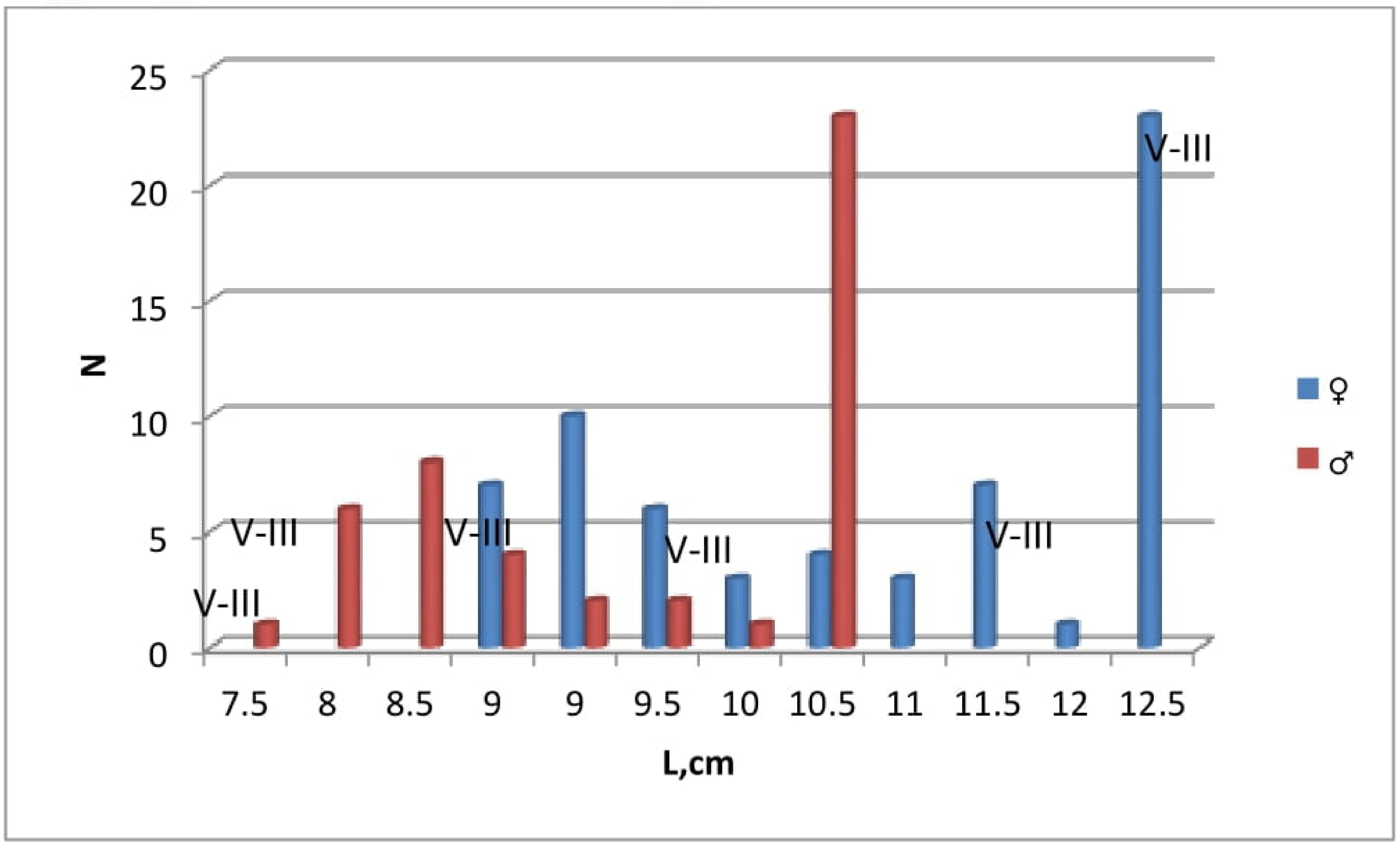

Figure 3.10.2 Sexual maturity by size of anchovies-female ♀ and male ♂.

V.3.11 Catch numbers and biomass by age and length

Monthly catches (in tons) together with mean weights of anchovy were used to derive the monthly catch numbers. The share (%) by age groups and catch numbers were used to create catch-at-age matrix for selected months by age groups **(Table 3.11.1).**

Table 3.11.1 Catch at age–(10^{-6}) matrix and biomass (kg) of anchovy for selected months.

Catch-at-Age *10^{-3} (in thousands)		
	1st quarter	**2nd quarter**
0	49,0042	0,7983
1	42,3820	0,6904
2	53,6397	0,8738
3	39,7331	0,6473
4	22,5154	0,3668
∑	**207,2744**	**3,3767**
Biomass (kg)		
Age groups	**1st quarter**	**2nd quarter**
0	130,3070	2,1228

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

1	204,1583	3,3259
2	259,2407	4,2232
3	298,3957	4,8611
4	232,5844	3,7890
∑	**1124,686**	**18,3220**

Monthly catches (in tons) together with mean weights of anchovy were used to derive the monthly catch numbers. The share (%) by length groups and catch numbers were used to create catch at length matrix for selected months by age groups **(Table 3.11.2).**

Table 3.11.2 Catch at length (10^{-6}) matrix and biomass (kg) of anchovy for selected months.

