BIOLOGICAL MONITORING (BIOLOGICAL SAMPLES COLLECTION) OF THE LANDED RAPANA CATCH BY THE BULGARIAN FISHING FLEET

SCIENTIFIC REPORT FOR 1ST AND 2ND QUARTERS OF 2021

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МИНИСТЕРСТВО НА ЗЕМЕДЕЛИЕТО, ХРАНИТЕ И ГОРИТЕ

ПРОГРАМА ЗА МОРСКО ДЕЛО И РИБАРСТВО

This study is carried out by researchers from the Institute of Fish Resources – Varna, Agricultural Academy (AA), within Contract EAFA-Burgas/ D-199/10.12.2019 and is focused on the assessment of the quantity and biological parameters of *Rapana venosa* from the landed catch by the Bulgarian fishing fleet in 2021.

This research was done with the financial support from the European Commission in accordance with 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).

The current research is indicative for the first half of 2021 and shows the dynamics of the biological parameters of *Rapana venosa* from the landed catch at Sozopol, Nesebar and Kavarna ports, based on the biometric measurements and analysis of 600 specimens of the target species.

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Petrova E., Mihneva V., Tserkova F., Stoykov S., Valchev S., Penchev Ph., 2021. BIOLOGICAL MONITORING (BIOLOGICAL SAMPLES COLLECTION) OF THE LANDED RAPANA CATCH BY THE BULGARIAN FISHING FLEET FOR 1st and 2nd QUARTERS OF 2021, Report under Contract with the Executive Agency for Fisheries and Aquaculture, National Fisheries Data Collection Program 2021, p. 47.

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1. INTRODUCTION

The current report is representative for the first half of 2021 and is based on biometric measurements on 600 specimens of *R. venosa*. The report presents data and analyzes on the biological characteristics of the target species - quantities, size-weight composition, linear-weight relationships and sex structure according to data from landings at three ports – Sozopol, Nesebar and Kavarna.

1.1. COLLECTED DATA

The current study allowed the collection of several types of data:

1. Data about the fishing vessels' activity
- Fish expedition data
- Departure port
- Arrival port
- Fishing vessel name
- Vessel length (m)

2. Fishing gear
- Depth scale of the fishing activities

3. Basic biological data
- Total weight of the target species, landed at a port
- Number of collected individuals in the biological sample
- Total weight of the individuals (Total weight, weight with shell (TW, g)
- Shell length of the individuals (Shell length, SL, mm),
- Shell width of the individuals (Wd, mm)
- Aperture shell length of the individuals (Aperture length, AL, mm).

4. Additional biological data
- Sex ratio, sex maturity of collected individuals and gonadosomatic index (when applicable);
- Size and weight structure by sex, sex ratio to shell length and sex ratio to total weight;

The final results are presented in the form of tables and figures with data about:

- Landings of the target species at ports
- Biological parameters of *Rapana venosa* – lenghts, weight, length-weight relationships, sex structure from the samples of the observed ports.

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2. MATERIAL AND METHODOLOGY

2.1. SAMPLING SCHEME

The collection of biological samples (based on 600 specimens of *Rapana venosa*) was carried out by landings in ports, as the samples are collected from three ports - in the northern and southern marine waters, with intensive catching of Rapa whelk. The main ports for sampling include - Sozopol, Nessebar and Kavarna.

The Rapana fishery is limited in the first quarter of the year, as the mollusks spend the adverse winter conditions by burying themselves in the bottom substrate. During this period of the year, the fishing days for rapa whelk are few in number, therefore only two samples were collected in March 2021. During the period IV - VI.2021, the rapana fishery becomes more intensive, therefore the survey covers five days from this interval, and the collected information is summarized in Table 1.

Table 1.

Vessels and ports, where biological samples were taken from *Rapana venosa* landings

Date	Reg.No of fishing vessel	Length of the vessel, Technical specifications	Departure port	Arrival port	Fishing method
10.03.2021	C3 124	5.6 m	Sozopol	Sozopol	Scuba diving
30.03.2021	HC 1122	7.55 m	Nesebar	Nesebar	Scuba diving
21.04.2021	BH 8311	14.95 m	Kavarna	Kavarna	Beam trawls
26.05.2021	BH 8186	14.90 m	Kavarna	Kavarna	Beam trawls
27.05.2021	BH 8406	14.52 m	Kavarna	Kavarna	Beam trawls
28.05.2021	BH 8311	14.95 m	Kavarna	Kavarna	Beam trawls

The beam-trawl has the following parameters – maximum width - 5.3 m, maximum depth - 6 м: vertical opening - 280 mm; horizontal opening between the rails - 5 m; effective part of the upper collar - 4.8 m; trawling velocity - 3 - 3.6 Nd; trawling duration 60 - 80 mins.

In March 2021, the samples were collected by a scuba diving method, this method is selective and includes the collection of large specimens, therefore in the summaries, there is a distinction between the data collected by the two methods.

2.2. SAMPLE ANALYSIS

Random samples of *R. venosa* were taken from the landings by ports with the purpose to monitor the dynamics and species characteristics during the active fishing season.

The accuracy of the program for sample collection is based on the following documents:

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- "Report of the Workshop on Sampling and Calculation Methodology for Fisheries Data" (WKSCMFD) (ICES 2004):
https://www.ices.dk/sites/pub/CM%20Doccuments/2004/ACFM/ACFM1204.pdf
- Report SGPIDS (ICES, 2011a):
https://www.ices.dk/community/Documents/PGCCDBS/SGPIDS%202111.pdf
- Report of the Study Group on Practical Implementation of Discard Samples (SGPIDS) 2013:
https://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/acom/2013/SGPIDS/SGPIDS13.1.pdf

2.3. LABORATORY ANALYSIS

- For each individual, the following biometric parameters were measured – total weight of the individual (total weight, weight with shell, TW, g), body weight (body weight, weight w/o shell, BW, g), shell length (shell length, SL, mm), shell width (Wd, mm) and aperture length (aperture length, AL, mm);
- The relationships for the individual biometric parameters to each of the other biometric parameters were calculated.;
- The sex ratio and the gonadosomatic index were determined, as well as the sexual maturity of the collected individuals (if applicable);
- The length - weight structure by sex, the ratio of the sexes to the shell length and to the weight of the specimens were determined.

2.4. ANALYTICAL METHODS

The morphometric relationships between the biological parameters - total weight (TW), shell length (SL), shell width (Wd), aperture length (AL) were analyzed on the basis of classical allometric models. The least squares method was used to estimate the linear - weight relationships (**LWR**), based on the following equation:

$W = a \times L^b$, where, W – weight; L – length; a, b – constants.

The gonadosomatic index (**GSI**) is determined by the mass of the gonads as a proportion of total body weight. It is presented with the formula:

GSI = [gonad weight / body weight] × 100.

The XLSTAT software product was used to display the linear-weight histograms of the samples from the *Rapana* landings. The statistical data about the different length and weight classes, presented in the histograms, include lower and upper limits, frequency, relative frequency, and density.

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When estimating the percentage difference between two values, a and b, the used formula was = |Absolute difference between the two values/Average of both the values| × 100 %

3. Results

3.1. Biometric measuremetns and length-weight relationships

3.1.1.Port Sozopol, 10.03.2021

The sample includes 100 individuals *Rapana*, weighing 4,168 kg, from a total of 120 kg of rapa whelk landed at the port of Sozopol.

The mean weight of the measured specimens reached 41.68 g ± 9.12 SD, with an average length of 60.38 mm ± 4.95 SD, a shell width of 43.66 mm ± 3.54 SD and an aperture length of 40.71 ± 3.44 SD. Body weight (BW, g) is averaged at 12.99 g ± 3.70 SD and formed 29.57% ± 3.65 SD of total weight, ranging between 20.93 and 36.17% of the total weight (Table 2).

Table 2

Summarized statistics about the measured biological parameters - total weight (TW - weight with shell, TW, g), body weight (BW, g), % of BW from TW, shell length (shell length, SL, mm), shell width (Wd, mm) and aperture length (AL, mm) for the sample from the port Sozopol, 10.03.2021.

	TW, g	BW, g	% BW from TW	SL, mm	Wd, mm	AL, mm
Mean	41.68	12.99	29.57	60.38	43.66	40.71
Standard Error	0.91	0.52	0.52	0.50	0.35	0.34
Median	40.15	12.20	29.66	60.00	43.50	41.00
Mode	40.00	10.46	#N/A	58.00	44.00	41.00
Standard Deviation	9.12	3.70	3.65	4.95	3.54	3.44
Sample Variance	83.26	13.70	13.36	24.54	12.55	11.80
Kurtosis	1.43	-0.36	-0.69	0.01	0.06	0.15
Skewness	0.93	0.60	-0.12	0.40	0.38	0.44
Range	50.94	14.86	15.24	25.00	18.00	17.00
Minimum	21.51	7.41	20.93	50.00	35.00	33.00
Maximum	72.45	22.27	36.17	75.00	53.00	50.00
Sum	4167.94	649.34	1478.41	6038.00	4366.00	4071.00
Count	100.00	50.00	50.00	100.00	100.00	100.00
Confidence Level (95.0%)	1.81	1.05	1.04	0.98	0.70	0.68

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The most common length classes are - 46 - 66 mm (85% of the measured specimens). In terms of the weight composition, the following classes dominate: 25.6 - 51.2 g (87 % of all measured specimens).

The mean ratio - width (Wd, mm)/length (SL, mm) amounts to 72.39% ± 3.24 SD, and AL/SL (%) amounts to 67.48% ± 3.01 SD, while for the ratio AL/Wd (%), the obtained average value is 93.23% ± 1.57 SD (Table 3).

Table 3

Percentage ratios between shell width and length (Wd/SL, %), aperture length/total shell length (AL/SL, %) and aperture length/total shell width (AL/Wd, %) of the individuals from the sample from port Sozopol, 10.03.2021

	Wd/SL (%)	AL/SL (%)	AL/Wd (%)
Mean	72.39	67.48	93.23
Standard Error	0.32	0.30	0.16
Median	72.36	67.24	93.10
Mode	73.33	66.67	93.18
Standard Deviation	3.24	3.01	1.57
Sample Variance	10.52	9.07	2.47
Kurtosis	1.19	1.17	0.92
Skewness	0.14	0.24	0.35
Range	20.01	18.71	8.35
Minimum	62.69	58.21	89.47
Maximum	82.69	76.92	97.83
Sum	7238.55	6747.68	9323.27
Count	100.00	100.00	100.00
Confidence Level (95.0%)	0.64	0.60	0.31

The L-W relationships are estimated (Fig.1). The parameters *a, b* of the linear-weight relationships and the values of the correlation coefficient R^2 are presented in Table 4.

Table 4

Parameters a, b of L-W relationships and value of R^2 for the sample from port Sozopol, 10.03.2021.