Catch at length $*10^{-3}$		
Length group (cm)	**1st quarter**	**2nd quarter**
6	3,973312	0,0647
6,5	10,595499	0,1726
7	17,879904	0,2913
7,5	16,555467	0,2697
8.0	21,853216	0,3560
8.5	13,906592	0,2265
9.0	29,79984	0,4855
9.5	23,177653	0,3776
10.0	23,839872	0,3884
10.5	8,6088427	0,1402
11.0	14,568811	0,2373
11.5	10,595499	0,1726
12.0	10,595499	0,1726
12.5	1,3244373	0,0216
∑	**207,2744**	**3,3767**
Biomass (kg)		
Length group (cm)	**1st quarter**	**2nd quarter**
6	7,3043	0,1190
6,5	22,5618	0,3675
7	47,3817	0,7719
7,5	53,0636	0,8644
8.0	80,5721	1,3126
8.5	57,6859	0,9397

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

9.0	145,9795	2,3781
9,5	129,5300	2,1101
10	155,5485	2,5340
10,5	65,0895	1,0604
11	127,3844	2,0752
11,5	101,3923	1,6518
12	114,7956	1,8701
12,5	16,3965	0,2671
∑	**1124,6857**	**18,3220**

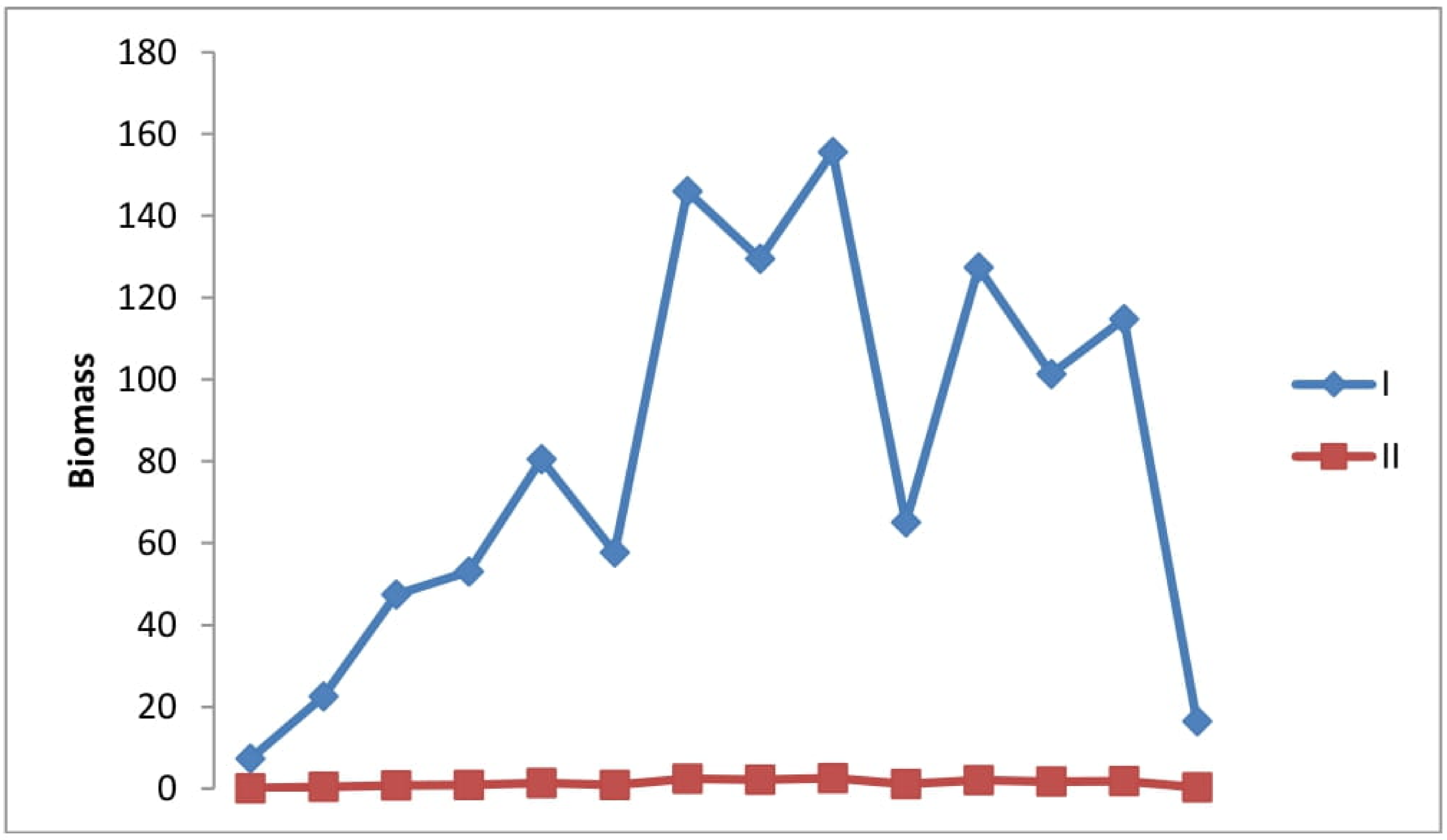

Figure 3.11.1 Biomass dynamics for 1st and 2nd quarter, 2021.

III.3.12 Coefficient of variation of length

na

III.3.13 Conclusions and recommendations

The analysis of the biological parameters of the anchovy makes it possible to draw the following **conclusions:**

1) The percentage participation (%) of the age groups in the 1th and 2th quarters shows the dominance of individual generations during the winter and spring months.

2) The age composition is made up of 4-5 age groups, with 5 - annual fish not found.

(3) Linear and weight dimensions reach significantly high values. It follows from the analysis that the increase in anchovy during the study period was allometric.

4) Conditioning data show that conditioning has higher values during the winter period (January).

5) Females (♀) prevailed by 64%, followed by male (♂) specimens by (36%) .

(6) The size structure shows that the average length values by age group vary across different limits during the study period. Average sizes by age group in January are smaller than in other months.

7) The dynamics of the gonadosomatic index during preparation and dirt indicates a characteristic rapid maturation of sex products.

8) January to March biomass of anchovy is higher, then in April-June decreases.

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VI. Biological monitoring of picked dogfish (*Squalus acanthias*) landings

VI.1 Objectives

The study examines the population structure of specimens caught by Bulgarian fishermen.

VI.2 Sampling

VI.2.1 Geographic area coverage

Shark specimens were measured and weighed on board fishing vessels.