Parameters	$TW(g) = a.SL(mm)^b$	$TW(g) = a.Wd(mm)^b$	$W(g) = a.AL(mm)^b$
a	0.0051	0.006	0.0095
b	2.19	2.34	2.25

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R^2	0.75	0.80	0.81

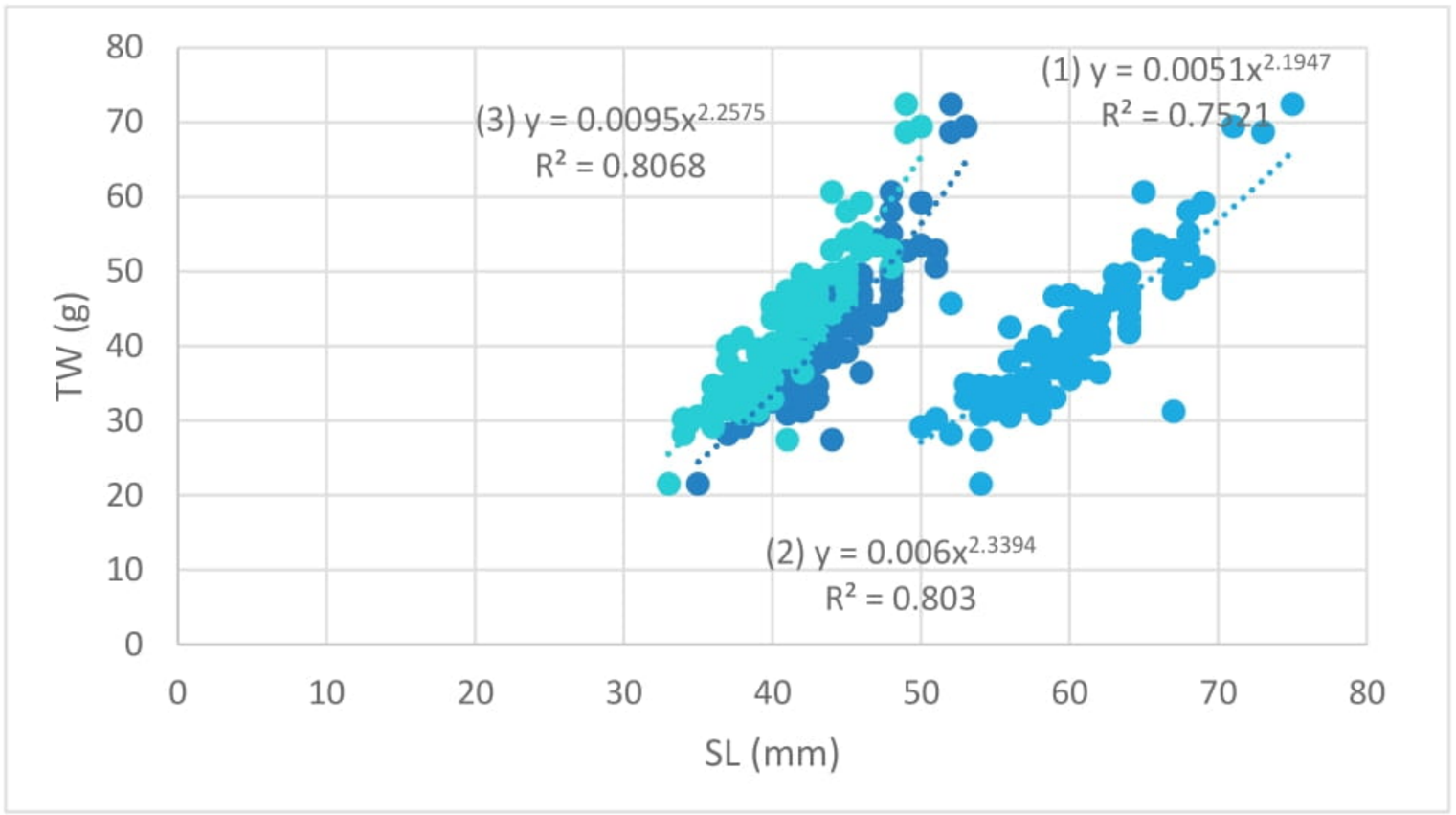

Figure 1. LWR for *Rapana venosa* sample from the port Sozopol, 10.03.2021: (1) LWR between total weight (TW, g) and linear size (SL, mm); (2) LWR of total weight (TW, g) and shell width (Wd, mm); and (3) LWR of total weight (TW, g) and aperture length (AL, mm)

3.1.2. Port Nesebar, 29.03.2021

The sample includes 100 specimens of *Rapana*, weighing 4,320 kg, from a total of 43 kg of rapa whelk, landed at the port of Nessebar (from the investigated fishing vessel).

The mean weight of the measured specimens was 43.20 g ± 8.45 SD, with an average length of 60.81 mm ± 5.15 SD, a shell width of 43.76 mm ± 3.46 SD and an aperture length of 40.89 ± 3.34 SD. The body weight (BW, g) averaged at 12.67 g ± 3.60 SD and formed 29.93% ± 4.05 SD of total weight, ranging between 16.22 and 36.71% of total weight (Table 5).

Table 5

Summarized statistics about the measured biological parameters - total weight (TW - weight with shell, TW, g), body weight (BW, g), % of BW from TW, shell length (shell length, SL, mm), shell width (Wd, mm) and aperture length (AL, mm) for the sample from the port Nesebar, 29.03.2021.

	TW,g	**BW, g**	**% BW from TW**	**SL, mm**	**Wd, mm**	**AL, mm**
Mean	43.20	12.67	29.93	60.81	43.76	40.89
Standard Error	0.85	0.51	0.57	0.52	0.35	0.33

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Median	41.95	12.54	30.69	61.00	44.00	41.00
Mode	39.99	8.10	#N/A	65.00	46.00	42.00
Standard Deviation	8.45	3.60	4.05	5.18	3.46	3.34
Sample Variance	71.43	12.96	16.38	26.82	11.94	11.17
Kurtosis	-0.83	-0.34	1.46	-0.96	-0.42	-0.49
Skewness	0.34	0.41	-0.91	-0.05	0.23	0.14
Range	33.15	14.90	20.49	21.00	16.00	15.00
Minimum	28.42	6.68	16.22	50.00	36.00	34.00
Maximum	61.57	21.58	36.71	71.00	52.00	49.00
Sum	4320.16	633.32	1496.61	6081.00	4376.00	4089.00
Count	100.00	50.00	50.00	100.00	100.00	100.00
Confidence Level (95.0%)	1.68	1.02	1.15	1.03	0.69	0.66

The most common length classes are 46 - 66 mm (83 % of the measured specimens). In regard to the weight structure (TW, g), the following classes dominate: 25.6 - 51.2 g (83 % of all measured specimens).

The mean ratio - width (Wd, mm) / length (SL, mm) amounts to 72.09% ± 3.74 SD, and AL/SL (%) amounts to 67.35% ± 3.52 SD, while the ratio AL / Wd (%), e obtained average value - 93.43% ± 1.55 SD (Table 6).

Table 6

Percentage ratios between shell width and length (Wd/SL, %), aperture length/total shell length (AL/SL, %) and aperture length/total shell width (AL/Wd, %) for the sample from port Nesebar, 29.03.2021

	Wd/SL (%)	**AL/SL (%)**	**AL/Wd (%)**
Mean	72.09	67.35	93.43
Standard Error	0.37	0.35	0.16
Median	71.54	66.67	93.33
Mode	71.43	66.67	92.68
Standard Deviation	3.74	3.52	1.55
Sample Variance	14.01	12.42	2.42
Kurtosis	5.87	4.60	0.09
Skewness	1.79	1.64	0.11
Range	24.94	22.15	8.03
Minimum	65.63	60.87	89.74
Maximum	90.57	83.02	97.78
Sum	7209.29	6735.06	9343.24

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Count	100.00	100.00	100.00
Confidence Level (95.0%)	0.74	0.70	0.31

The L-W relationships are estimated (Fig.2). The parameters a, b of the linear-weight relationships and the values of the correlation coefficient R^2 are presented in Table 7.

Table 7

Parameters a, b of L-W relationships and value of R^2 for the sample from port Nesebar, 29.03.2021.

Parameters	$\mathbf{TW(g) = a.SL(mm)^b}$	$\mathbf{TW(g) = a.Wd(mm)^b}$	$\mathbf{W(g) = a.AL(mm)^b}$
a	0.0209	0.0086	0.015
b	1.86	2.25	2.14
R2	0.68	0.83	0.81

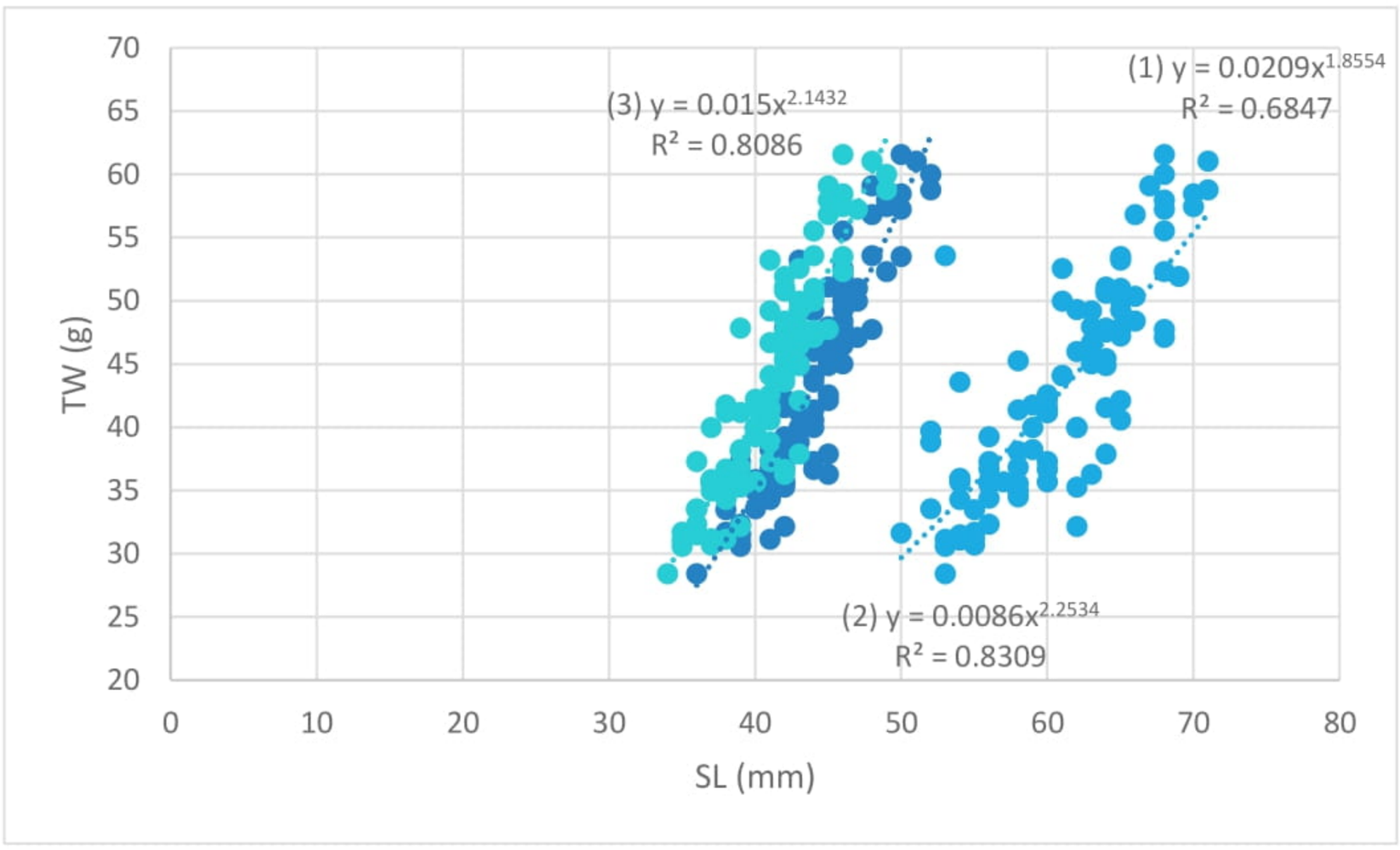

Figure 2. LWR for *Rapana venosa* sample from the port Nesebar, 29.03.2021: (1) LWR between total weight (TW, g) and linear size (SL, mm); (2) LWR of total weight (TW, g) and shell width (Wd, mm); and (3) LWR of total weight (TW, g) and aperture length (AL, mm)

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3.1.3. Port Kavarna, 21.04.2021

The sample includes 100 individuals Rapana (collected by beam trawl), weighing 2,681 kg, from a total of 2047 kg of rapa whelk, landed at the port of Kavarna (from the investigated fishing vessel).

The mean weight of the measured specimens was 26.81 g ± 10.58 SD, with an average length of 52.42 mm ± 6.20 SD, a shell width of 39.03 mm ± 5.34 SD and an aperture length of 36.47 ± 5.04 SD. The body weight (BW, g) averaged 10.57 g ± 3.23 SD and formed 41.24% ± 3.99 SD of total weight, ranging between 25.58 and 47.54% of the total weight (Table 8).

Table 8

Summarized statistics about the measured biological parameters - total weight (TW - weight with shell, TW, g), body weight (BW, g), % of BW from TW, shell length (shell length, SL, mm), shell width (Wd, mm) and aperture length (aperture length, AL, mm) for the sample from the port Kavarna, 21.04.2021.