VI.2.2 Sampling period

A total of **60 specimens** were collected and measured (length and weight) distribution and sex were determined.

Data	Harbor	F/V	Catch/kg
27.2.2021	Kavarna	KB5642	43
5.3.2021	Kavarna	AMBAR VN4496	80
13.4.2021	Nesebar	LEVANT Ns745	5

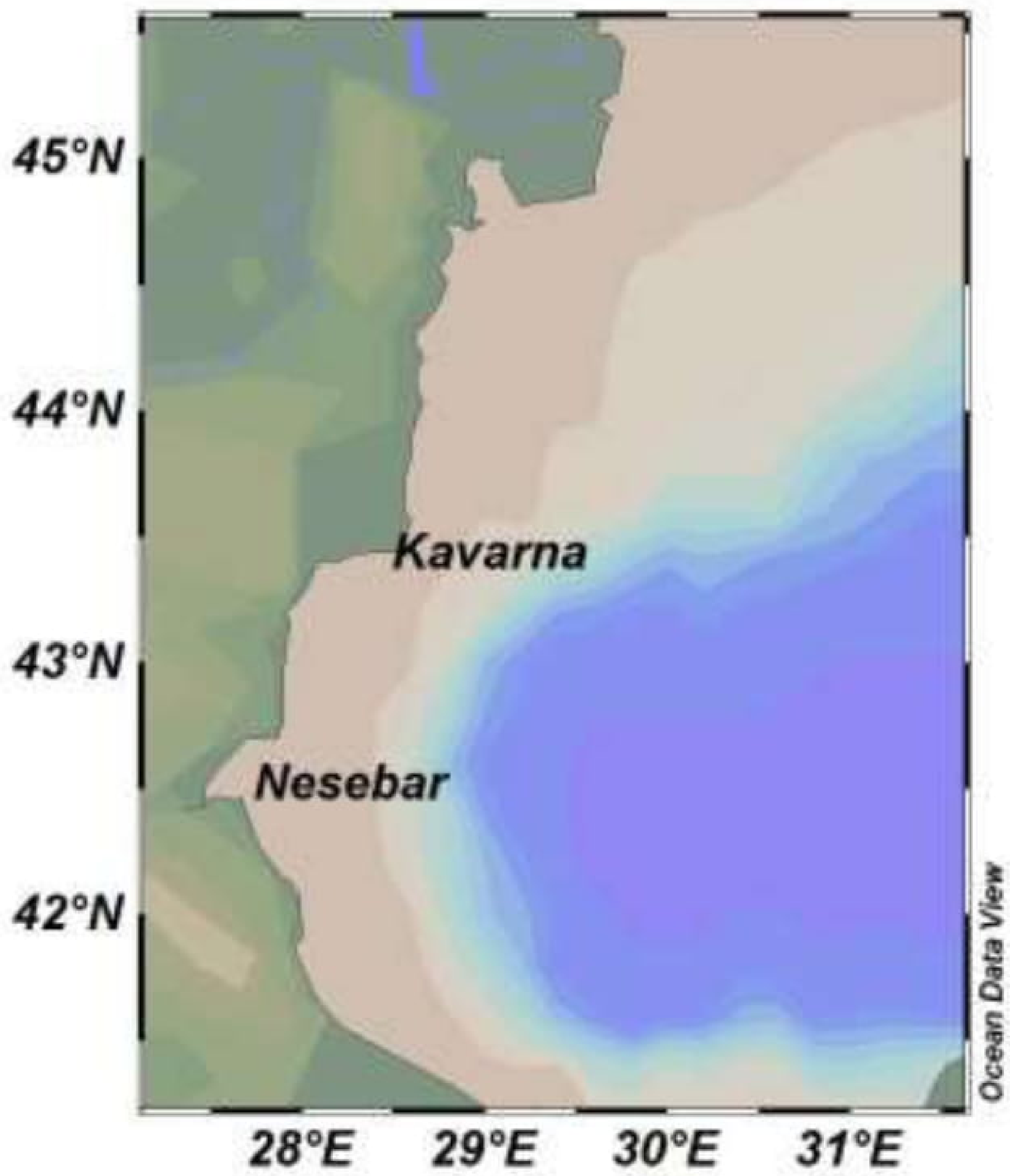


Figure 2.2.1 Sampling ports of picked dogfish.

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.", финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

VI.3. Landings statistics of spiny dogfish

Official statistics of the spiny dogfish targeted and by caught catches (tonnes) show the total absence in January 2021. The catches in February were 4.286 t, March-April decreased and the highest catches were recorded in May (7.7938). On the Fig. 3.1.is shown that the OTM by catch of spiny dogfish was observed only in June with 0.17 tonnes by catch.

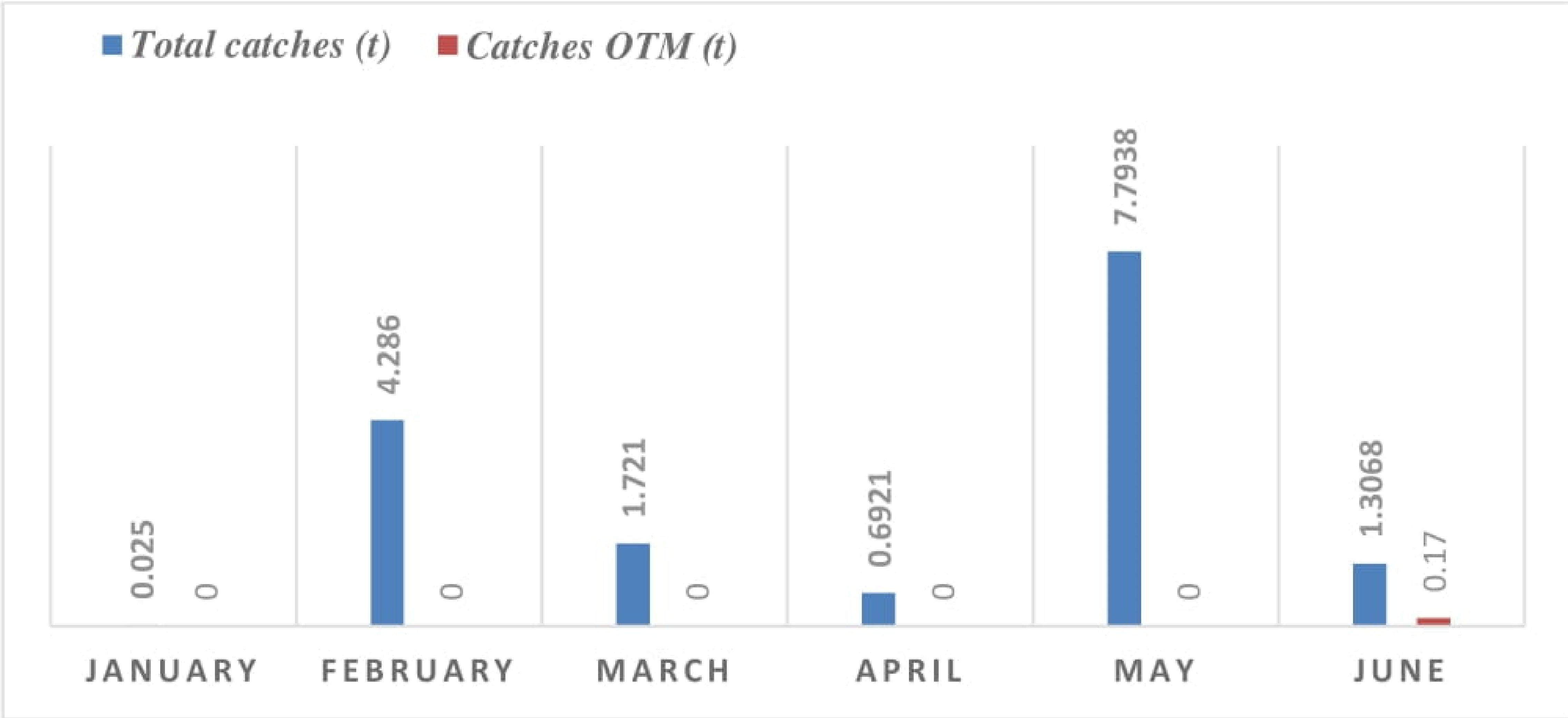


Fig. 3.1 Official statistics on shark catches in the period January - June 2021.

VI.4Results

VI.4.1 Size and weight structure

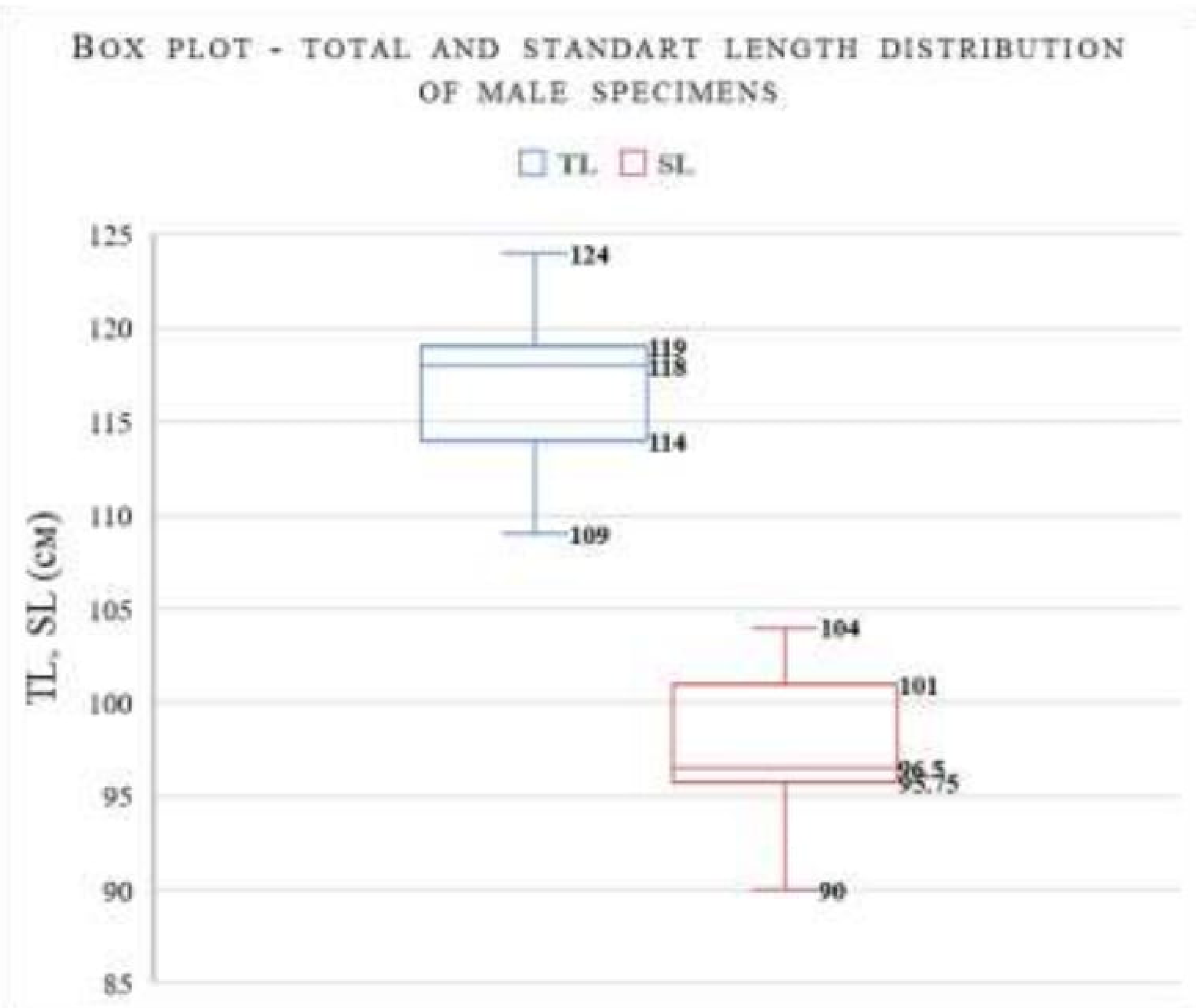


Figure 4.1.1 Box plot of total and standard length of picked dogfish (males).