	TW,g	BW, g	% BW from TW	SL, mm	Wd, mm	AL, mm
Mean	26.81	10.57	41.24	52.42	39.03	36.47
Standard Error	1.06	0.46	0.56	0.62	0.53	0.50
Median	25.49	10.58	42.22	52.00	38.00	36.00
Mode	#N/A	#N/A	#N/A	52.00	39.00	35.00
Standard Deviation	10.58	3.23	3.99	6.20	5.34	5.04
Sample Variance	111.97	10.41	15.92	38.45	28.51	25.44
Kurtosis	6.27	-0.18	4.40	2.96	1.48	1.46
Skewness	2.07	0.52	-1.73	0.99	0.92	1.01
Range	63.30	13.43	21.96	41.00	30.00	27.00
Minimum	10.62	5.48	25.58	36.00	27.00	26.00
Maximum	73.92	18.91	47.54	77.00	57.00	53.00
Sum	2681.11	528.74	2061.90	5242.00	3903.00	3647.00
Count	100.00	50.00	50.00	100.00	100.00	100.00
Confidence Level (95.0%)	2.10	0.92	1.13	1.23	1.06	1.00

The most common size classes are 46 - 66 mm (89 % of the measured specimens). In terms of the weight structure, the following classes dominate <51.2 g (96% of all measured specimens).

The mean ratio of shell width (Wd, mm)/length (SL, mm) was 74.38% ± 3.66 SD, and the AL/ SL (%) ratio was 69.50% ± 3.63 SD, while for ratio of AL/ Wd (%) was obtained an average value of 93.45 % ± 1.87 SD (Table 9).

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Table 9

Percentage ratios between shell width and length (Wd/SL, %), aperture length/total shell length (AL/SL, %) and aperture length/shell width (AL/Wd, %) for the sampe from port Kavarna, 21.04.2021

	Wd/SL (%)	AL/SL (%)	AL/Wd (%)
Mean	74.38	69.50	93.45
Standard Error	0.37	0.36	0.19
Median	73.76	69.03	93.41
Mode	72.22	71.43	91.43
Standard Deviation	3.66	3.63	1.87
Sample Variance	13.39	13.16	3.48
Kurtosis	3.43	3.06	0.64
Skewness	1.29	1.25	0.33
Range	22.99	21.87	10.81
Minimum	67.39	62.75	89.19
Maximum	90.38	84.62	100.00
Sum	7437.94	6950.37	9344.98
Count	100.00	100.00	100.00
Confidence Level (95.0%)	0.73	0.72	0.37

The L-W relationships are estimated (Fig.3). The parameters a, b of the linear-weight relationships and the values of the correlation coefficient R^2 are presented in Table 10.

Table 10

Parameters a, b of L-W relationships and value of R^2 for the sample from port Kavarna, 21.04.2021.

Parameters	$\mathrm{T}\boldsymbol{W(g) = a.SL(mm)^b}$	$\mathrm{T}\boldsymbol{W(g) = a.Wd(mm)^b}$	$\boldsymbol{W(g) = a.AL(mm)^b}$
a	0.0004	0.0031	0.0038
b	2.78	2.46	2.46
R^2	0.89	0.88	0.89

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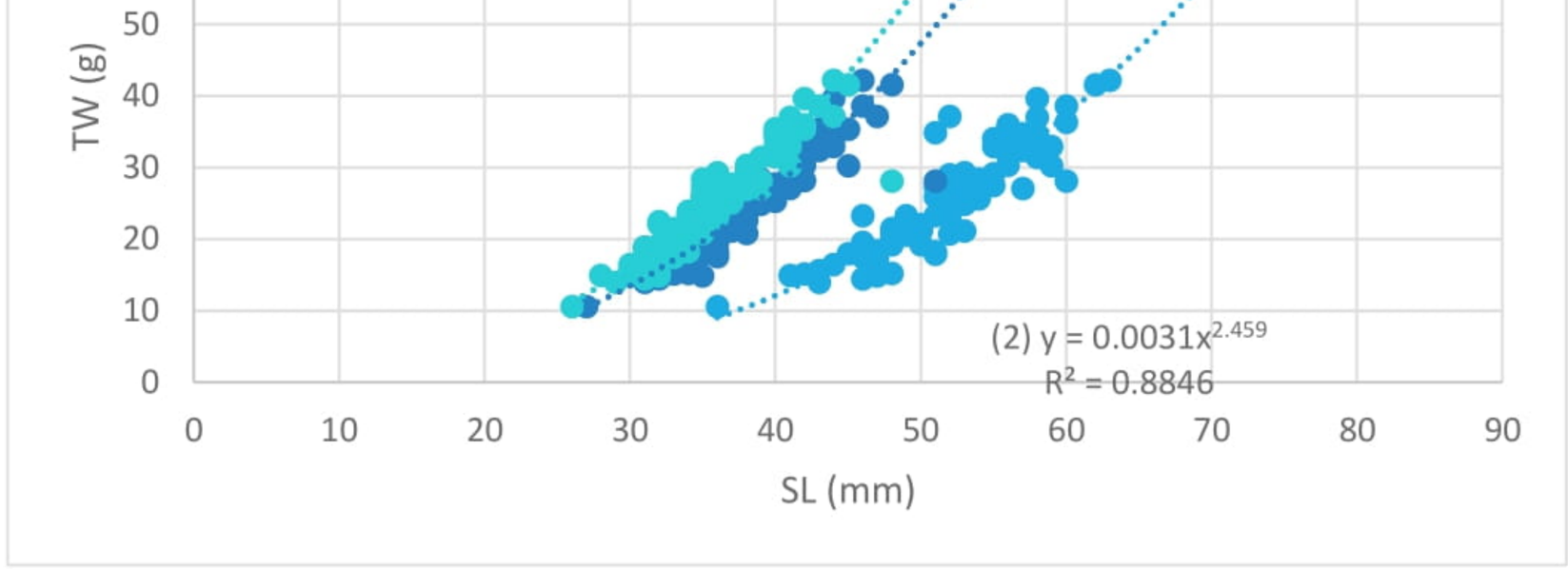

Figure 3. LWR for *Rapana venosa* sample from the port Kavarna, 21.04.2021: (1) LWR between total weight (TW, g) and linear size (SL, mm); (2) LWR of total weight (TW, g) and shell width (Wd, mm); and (3) LWR of total weight (TW, g) and aperture length (AL, mm)

3.1.4. Port Kavarna, 26.05.2021

The sample includes 100 *Rapana* specimens (collected by beam trawl), weighing 2,436 kg, from a total of 3905 kg rapa whelk, landed at the port of Kavarna (from the studied fishing vessel).

The mean weight of the measured specimens was 24.36 g ± 11.22 SD, with an average length of 50.79 mm ± 7.52 SD, a shell width of 37.85 mm ± 6.09 SD and an aperture length of 35.22 ± 5.89 SD. The body weight (BW, g) was averaged at 11.73 g ± 4.65 SD and formed 42.11% ± 6.63 SD of total weight, ranging between 31.42% and 81.10% of the total weight (Table 11).

Table 11

Summarized statistics about the measured biological parameters - total weight (TW - weight with shell, TW, g), body weight (BW, g), % of BW from TW, shell length (shell length, SL, mm), shell width (Wd, mm) and aperture length (aperture length, AL, mm) for the sample from the port Kavarna, 26.05.2021

	TW, g	BW, g	% BW from TW	SL, mm	Wd, mm	AL, mm
Mean	24.36	11.73	42.11	50.79	37.85	35.22
Standard Error	1.12	0.66	0.94	0.75	0.61	0.59
Median	22.35	10.81	41.62	50.00	38.00	35.00

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Mode	17.55	6.24	#N/A	51.00	39.00	36.00
Standard Deviation	11.22	4.65	6.63	7.52	6.09	5.89
Sample Variance	125.84	21.66	43.89	56.51	37.10	34.64
Kurtosis	7.37	2.08	24.85	1.40	1.64	2.04
Skewness	2.20	1.39	4.17	0.72	0.77	0.85
Range	68.04	21.25	49.68	42.00	35.00	35.00
Minimum	6.12	5.30	31.42	35.00	23.00	21.00
Maximum	74.16	26.55	81.10	77.00	58.00	56.00
Sum	2435.53	586.54	2105.57	5079.00	3785.00	3522.00
Count	100.00	50.00	50.00	100.00	100.00	100.00
Confidence Level (95.0%)	2.23	1.32	1.88	1.49	1.21	1.17

Specimens from length group - 46 - 56 mm have the most significant presence (55% of the measured specimens). In terms of weight groups, those weighing <25.6 g dominated (64% of all measured specimens).

The percentages of width (Wd, mm)/length (SL, mm) of the shells, aperture length (SL, mm)/total length (Wd, mm) of the shell and aperture length (AL, mm)/width (Wd, mm) are derived (Table 12).

Table 12

Percentage ratios between shell width and length (Wd/SL, %), aperture length/total shell length (AL/SL, %) and aperture length/total shell width (AL/Wd, %) for the sample from port Kavarna, 26.05.2021.

	Wd/SL (%)	AL/ SL (%)	AL/Wd (%)
Mean	74.44	69.21	92.99
Standard Error	0.29	0.29	0.19
Median	74.44	69.14	93.10
Mode	71.43	68.42	94.44
Standard Deviation	2.92	2.90	1.86
Sample Variance	8.50	8.41	3.47
Kurtosis	0.37	0.58	-0.33
Skewness	-0.23	-0.30	-0.25
Range	15.32	16.71	8.64
Minimum	65.71	60.00	88.24
Maximum	81.03	76.71	96.88
Sum	7443.84	6921.19	9298.69

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Count	100.00	100.00	100.00
Confidence Level (95.0%)	0.58	0.58	0.37

The L-W relationships are estimated (Fig. 4). The parameters *a, b* of the linear-weight relationships and the values of the correlation coefficient R^2 are presented in Table 13.

Table 13

Parameters a, b of L-W relationships and value of R^2 for the sample from port Kavarna, 26.05.2021

Parameters	$\mathbf{TW(g) = a.SL(mm)^b}$	$\mathbf{TW(g) = a.Wd(mm)^b}$	$\mathbf{W(g) = a.AL(mm)^b}$
a	0.0006	0.0027	0.0044
b	2.70	2.49	2.41
R^2	0.90	0.88	0.89

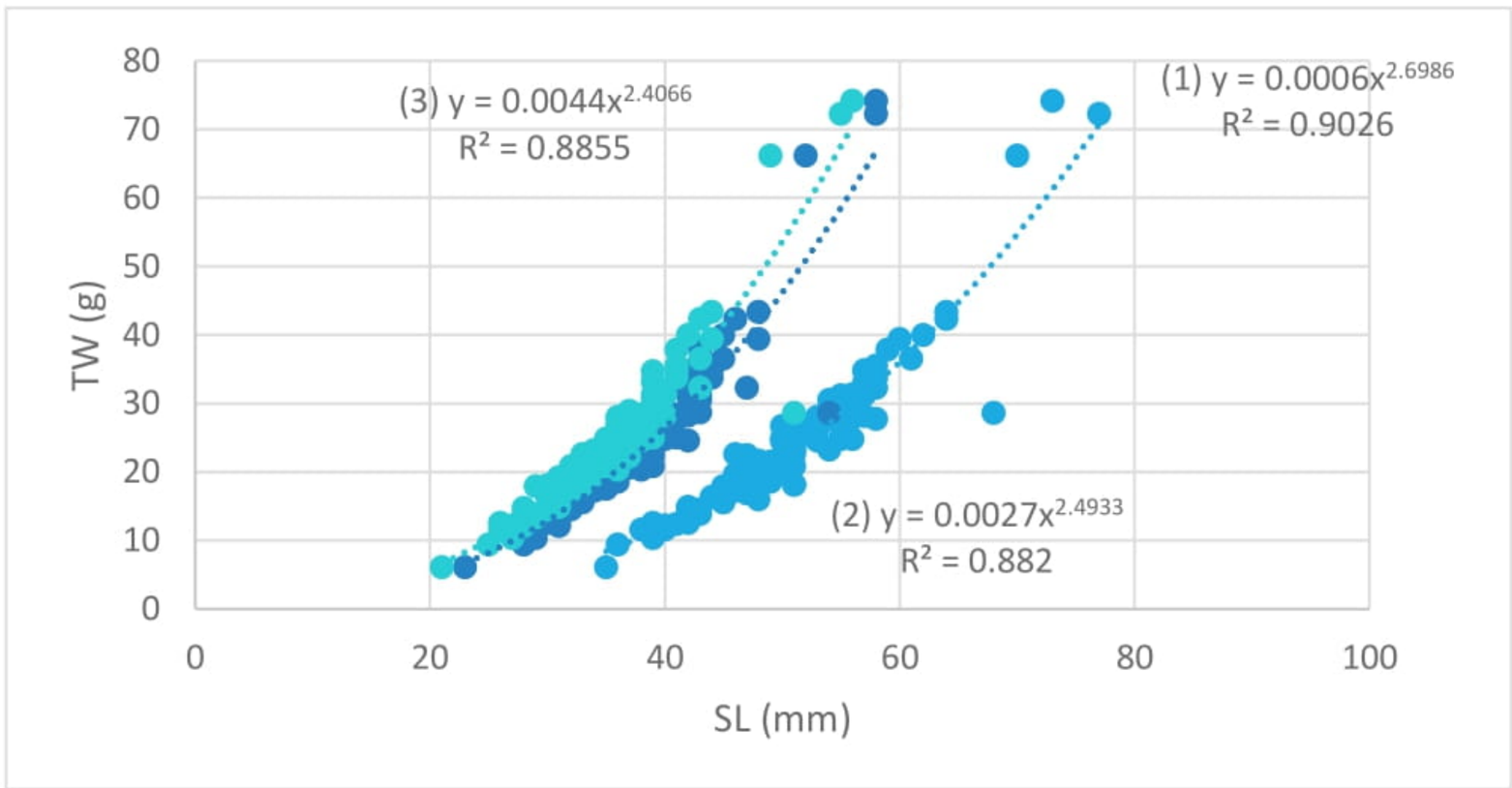

Figure 4. LWR for Rapana venosa sample from the port Kavarna, 26.05.2021: (1) LWR between total weight (TW, g) and linear size (SL, mm); (2) LWR of total weight (TW, g) and shell width (Wd, mm); and (3) LWR of total weight (TW, g) and aperture length (AL, mm)

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3.1.5. Port Kavarna, 27.05.2021

The sample includes 100 individuals *Rapana* (collected by beam - trawl), weighing 2.337 kg, from a total of 2078 kg landed at the port of Kavarna (from the investigated fishing vessel).

The mean weight of the measured specimens was 23.37 g ± 10.72 SD, with an average length of 49.66 mm ± 7.25 SD, a shell width of 37.06 mm ± 5.78 SD and an aperture length of 34.07 ± 5.66 SD. The body Shellless weight (BW, g) averaged 8.54 g ± 4.27 SD and formed 39.83% ± 4.77 SD of shell weight, ranging between 25.62% and 47.67% of total body weight (Table 14).

Table 14

Summarized statistics about the measured biological parameters - total weight (TW - weight with shell, TW, g), body weight (BW, g), % of BW from TW, shell length (shell length, SL, mm), shell width (Wd, mm) and aperture length (aperture length, AL, mm) for the sample from the port Kavarna, 27.05.2021.

	TW, g	BW, g	% BW from TW	SL, mm	Wd, mm	AL, mm
Mean	23.37	8.54	39.83	49.66	37.06	34.07
Standard Error	1.07	0.60	0.67	0.73	0.58	0.57
Median	20.17	7.43	41.22	48.50	36.00	33.00
Mode	20.00	6.34	#N/A	51.00	34.00	31.00
Standard Deviation	10.72	4.27	4.77	7.25	5.78	5.66
Sample Variance	114.92	18.25	22.74	52.59	33.45	32.09
Kurtosis	9.56	8.68	1.14	1.64	1.57	1.75
Skewness	2.46	2.65	-0.99	0.96	1.05	1.13
Range	74.13	23.23	22.05	42.00	32.00	31.00
Minimum	8.56	3.74	25.62	35.00	26.00	24.00
Maximum	82.69	26.97	47.67	77.00	58.00	55.00
Sum	2336.82	426.88	1991.27	4966.00	3706.00	3407.00
Count	100.00	50.00	50.00	100.00	100.00	100.00
Confidence Level (95.0%)	2.13	1.21	1.36	1.44	1.15	1.12

Specimens from length groups - 36 - 56 SL, mm, have the most significant presence in the sample (80% of the measured specimens). In terms of weight composition, the class < 25.6 TW g (72%) dominates.

The average value of the ratio width (Wd, mm)/length (SL, mm) of the shell is 74.60% ± 3.34 SD, and AL/SL (%) is 68.49% ± 3.11 SD, while for the ratio AL/ Wd (%), the obtained mean value was 91.83% ± 2.10 SD (Table 15).

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Table 15

Percentage ratios between shell width and length (Wd/SL, %), aperture length/total shell length (AL/SL, %) and aperture length/total shell width (AL/Wd, %) for the sample from port Kavarna, 27.05.2021

	Wd/SL (%)	AL/ SL (%)	AL/Wd (%)
Mean	74.60	68.49	91.83
Standard Error	0.33	0.31	0.21
Median	74.51	68.33	91.78
Mode	75.00	66.67	91.18
Standard Deviation	3.34	3.11	2.10
Sample Variance	11.18	9.68	4.39
Kurtosis	2.37	3.05	-0.34
Skewness	0.61	0.84	-0.26
Range	22.33	20.99	10.76
Minimum	65.91	61.36	86.11
Maximum	88.24	82.35	96.88
Sum	7460.50	6849.22	9182.84
Count	100.00	100.00	100.00
Confidence Level (95.0%)	0.66	0.62	0.42

The L-W relationships are estimated (Fig. 5). The parameters *a, b* of the length - weight relationships and the values of the correlation coefficient R^2 are presented in Table 16.

Table 16

Parameters a, b of L-W relationships and value of R^2 for the sample from port Kavarna, 27.05.2021

Parameters	$\mathrm{T}\boldsymbol{W(g) = a.SL(mm)^b}$	$\mathrm{T}\boldsymbol{W(g) = a.Wd(mm)^b}$	$\boldsymbol{W(g) = a.AL(mm)^b}$
a	0.001	0.0029	0.0056
b	2.57	2.48	2.35
R^2	0.90	0.94	0.95

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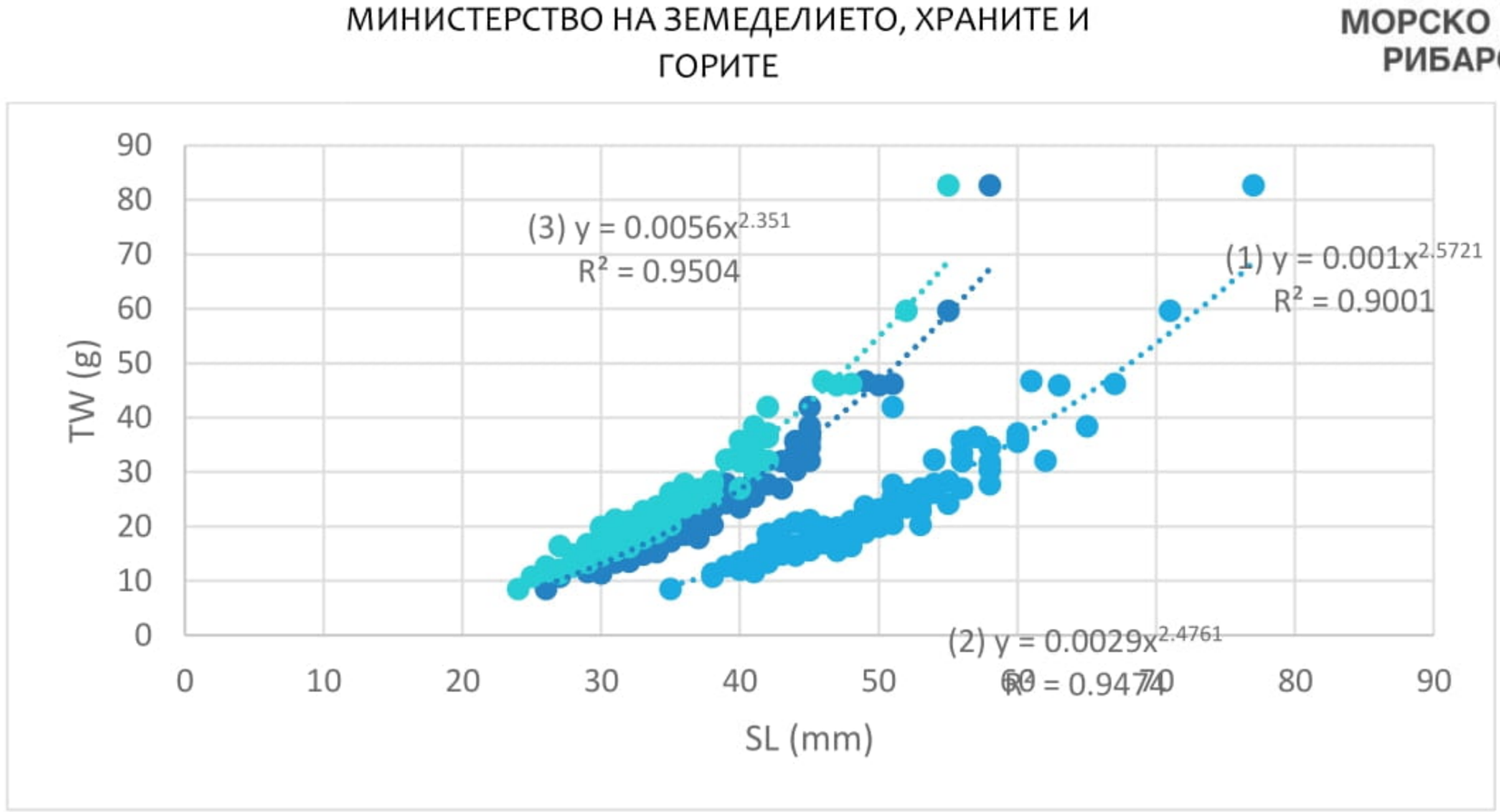

Figure 5. LWR for Rapana venosa sample from the port Kavarna, 27.05.2021: (1) LWR between total weight (TW, g) and linear size (SL, mm); (2) LWR of total weight (TW, g) and shell width (Wd, mm); and (3) LWR of total weight (TW, g) and aperture length (AL, mm)

3.1.6. Port Kavarna, 28.05.2021

The sample of 100 individuals (collected by beam - trawl) is with a weight of 2,360 kg, from a total of 370 kg rapa whelk, landed at the port of Kavarna (from the investigated fishing vessel).

The mean weight of the measured specimens was 23.60 g ± 9.23 SD, with an average length of 50.70 mm ± 6.38 SD, a shell width of 38.10 mm ± 5.15 SD and an aperture length of 35.13 ± 4.94 SD. The body weight (BW, g) is averaged at 10.45 g ± 3.98 SD and formed 41.48 % ± 3.94 SD of total weight, ranging between 25 % and 48 % of the total weight (Table 17).

Table 17

Summarized statistics about the measured biological parameters - total weight (TW - weight with shell, TW, g), body weight (BW, g), % of BW from TW, shell length (shell length, SL, mm), shell width (Wd, mm) and aperture length (aperture length, AL, mm) for the sample from the port Kavarna, 28.05.2021

	TW, g	BW, g	% BW from TW	SL, mm	Wd, mm	AL, mm
Mean	23.60	10.45	41.48	50.70	38.10	35.13
Standard Error	0.92	0.56	0.56	0.64	0.51	0.49
Median	21.72	9.44	41.47	49.00	37.00	34.50
Mode	20.00	10.00	44.70	49.00	37.00	34.00
Standard Deviation	9.23	3.98	3.94	6.38	5.15	4.94

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Sample Variance	85.24	15.84	15.51	40.70	26.49	24.36
Kurtosis	8.30	3.52	5.24	2.65	2.45	2.41
Skewness	2.31	1.70	-1.47	1.23	1.18	1.17
Range	62.76	20.15	22.89	39.00	30.00	30.00
Minimum	10.00	4.71	24.92	38.00	27.00	24.00
Maximum	72.76	24.86	47.81	77.00	57.00	54.00
Sum	2359.55	522.68	2074.09	5070.00	3810.00	3513.00
Count	100.00	50.00	50.00	100.00	100.00	100.00
Confidence Level (95.0%)	1.83	1.13	1.12	1.27	1.02	0.98

Specimens from length group - 46 - 56 SL, mm, have the most significant presence in the sample (63% of the measured specimens). In terms of weight composition (TW, g), the class with low individual weights <25.6 g (72% of all measured specimens) dominates.

The mean ratio (Wd, mm)/length (SL, mm) was 74.60% ± 3.36 SD, and AL SL (%) was 68.50% ± 3.13 SD, while for the AL/Wd (%) ratio obtained value amounts to - 91.85% ± 2.10 SD (Table 18).

Table 18

Percentage ratios between shell width and length (Wd/SL, %), aperture length/total shell length (AL/SL, %) and aperture length/total shell width (AL/Wd, %) for the sample from port Kavarna, 28.05.2021.