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

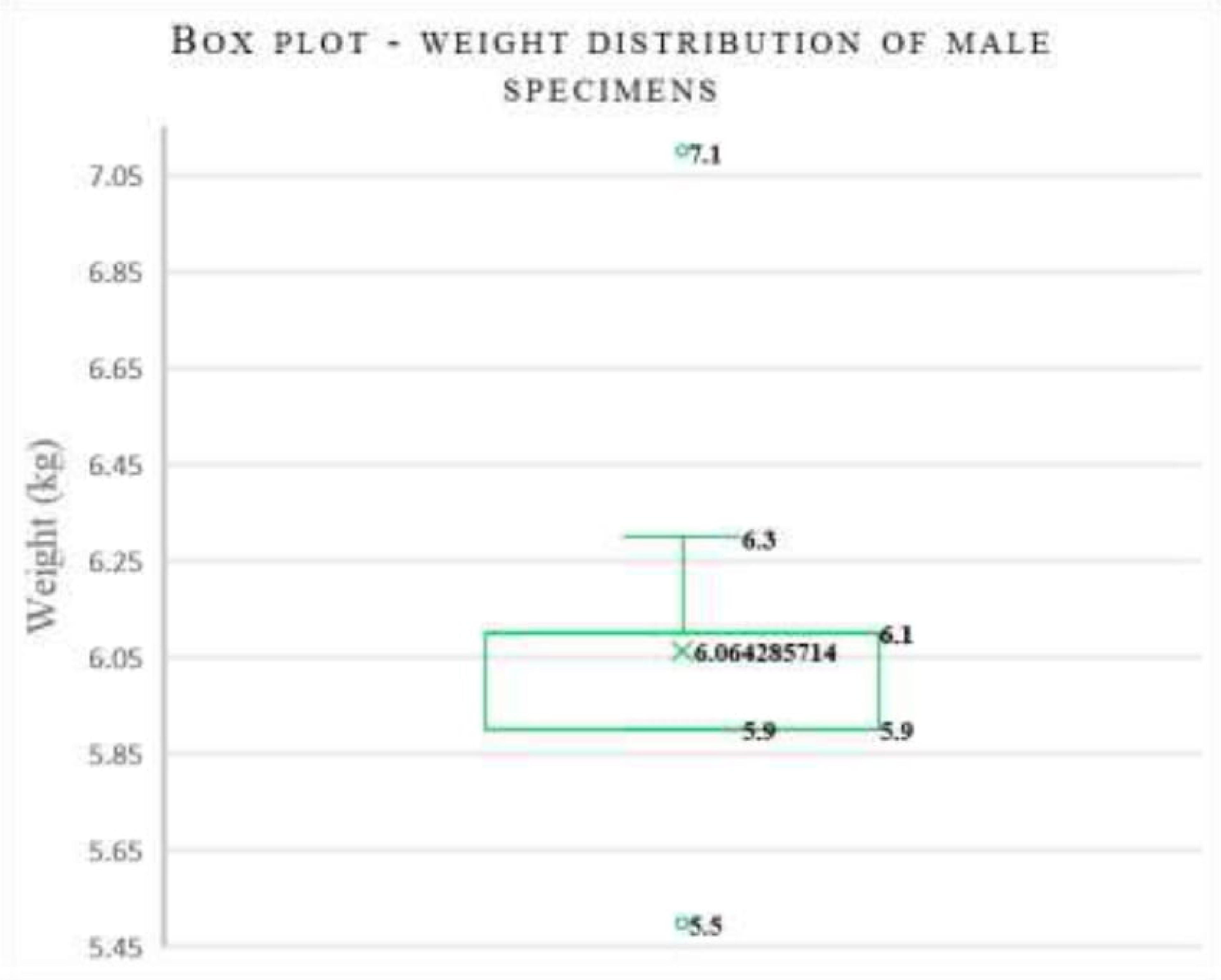


Figure 4.1.2 Box plot of weight of male picked dogfish (first 6 months of 2021).