	Wd/SL (%)	**AL/ SL (%)**	**AL/Wd (%)**
Mean	74.60	68.50	91.85
Standard Error	0.34	0.31	0.21
Median	74.51	68.33	91.89
Mode	75.00	66.67	91.18
Standard Deviation	3.36	3.13	2.10
Sample Variance	11.29	9.78	4.40
Kurtosis	2.33	2.99	-0.32
Skewness	0.61	0.83	-0.29
Range	22.33	20.99	10.76
Minimum	65.91	61.36	86.11
Maximum	88.24	82.35	96.88
Sum	7385.03	6781.30	9092.84
Count	99.00	99.00	99.00
Confidence Level (95.0%)	0.67	0.62	0.42

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The L-W relationships are estimated (Fig.6). The parameters *a, b* of the linear-weight relationships and the values of the correlation coefficient R^2 are presented in Table 19.

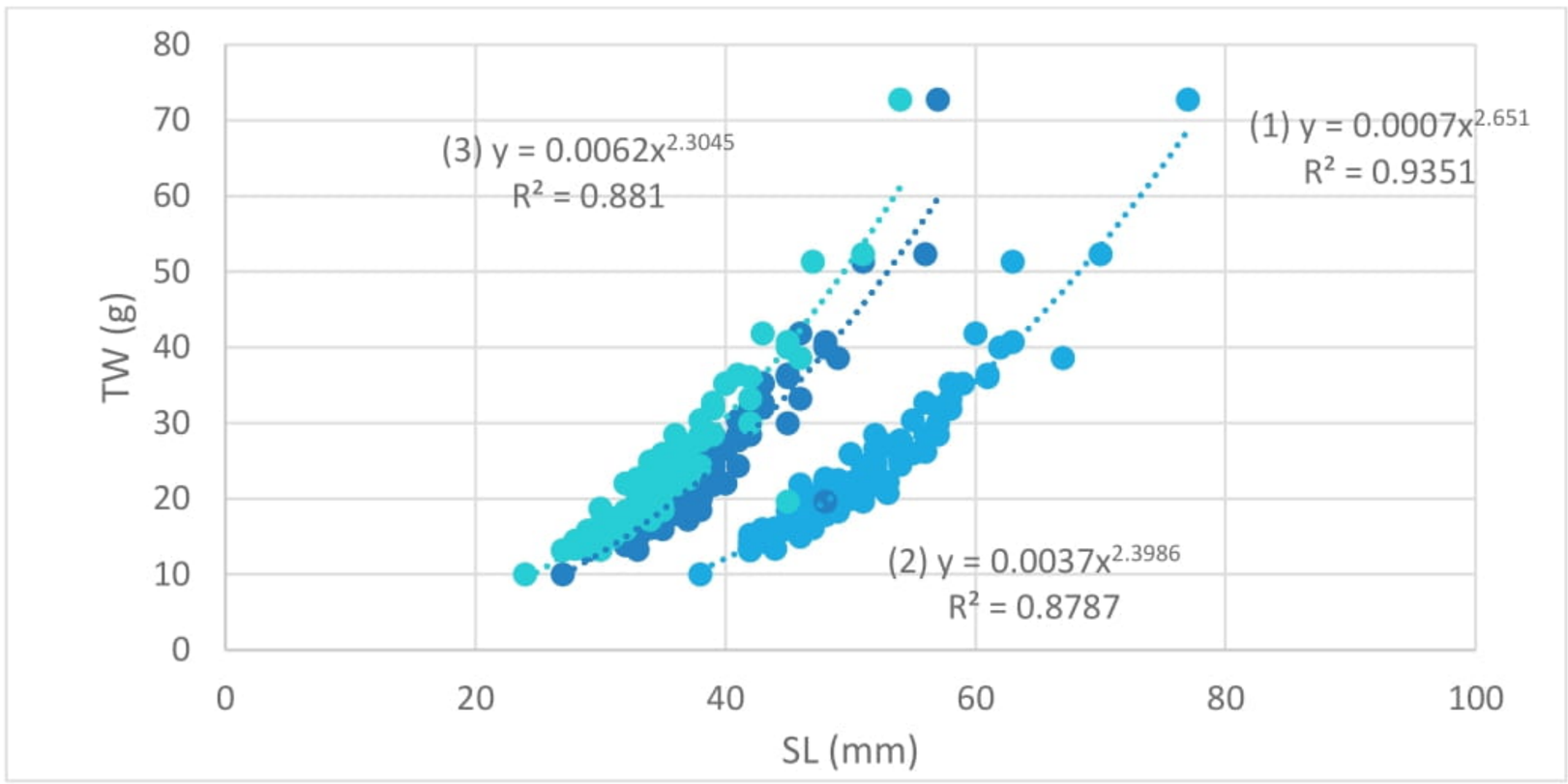

Figure 6. LWR for Rapana venosa sample from the port Kavarna, 28.05.2021: (1) LWR between total weight (TW, g) and linear size (SL, mm); (2) LWR of total weight (TW, g) and shell width (Wd, mm); and (3) LWR of total weight (TW, g) and aperture length (AL, mm)

Table 19

Parameters a, b of L-W relationships and value of R^2 for the sample from port Kavarna, 28.05.2021

Parameters	$\mathbf{TW(g) = a.SL(mm)^b}$	$\mathbf{TW(g) = a.Wd(mm)^b}$	$\mathbf{W(g) = a.AL(mm)^b}$
a	0.0007	0.0037	0.0062
b	2.65	2.40	2.30
R^2	0.94	0.88	0.88

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3.1.7. SUMMARISED RESULTS FOR THE FIRST HALF OF 2021

The data from the period March - June 2021 show that the total quantities of *Rapana* landings at the observed ports vary between 43 - 8246 kg / day; the most significant quantities were landed by beam trawls fishery at the port of Kavarna in mid-April 2021 (Table 20).

Table 20

Summarized data about the landings by days and ports by different types of vessels and different fishing methods during the first half of 2021

Date	Landing port	Total daily landing of *R. venosa* at the port (kg/day)	Fishing vessel number	Length of the fishing vessel from which the samples were collected	Landed quantity from the studied fishing vessel (kg)	Weight of the sample of 100 individuals *R. venosa* (kg)	Fishing technique
10.03.2021	Sozopol	120	C3 124	5.6	120	4.168	Scuba diving
29.03.2021	Nesebar	43	HC 1122	7.55	43	4.320	Scuba diving
21.04.2021	Kavarna	8246	BH 8311	14.95	2047	2.681	Beam trawl
26.05.2021	Kavarna	4351	BH 8186	14.90	3905	2.436	Beam trawl
27.05.2021	Kavarna	5168	BH 8406	14.52	2078	2.337	Beam trawl
28.05.2021	Kavarna	2933	BH 8311	14.95	370	2.360	Beam trawl

In the first half of 2021, the average length (SL, mm) of the specimens, collected at the studed ports from vessels with beam trawls, was 50.895 mm ± 6.91 SD (Fig. 10.1). In general, the variations of the average lengths by ports depend mostly on the method of catching - in the case of beam trawl fishery, they are between 49.66 - 52.44 mm, and in the case of scuba diving they reach between 60.38 - 60.81 mm. (Table 21.1). Accordingly, when fishing with beam trawl, the average weight (TW, g) is 24.54 g ± 10.51 SD, (Fig.10.2, Table 21.2), and by using of scuba diving, the average weight of rapa whelk is 42.44 g ± 8.79 SD. The average body weight (BW, g) for beam trawl fishery was 10.324 g ± 4.196 SD (Table 21.3) and formed 41.16 % of the weight of individuals during the study period, with the average percentage by ports varying between 40 % and 42 %. In the case of scuba diving, the body weight is 12 827 g ± 3.64 SD or 29.75 % of total weight.

Table 21

Statistical data about the distribution of the size (Sl, mm, 1), total weight (TW, g, 2) and body weight (BW, g, 3) of the samples from the observed ports during the first half of 2021. (Samples collected by scuba diving method are indicated in gray)

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1. **Size (SL, mm)**

Date	Port	Observations number	Minimum SL, mm	Maximum SL, mm	Mean SL, mm	Std. deviation
10.03.2021	Sozopol	100	50.000	75.000	60.380	4.954
29.03.2021	Nesebar	100	50.000	71.000	60.810	5.179
21.04.2021	Varna	100	36.000	77.000	52.420	6.201
26.05.2021	Kavarna	100	35.000	77.000	50.790	7.517
27.05.2021	Kavarna	100	35.000	77.000	49.660	7.252
28.05.2021	Kavarna	100	38.000	77.000	50.700	6.379

2. **Total weight (TW, g)**

Date	Port	Observations	Minimum	Maximum	Mean	Std. deviation
10.03.2021	Sozopol	100	21.510	72.450	41.679	9.125
29.03.2021	Nesebar	100	28.420	61.570	43.202	8.452
21.04.2021	Varna	100	10.620	73.920	26.811	10.582
26.05.2021	Kavarna	100	6.120	74.160	24.355	11.218
27.05.2021	Kavarna	100	8.560	82.690	23.368	10.720
28.05.2021	Kavarna	100	10.000	72.760	23.596	9.233

3. **Body weight (BW, g)**

Date	Port	Observations	Minimum	Maximum	Mean	Std. deviation
10.03.2021	Sozopol	50	7.410	22.270	12.987	3.701
29.03.2021	Nesebar	50	6.680	21.580	12.666	3.600
21.04.2021	Varna	50	5.480	18.910	10.575	3.227
26.05.2021	Kavarna	50	5.300	26.550	11.731	4.654
27.05.2021	Kavarna	50	3.740	26.970	8.538	4.272
28.05.2021	Kavarna	50	4.710	24.860	10.454	3.980

Based on the summarized data for the first half of 2021, the specimens from size group - 36 - 56 SL mm have the most significant presence (78% of the measured specimens) (Fig. 7.1, Table 22.1).

In terms of weight composition (TW, g), classes dominate: <51.2 g (97% of the total number of measured specimens) (Fig. 7.2, Table 22.2).

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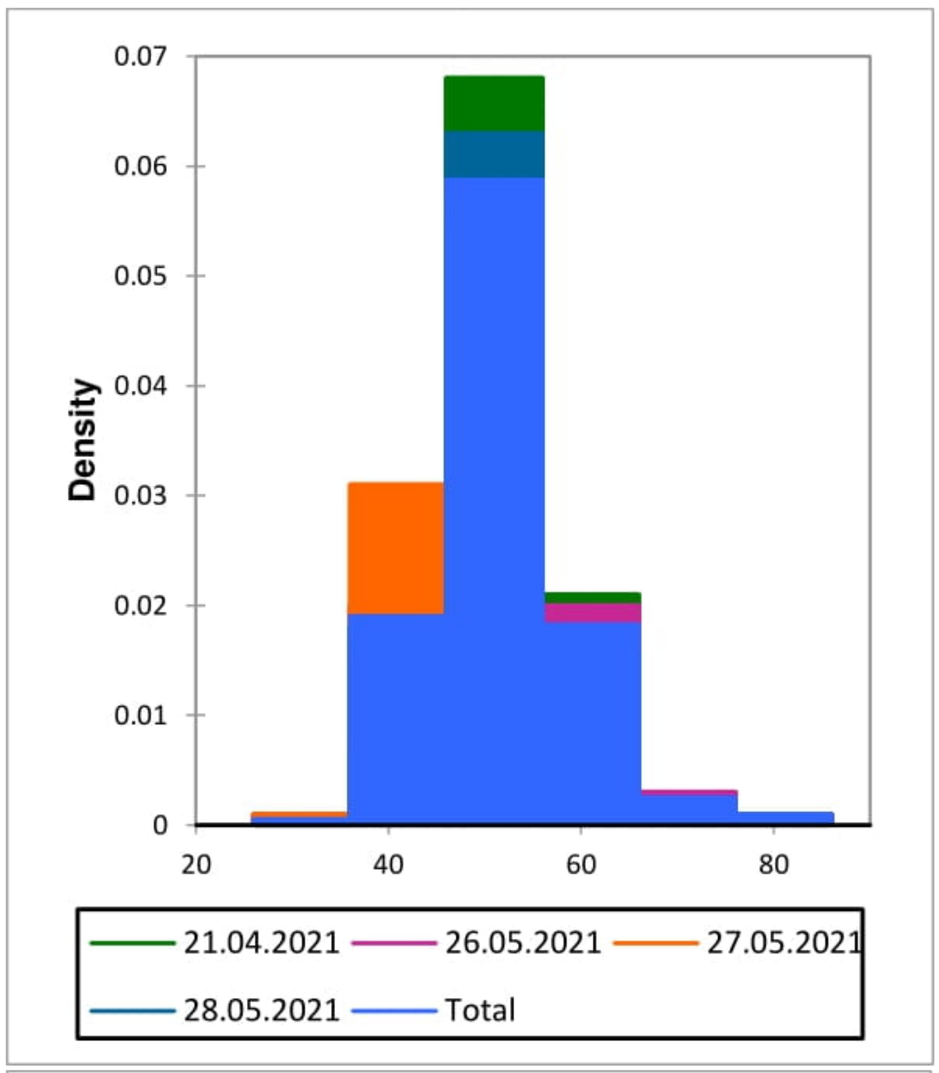
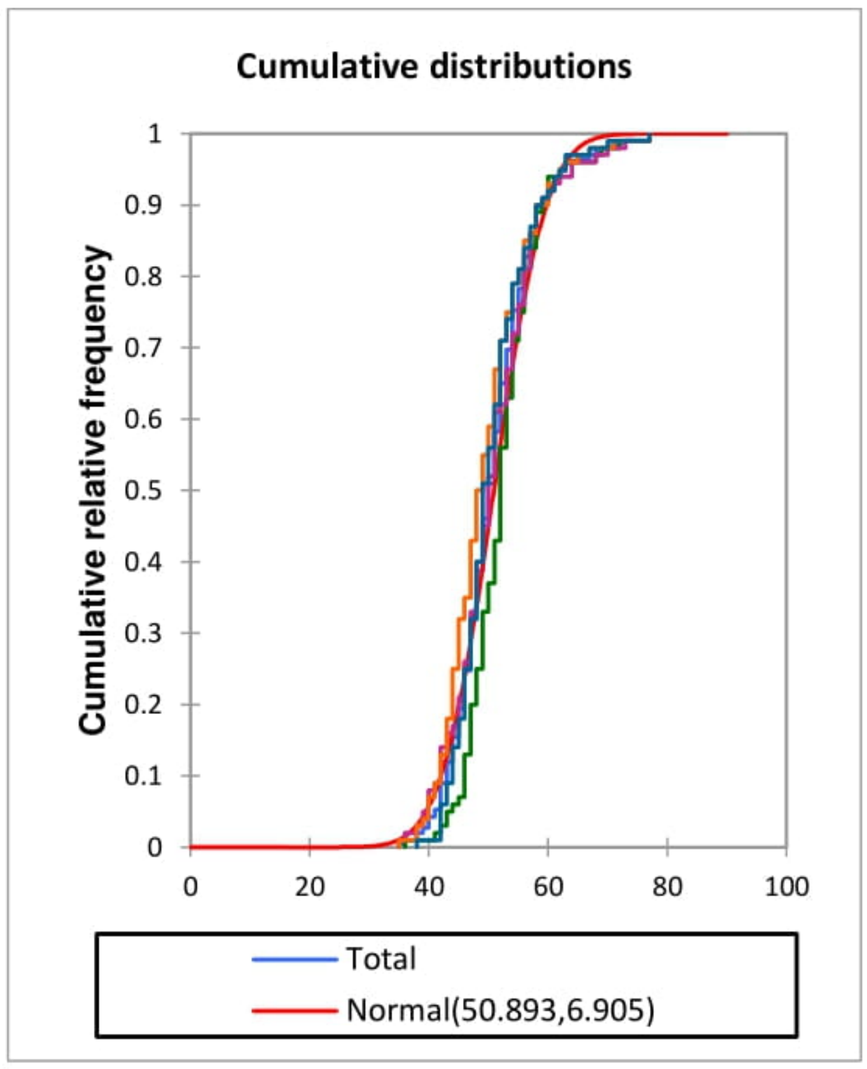
1.





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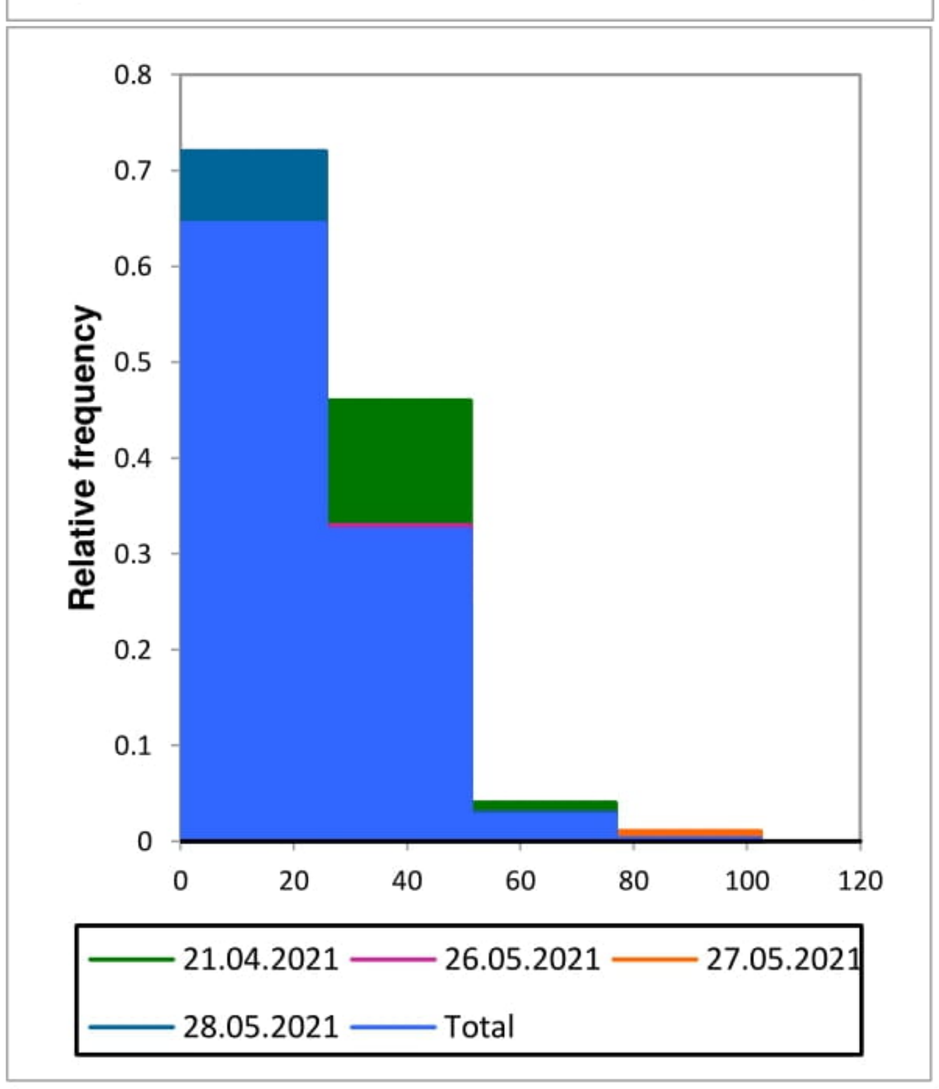

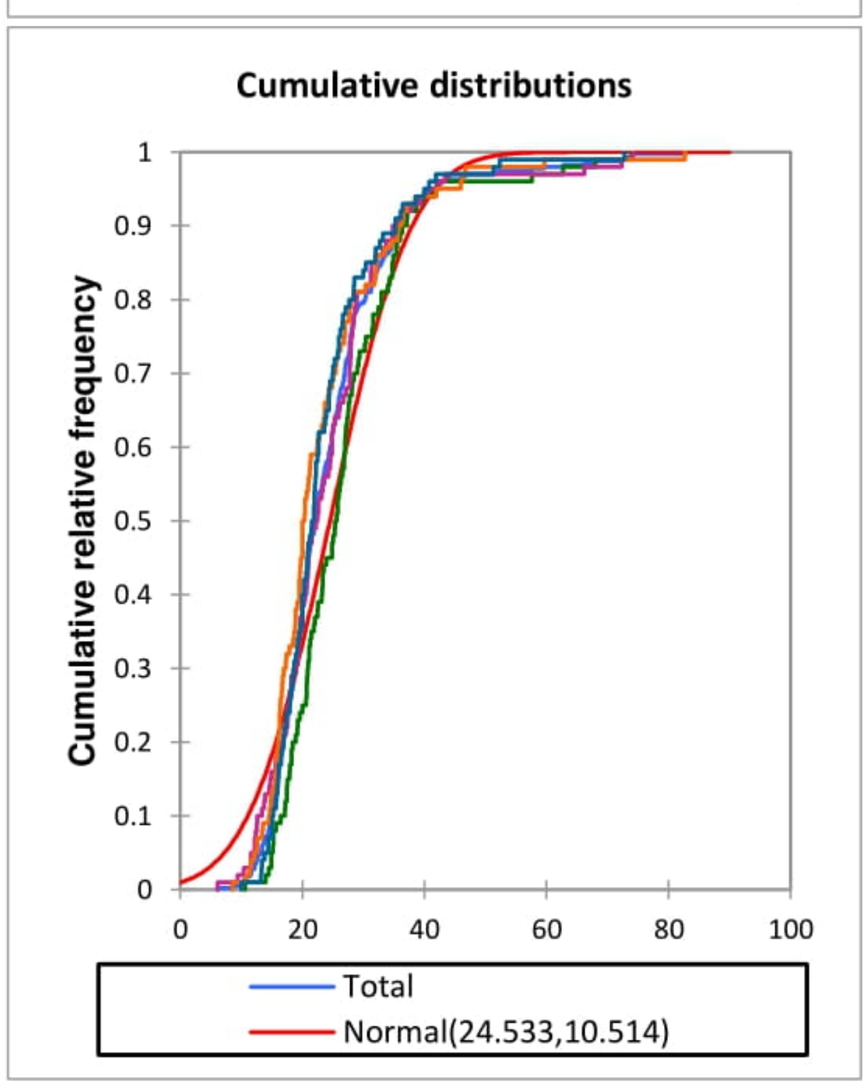

Figure 7. Distribution of the length (SL, mm, 1) and weight classes (TW g, 2) of *Rapana venosa* from the beam trawls samples during the first half of 2021.

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Table 22

Statistical data about the distribution of the length (mm, 1) and weight (g, 2) classes of *R. venosa*, collected by beam trawl in the fisrt half of 2021.

1

Lower bound	Upper bound	Frequency	Relative frequency	Density
26	36	2	0.005	0.001
36	46	76	0.190	0.019
46	56	235	0.588	0.059
56	66	73	0.183	0.018
66	76	10	0.025	0.003
76	86	4	0.010	0.001

2

Lower bound	Upper bound	Frequency	Relative frequency	Density
0	25.6	258	0.645	0.025
25.6	51.2	130	0.325	0.013
51.2	76.8	11	0.028	0.001
76.8	102.4	1	0.003	0.000

Detailed data on the percentage distribution by length and weight classes of all samples in the first half of 2021 are presented in Fig. 8 and Fig. 9.

While in beam trawl sampling, the dominant length groups were 36 - 56 mm SL (78 %), in the samples, collected by scuba diving, the dominant size classes were 46 - 66 mm SL (84 %) (Figure 8).