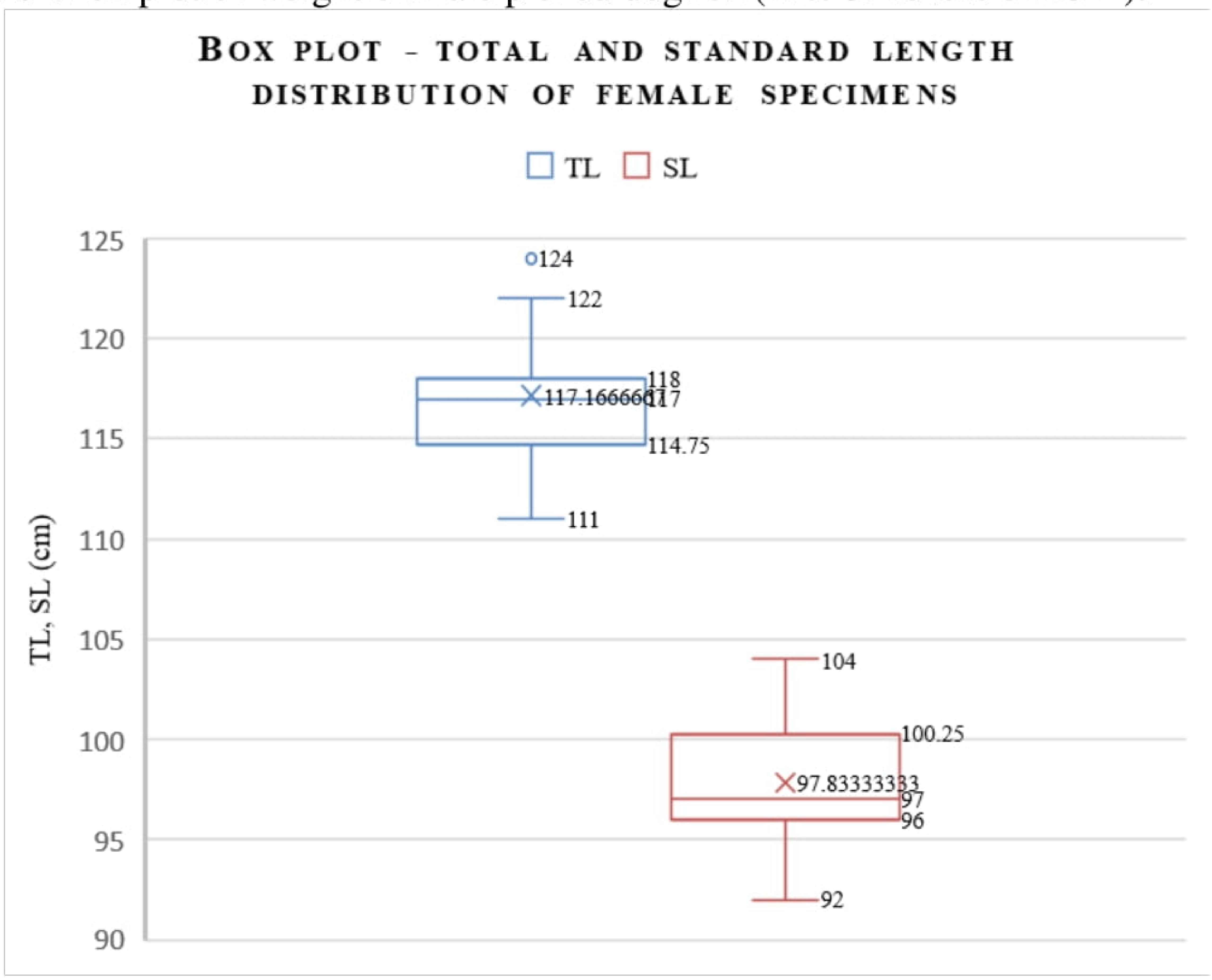


Figure 4.1.3 Box plot of total and standard length of picked dogfish (females,first 6 months of 2021).