Respectively, the samples from beam trawls were dominated by specimens with low weight <51.2 g TW (97 % of the total number in the samples), and in the landings from the ports of Sozopol and Nessebar (collected by scuba diving method) the specimens from weight groups 25.6 - 76.8 g TW predominate (99.5% of the measured specimens) (Fig. 9)

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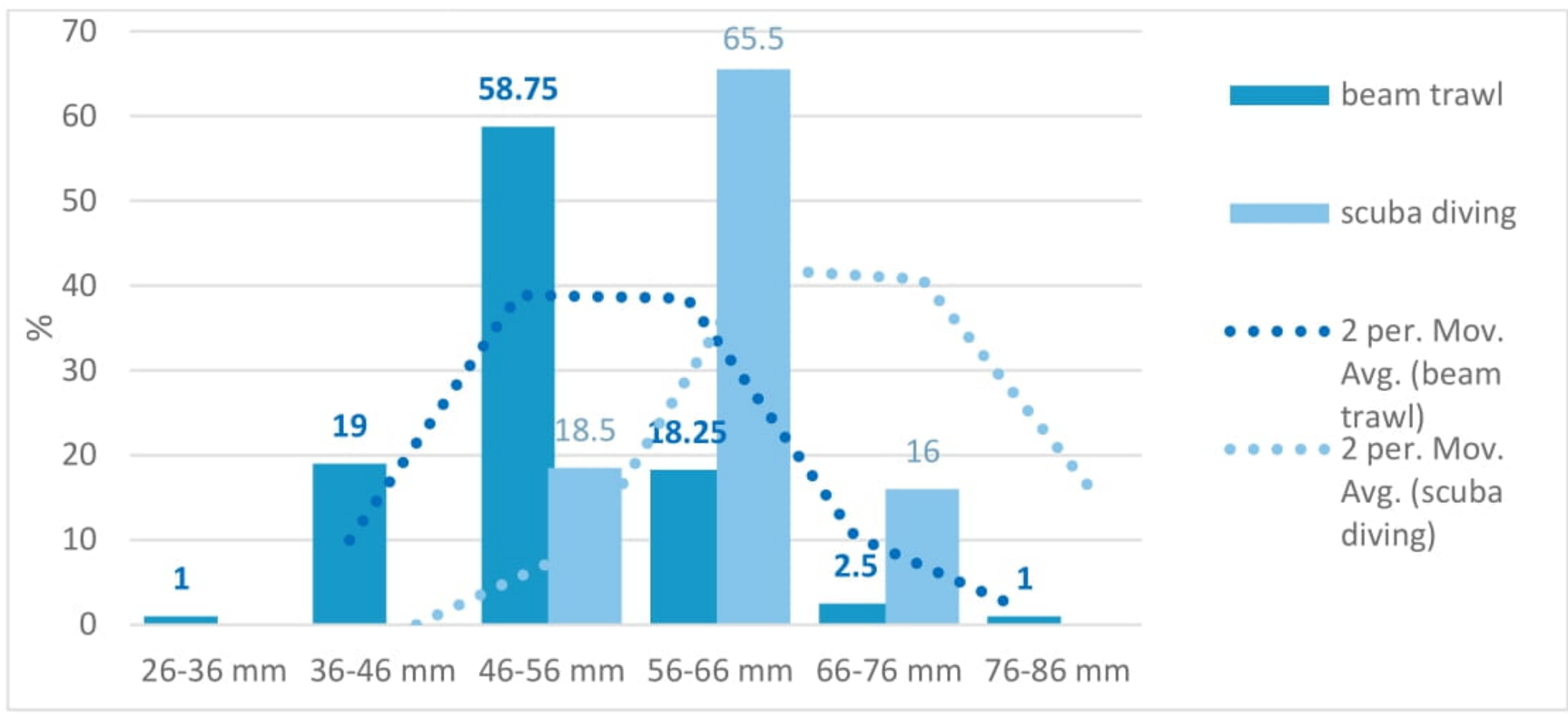

Figure 8. Percentage distribution by length classes (SL, mm) and moving averages based on the data from beam trawling and scuba diving, in the first half of 2021.

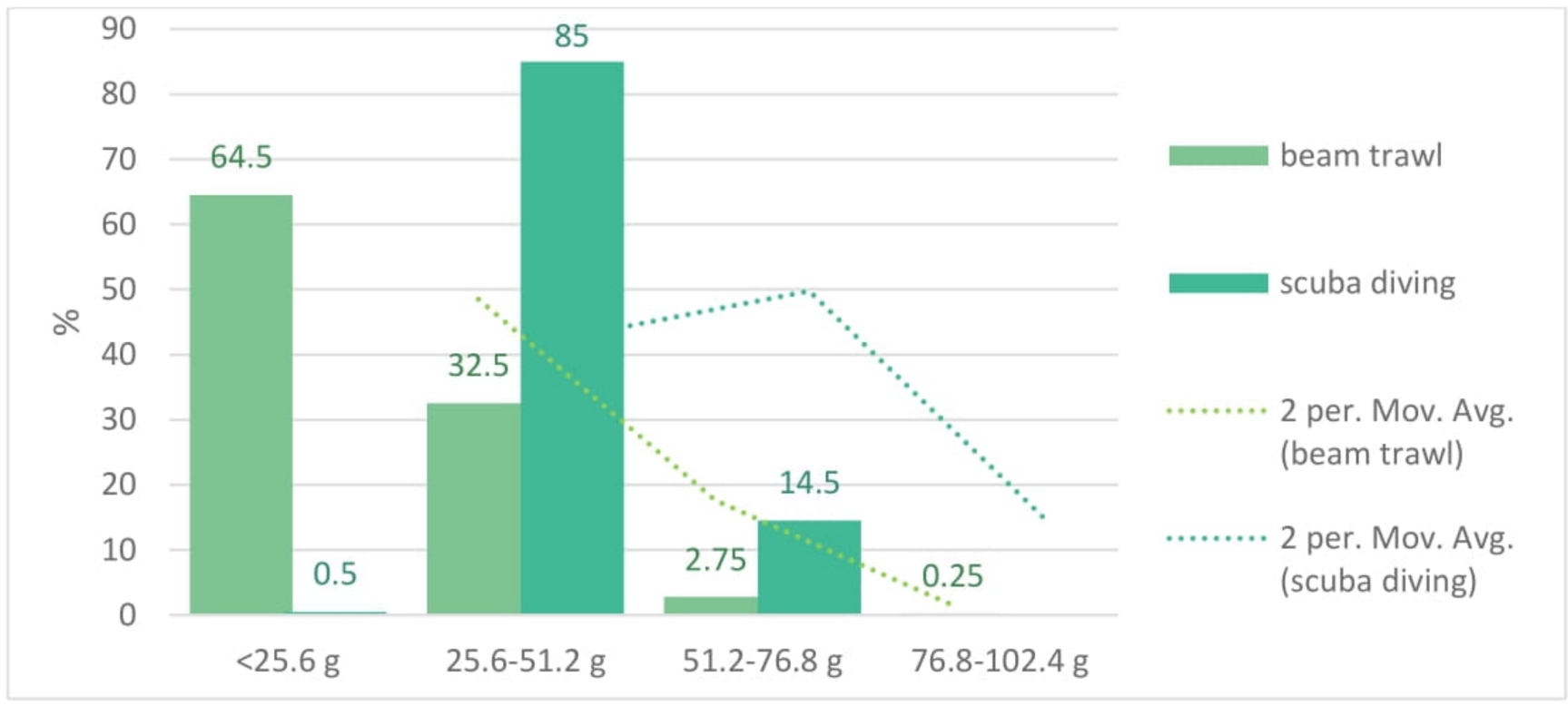

Figure 9. Percentage distribution by weight class (TW, g) and moving averages based on the data from beam trawling and scuba diving method in the first half of 2021.

The comparative analysis of the established parameters *a* and *b* of the L-W relationship: TW (g) = a. SL (mm)^^{b} shows a predominant allometric increase of *R. venosa* in all samples at coefficient *b* ≠ 3 (Fig.10). The parameter b <3 is an indicator of negative allometric growth, i.e in large specimens, the increase in length precedes the increase in weight. The coefficient *b* has the lowest value b = 2.57 for the sample from the port of Kavarna, 27.05.2021.

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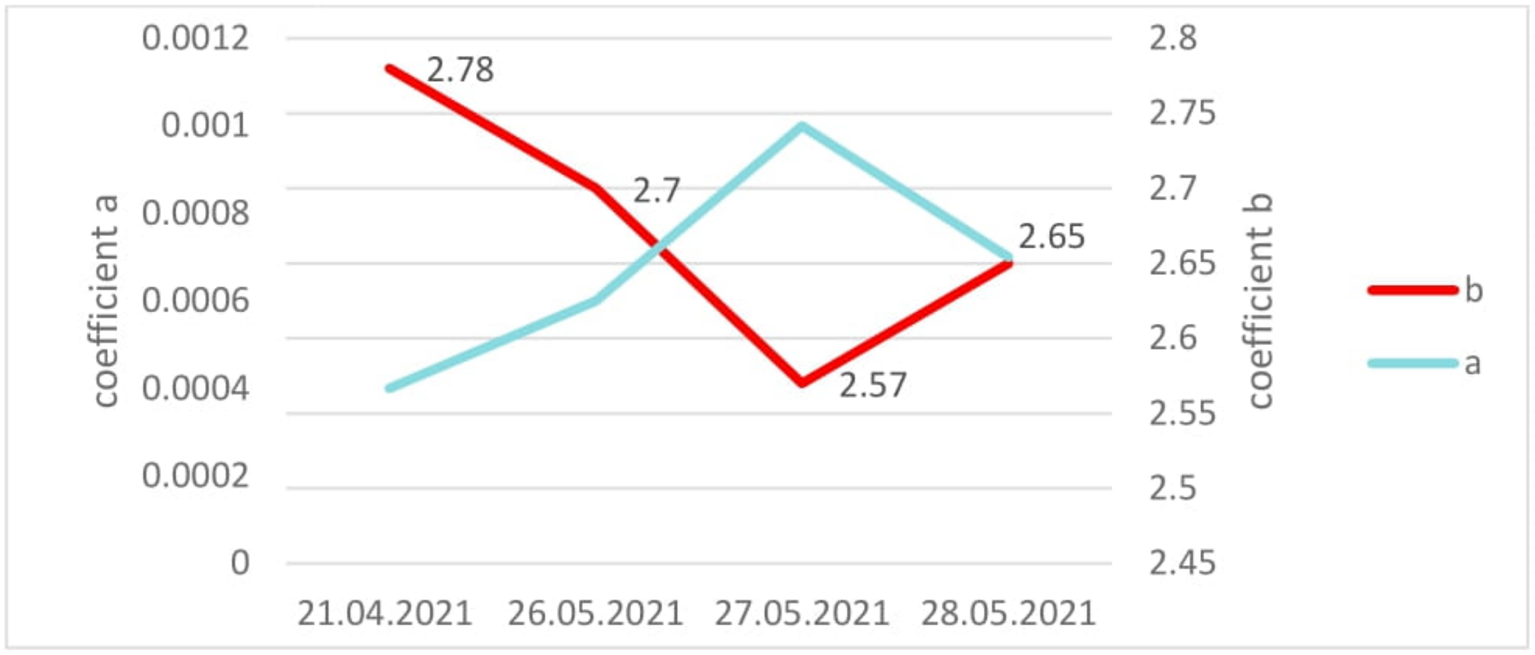

Figure 10. Parameters *a, b* of the LWR, expressed by the equation: $TW(g) = a.SL(mm)^b$, for the different ports during the first half of 2021

The data about the percentage ratios of the shell width/length (Wd/SL, %) of *R. venosa*, aperture ur erture length/shell length (AL/SL, %) and aperture length/shell width (AL/Wd, %) by ports for the first half of 2021 is presented in Fig. 11.

Figure 11. Percentage ratios of the shell width/length (Wd/SL, %) of *R. venosa*, aperture length/shell length (AL/SL, %) and aperture length/ shell width (AL/Wd, %) during the first of 2021.

In beam trawl catches, the average share Wd/SL reached 74.51 % in the first half of 2021, with minimal variation between samples. Accordingly, the share of AL/SL was 68.93 % on average, and varied between 68.5 % and 69.5 %. The average value of the AL/Wd share (%) in the first half of 2021

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amounted to 95.53 %. When fishing by scuba diving, the average values are respectively - 72.24% Wd/SL, 67.42 % AL/SL and 93.33% AL/Wd.

3.2. Sex Structure

3.2.1. Port Sozopol, 10.03.2021

The ratio between sexes in a representative subsample is 58 % ♂ to 42 % ♀ or 1.4: 1.

For females, the mean length of the shell (SL, mm) is 61.86 mm ± 5.70 SD, while this parameter decreases by 1.05 % for males specimens (Table 23).

Table 23

Summarized statistics of the biological parameters - total weight of the individuals, shell length (SL, mm) and total weight (TW, g) by sex in the sample from port Sozopol, 10.03.2021

	SL, mm		TW, g	
	Females	Males	Females	Males
Mean	61.86	61.21	44.36	43.07
Standard Error	1.24	0.94	2.25	1.85
Median	62.00	61.00	42.59	41.86
Mode	58.00	58.00	34.72	#N/A
Standard Deviation	5.70	5.07	10.30	9.99
Sample Variance	32.53	25.67	106.07	99.70
Kurtosis	-1.16	1.23	0.26	2.40
Skewness	-0.12	0.95	0.66	1.37
Range	19.00	22.00	41.24	41.85
Minimum	52.00	53.00	28.23	30.60
Maximum	71.00	75.00	69.47	72.45
Sum	1299.00	1775.00	931.58	1248.95
Count	21.00	29.00	21.00	29.00
Confidence Level (95.0%)	2.60	1.93	4.69	3.80

For the parameters shell width (Wd, mm) and aperture length (AL, mm), the percentage differences between males and females were 1.31% and 0.74%, respectively, in favor of females (Table 24).