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

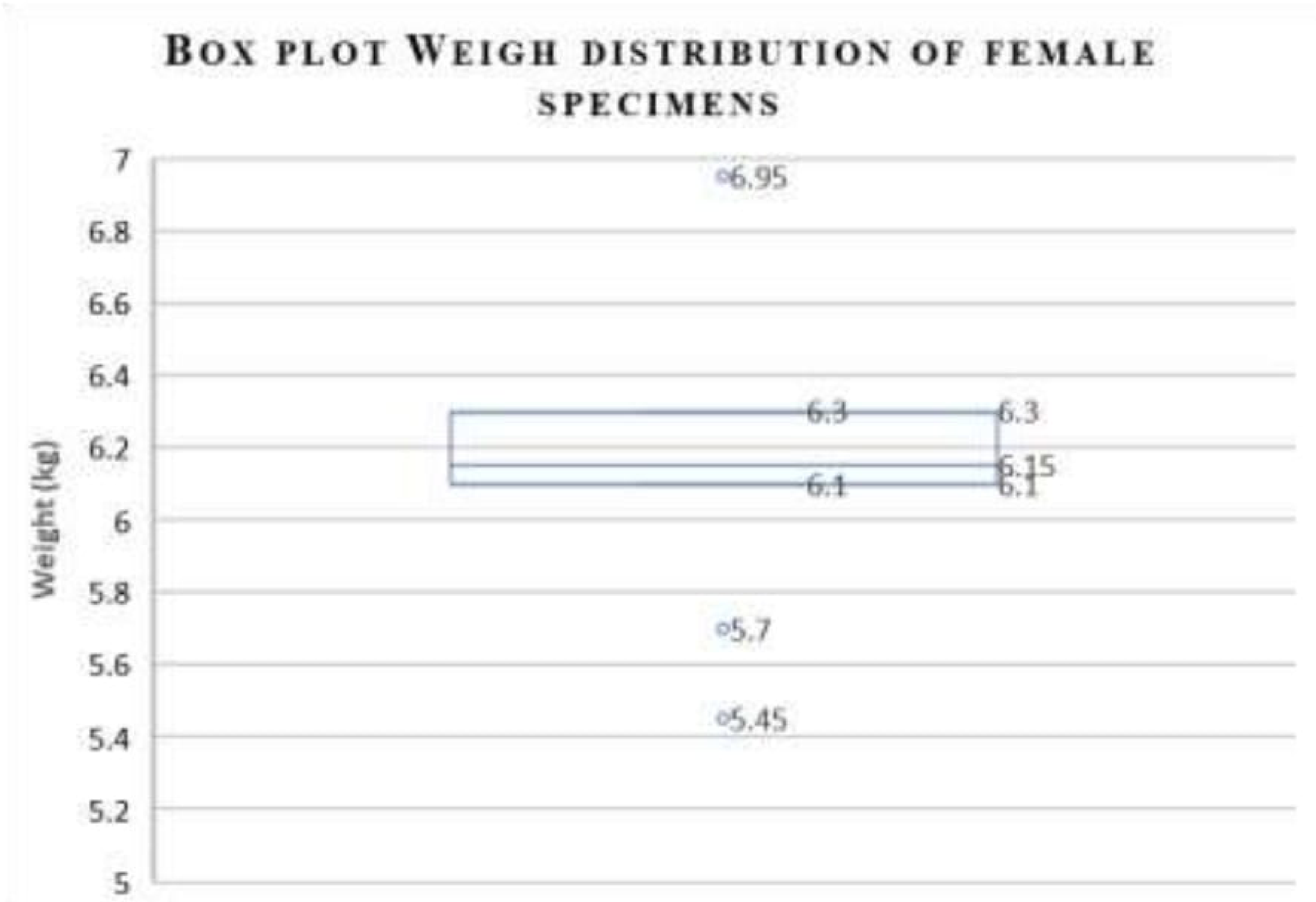
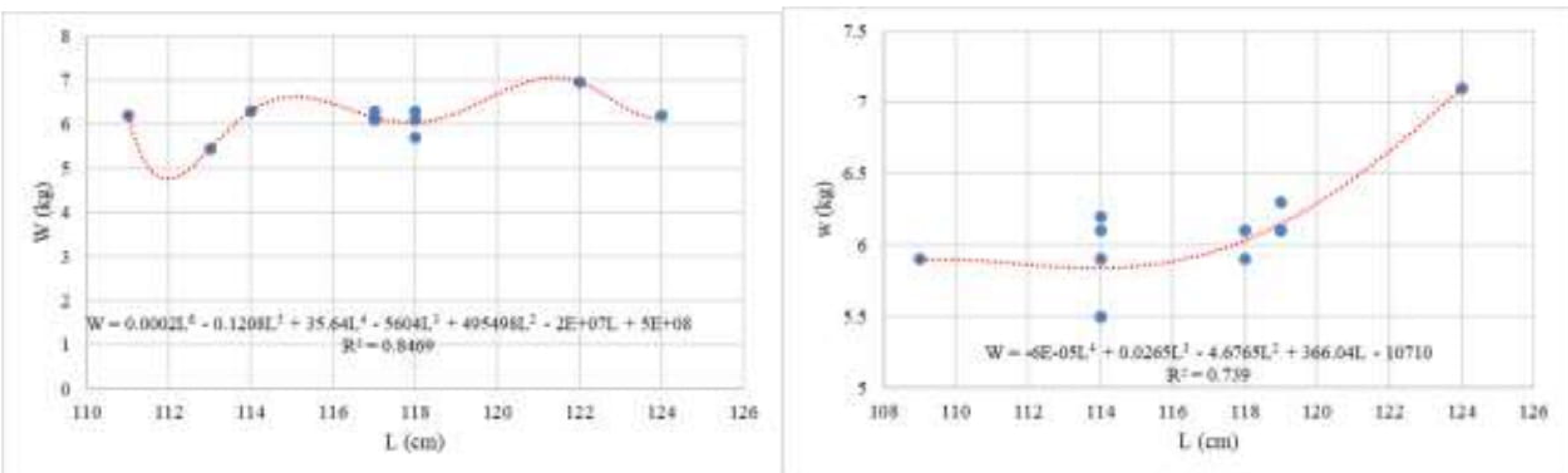


Figure 4.1.4 Box plot of weight of female picked dogfish (first 6 months of 2021).

The total length of the samples varies between 118-124 cm for males (Fig. 4.1.1) and 117.16-122 cm for females (Fig. 4.1.3), which shows that all of the studied specimens have reached sexual maturity (total length about 70 cm in females and about 85 cm in males). The weight of the studied specimens varies in the range 5.5-6.3 kg cm for males (Fig. 4.1.2) and 5.45-6.95 kg for females (Fig. 4.1.4) with close average values (6 kg for males and 6.15 kg for females). . The Fulton condition factor has slightly higher values for females (0.38) than the average value calculated for males (0.36).



a **b**

Figure 4.1.5 a. LWR of female specimens – 6th order polynomial relationship;
b. LWR of male specimens.

VI.4.2 Sex ratio and Fecundity

At 30 samples were used for maturity determined (January- June). During January-June, female specimens are sexually mature with apparent presence of embryos. The females were developed gonads, occupying a large part of the abdominal cavity, with a high degree of maturity.

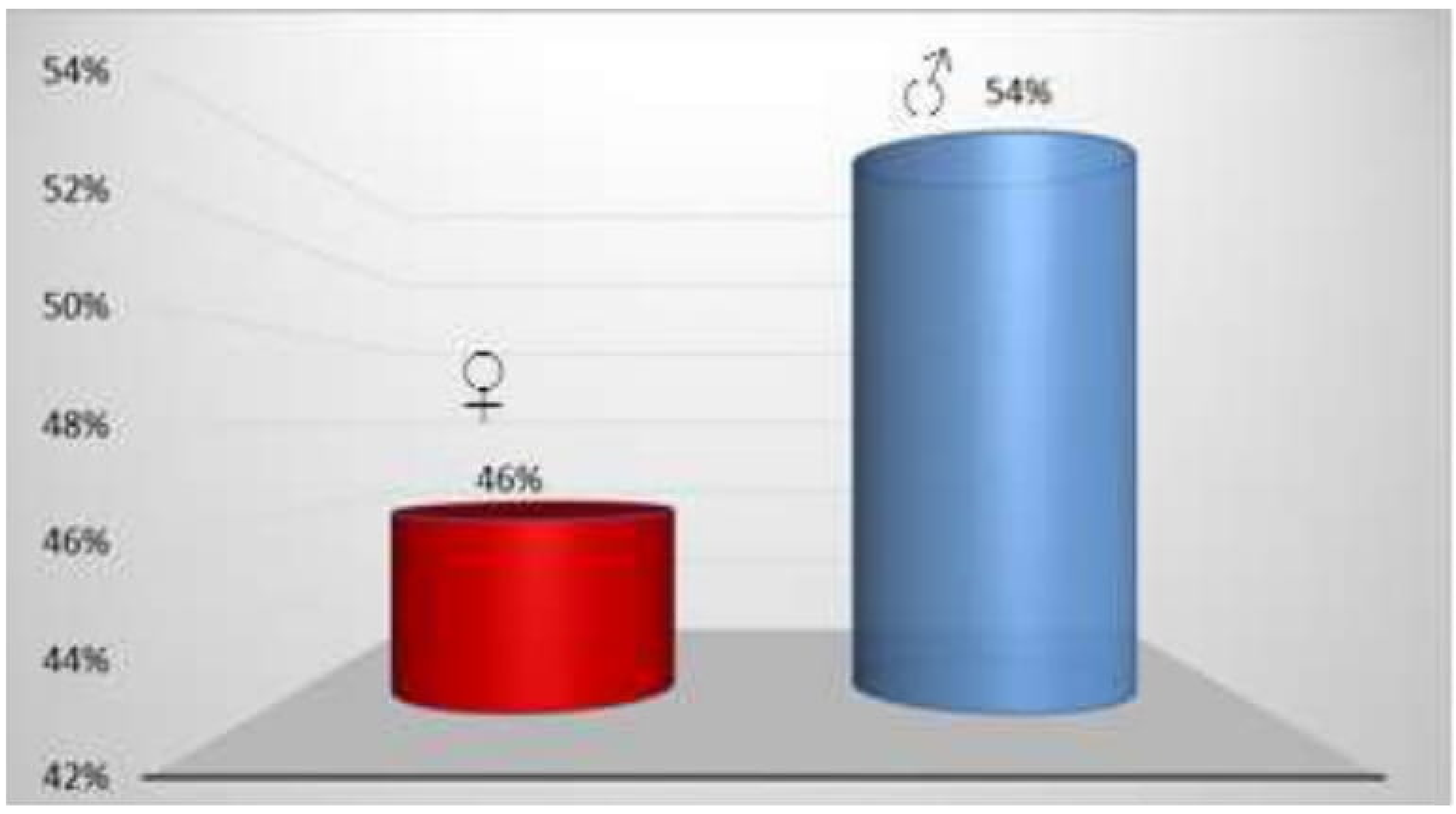


Fig.4.2.1 Sex ratio of Spiny dogfish.

VI. 4.3 Conclusions and recommendations

1) The catches of picked dogfish with OTM devices in the first 6 months of 2021 were insignificant and only in June.

2) The distribution of the total length of the Black Sea picked dogfish male -♂ in the first six months of 2021 varies within narrow limits: 100-109 cm.

3) The weight varies from 5.5 to 6.3 kg for males ♂.

4) The TL of the females varies from 111 to 124 cm (TL), which is indicative that the females have larger sizes in the observed samples.

5) The individual weights of the females ranged from 5.45 to 6.94 kg.

6) The L-W connection of females and males follows a complex polynomial connection.

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

7) In January-June, the females are sexually mature with visible embryos. The females had developed gonads, occupying a large part of the abdominal cavity, in a high degree of maturity.

VII.Feeding

VII.1 Feeding *of sprat* (*Sprattus sprattus*)

In the 1st and 2th quarters of 2021, 100% of the *Sprattus sprattus* stomachs analyzed turned out to be empty.

VII.2 Feeding of whiting *(Merlangius merlangus)*

In the 1st and 2th quarters of 2021, 100% of the *Merlangius merlangus* stomachs analyzed turned out to be empty.

VII.3 Food spectrum of horse mackerel(*Trachurus mediterraneus ponticus*)

In the 1st and 2th quarters of 2021, 100 % of the *Trachurus mediterraneus ponticus* stomachs analysed turned out to be empty.

VII.4 Food spectrum of red mullet (*Mullus barbatus*)

In the 1st and 2th quarters of 2021, 100% of the *M. barbatus* stomachs analyzed turned out to be empty.

VII.6 Food spectrum of anchovy (*Engraulis encrasicolus*)

In the 1st and 2th quarters of 2021, 100% of the *Engraulis encrasicolus* stomachs analyzed turned out to be empty.

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.", финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

VIII. Anex

Sprattus sprattus		
	Number of specimens from the study	**Number of specimens Contract 161/28/05/2018, EAFA/IO-BAS**
length	1024	1250
weight	1024	1250
age	250	1250
sex ratio	60	250
fecundity	60	500
sexual maturity	500	1000

Trachurus mediterraneus ponticus		
	Number of specimens from the study	**Number of specimens Contract 161/28/05/2018, EAFA/IO-BAS**
length	583	1500
weight	583	1500
age	400	500
sex ratio	250	250
fecundity	100	100

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

sexual maturity	250	250

Merlangius merlangus euxinus		
	Number of specimens from the study	**Number of specimens Contract 161/28/05/2018, EAFA/IO-BAS**
length	226	250
weight	226	250
age	226	250
sex ratio	100	100
fecundity	100	100
sexual maturity	100	100

Mullus barbatus		
	Number of specimens from the study	**Number of specimens Contract 161/28/05/2018, EAFA /IO-BAS**
length	320	500
weight	320	500
age	250	500
sex ratio	60	250
fecundity	60	100
sexual maturity	60	250

Engraulis encrasicolus		
	Number of specimens from the study	**Number of specimens Contract 161/28/05/2018, EAFA/IO-BAS**
length	313	500
weight	313	500

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство

age	313	500
sex ratio	250	250
fecundity	100	100
sexual maturity	250	250

Проект № BG14MFOP001-3.003-0002-C02, „Събиране, управление и използване на данни за целите на научния анализ и изпълнението на Общата политика в областта на рибарството за периода 2020-2021 г.“, финансиран от Програмата за морско дело и рибарство, съфинансирана от Европейския съюз чрез Европейския фонд за морско дело и рибарство