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Table 24

Summarized statistic of the biological parameters - shell width (Wd, mm) and aperture length (aperture length, AL, mm) by sex in the sample from port Sozopol, 10.03.2021

	Wd, mm		Al, mm	
	Females	Males	Females	Males
Mean	44.90	44.31	41.62	41.31
Standard Error	0.92	0.64	0.89	0.62
Median	45.00	44.00	42.00	41.00
Mode	43.00	44.00	42.00	42.00
Standard Deviation	4.19	3.43	4.07	3.35
Sample Variance	17.59	11.79	16.55	11.22
Kurtosis	-0.57	0.32	-0.30	0.49
Skewness	0.02	0.52	0.15	0.64
Range	16.00	14.00	16.00	14.00
Minimum	37.00	38.00	34.00	35.00
Maximum	53.00	52.00	50.00	49.00
Sum	943.00	1285.00	874.00	1198.00
Count	21.00	29.00	21.00	29.00
Confidence Level (95.0%)	1.91	1.31	1.85	1.27

3.2.2. Port Nesebar, 29.03.2021

The ratio between sexes in a representative subsample is 66 % ♂ to 34 % ♀ or 1.9: 1.

The shell length of the female individuals was 60.53 mm ± 4.11 SD, while the mean shell length of males decreased by 1.07 % (Table 25).

Table 25

Summarized statistics of the biological parameters - total weight of the individuals, shell length (SL, mm) and total weight (TW, g) by sex in the sample from port Nesebar, 29.03.2021

	SL, mm		TW, g	
	Females	Males	Females	Males
Mean	60.53	59.88	44.05	40.82
Standard Error	1.00	0.93	2.00	1.54

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Median	61.00	60.00	44.07	39.99
Mode	61.00	64.00	#N/A	#N/A
Standard Deviation	4.11	5.35	8.23	8.87
Sample Variance	16.89	28.67	67.69	78.64
Kurtosis	-0.90	-0.93	-1.21	-0.01
Skewness	0.23	0.04	0.12	0.73
Range	13.00	21.00	27.38	33.15
Minimum	55.00	50.00	31.73	28.42
Maximum	68.00	71.00	59.11	61.57
Sum	1029.00	1976.00	748.79	1347.03
Count	17.00	33.00	17.00	33.00
Confidence Level (95.0%)	2.11	1.90	4.23	3.14

For the parameters shell width (Wd, mm) and aperture length (AL, mm), the percentage differences between males and females were 0.49 % and 0.57 %, respectively, in favor of females (Table 26).

Table 26

Summarized statistic of the biological parameters - shell width (Wd, mm) and aperture length (aperture length, AL, mm) by sex in the sample from port Nesebar, 29.03.2021

	Wd, mm		Al, mm	
	Females	Males	Females	Males
Mean	43.12	42.91	40.35	40.12
Standard Error	0.86	0.67	0.85	0.64
Median	44.00	42.00	42.00	40.00
Mode	46.00	39.00	43.00	42.00
Standard Deviation	3.53	3.83	3.50	3.68
Sample Variance	12.49	14.65	12.24	13.55
Kurtosis	-1.31	0.42	-1.44	0.41
Skewness	-0.02	0.67	-0.13	0.61
Range	11.00	16.00	11.00	15.00
Minimum	38.00	36.00	35.00	34.00
Maximum	49.00	52.00	46.00	49.00
Sum	733.00	1416.00	686.00	1324.00
Count	17.00	33.00	17.00	33.00

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Confidence Level (95.0%)	1.82	1.36	1.80	1.31

3.2.3. PORT KAVARNA, 21.04.2021

The ratio between sexes in a represenatative subsample is 58 % ♂ to 42 % ♀ or 1.4: 1.

The shell length of the female individuals is 50.14 mm ± 3.90 SD, while the mean length of the shell for the males increases by by 7.23 % on average (Table 27).

Table 27

Summarized statistics of the biological parameters - total weight of the individuals, shell length (SL, mm) and total weight (TW, g) by sex in the sample from port Kavarna, 21.04.2021

	SL, mm		TW, g	
	Females	**Males**	**Females**	**Males**
Mean	50.14	53.79	23.00	28.25
Standard Error	0.85	1.11	1.26	2.19
Median	51.00	53.00	21.88	25.85
Mode	52.00	56.00	#N/A	#N/A
Standard Deviation	3.90	5.98	5.77	11.78
Sample Variance	15.23	35.74	33.24	138.87
Kurtosis	0.61	1.53	1.08	7.13
Skewness	0.50	1.00	0.86	2.12
Range	17.00	26.00	23.41	59.44
Minimum	43.00	46.00	15.25	14.48
Maximum	60.00	72.00	38.66	73.92
Sum	1053.00	1560.00	482.90	819.29
Count	21.00	29.00	21.00	29.00
Confidence Level (95.0%)	1.78	2.27	2.62	4.48

For the parameters - shell width (Wd, mm) and aperture length (AL, mm), the percentage differences between both sexes are 7.56 % and 8.01 %, respectively, in favor of males (Table 28).

Table 28

Summarized statistic of the biological parameters - shell width (Wd, mm) and aperture length (aperture length, AL, mm) by sex in the sample from port Kavarna, 21.04.2021

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	Wd, mm		Al, mm	
	Females	Males	Females	Males
Mean	37.19	40.00	34.57	37.34
Standard Error	0.67	0.92	0.63	0.87
Median	37.00	39.00	35.00	37.00
Mode	38.00	35.00	33.00	35.00
Standard Deviation	3.08	4.93	2.89	4.71
Sample Variance	9.46	24.29	8.36	22.16
Kurtosis	1.89	0.10	2.39	0.22
Skewness	1.08	0.58	1.04	0.68
Range	13.00	21.00	13.00	19.00
Minimum	33.00	32.00	30.00	31.00
Maximum	46.00	53.00	43.00	50.00
Sum	781.00	1160.00	726.00	1083.00
Count	21.00	29.00	21.00	29.00
Confidence Level (95.0%)	1.40	1.87	1.32	1.79

3.2.4. PORT KAVARNA, 26.05.2021

The ratio between sexes in the representative part of the sample is 64 % ♂ : 36 % ♀ or 1.8: 1.

In terms of shell size (SL, mm), the average size of females was 51.83 mm ± 6.39 SD, and the average size of males was 5.94% larger (Table 28). Regarding the parameter body weight (TW, g), the average weight of males was 29.61 g ± 13.51 SD, and the average weight of females was 11.85% lower (Table 29).

Table 29

Summarized statistics of the biological parameters - total weight of the individuals, shell length (SL, mm) and total weight (TW, g) by sex in the sample from port Kavarna, 26.05.2021

	SL, mm		TW, g	
	Females	Males	Females	Males
Mean	51.83	54.91	26.10	29.61
Standard Error	1.51	1.43	2.77	2.39
Median	51.00	55.50	23.48	26.89

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Mode	51.00	56.00	#N/A	#N/A
Standard Deviation	6.39	8.06	11.74	13.51
Sample Variance	40.85	64.99	137.79	182.43
Kurtosis	2.99	1.27	8.07	5.55
Skewness	1.34	0.75	2.54	2.17
Range	28.00	38.00	51.42	61.56
Minimum	42.00	39.00	14.79	12.60
Maximum	70.00	77.00	66.21	74.16
Sum	933.00	1757.00	469.81	947.51
Count	18.00	32.00	18.00	32.00
Confidence Level (95.0%)	3.18	2.91	5.84	4.87

For the parameters shell width (Wd, mm) and aperture length (AL, mm), the percentage differences between males and females were 6.25 % and 6.90 %, respectively, in favor of males (Table 30).

Table 30

Summarized statistic of the biological parameters - shell width (Wd, mm) and aperture length (aperture length, AL, mm) by sex in the sample from port Kavarna, 26.05.2021

	Wd, mm		Al,mm	
	Females	**Males**	**Females**	**Males**
Mean	38.67	41.09	35.78	38.25
Standard Error	1.17	1.18	1.16	1.16
Median	38.50	40.50	35.50	38.00
Mode	39.00	41.00	32.00	38.00
Standard Deviation	4.95	6.69	4.91	6.55
Sample Variance	24.47	44.80	24.07	42.84
Kurtosis	1.98	1.20	2.04	1.69
Skewness	0.99	0.99	1.07	1.16
Range	21.00	28.00	21.00	28.00
Minimum	31.00	30.00	28.00	28.00
Maximum	52.00	58.00	49.00	56.00
Sum	696.00	1315.00	644.00	1224.00
Count	18.00	32.00	18.00	32.00
Confidence Level(95.0%)	2.46	2.41	2.44	2.36

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3.2.5. Port Kavarna, 27.05.2021

The ratio between sexes in the representative part of the sample is 48 % ♂ : 52 % ♀ or 1 : 1.08.

Regarding the size of the shell (SL, mm), in females the average size was 45.50 mm ± 5.66 SD, and in males the average size was 14.84% larger (Table 31). In terms of body weight (TW, g), the average weight in males was 26.14 g ± 15.52 SD, and the mean weight in females was 47.68 % lower (Table 31).

Table 31

Summarized statistics of the biological parameters - total weight of the individuals, shell length (SL, mm) and total weight (TW, g) by sex in the sample from port Kavarna, 27.05.2021

	SL, mm		TW, g	
	Females	Males	Females	Males
Mean	45.50	52.25	17.70	26.14
Standard Error	1.11	1.75	1.02	3.17
Median	44.50	49.50	16.47	20.47
Mode	44.00	48.00	20.00	#N/A
Standard Deviation	5.66	8.56	5.20	15.52
Sample Variance	32.02	73.24	27.02	240.93
Kurtosis	-0.79	2.38	-0.89	7.84
Skewness	0.20	1.62	0.32	2.70
Range	21.00	34.00	18.46	67.42
Minimum	35.00	43.00	8.56	15.27
Maximum	56.00	77.00	27.02	82.69
Sum	1183.00	1254.00	460.25	627.34
Number of obs	26.00	24.00	26.00	24.00
Confidence Level (95.0%)	2.79	3.61	2.10	6.55

For the parameters shell width (Wd, mm) and aperture length (AL, mm), the percentage differences between both sexes are 13.23 % and 14.66 %, respectively, in favor of males (Table 32).

Table 32

Summarized statistic of the biological parameters - shell width (Wd, mm) and aperture length (aperture length, AL, mm) by sex in the sample from port Kavarna, 27.05.2021

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	Wd, mm		Al,mm	
	Females	Males	Females	Males
Mean	33.85	38.33	30.96	35.50
Standard Error	0.81	1.40	0.77	1.37
Median	34.00	36.00	31.00	33.50
Mode	34.00	36.00	31.00	41.00
Standard Deviation	4.12	6.88	3.93	6.72
Sample Variance	17.02	47.36	15.48	45.13
Kurtosis	-0.23	2.69	-0.25	2.98
Skewness	0.13	1.62	0.36	1.70
Range	17.00	29.00	16.00	28.00
Minimum	26.00	29.00	24.00	27.00
Maximum	43.00	58.00	40.00	55.00
Sum	880.00	920.00	805.00	852.00
Count	26.00	24.00	26.00	24.00
Confidence Level(95.0%)	1.67	2.91	1.59	2.84

3.2.6. PORT KAVARNA, 28.05.2021

The ratio between sexes in the representative subsample is 70 % ♂ : 30 % ♀ or 2.3 : 1.

In terms of shell size (SL, mm), the mean length of females was 52.13 mm ± 5.51 SD, 0.96% smaller than in males (Table 33). The mean weight of males was 25.21 g ± 11.44 SD, and for females the mean weight was 3 % higher (Table 33).

Table 33

Summarized statistics of the biological parameters - total weight of the individuals, shell length (SL, mm) and total weight (TW, g) by sex in the sample from port Kavarna, 28.05.2021.

	SL, mm		TW, g	
	Females	Males	Females	Males
Mean	52.13	52.63	25.98	25.21
Standard Error	1.42	1.21	2.44	1.93
Median	51.00	50.00	23.57	21.21
Mode	52.00	49.00	#N/A	#N/A
Standard Deviation	5.51	7.13	9.44	11.44
Sample Variance	30.41	50.83	89.15	130.97

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Kurtosis	0.46	3.69	2.96	8.58
Skewness	0.90	1.83	1.76	2.64
Range	19.00	33.00	35.54	59.38
Minimum	44.00	44.00	15.78	13.38
Maximum	63.00	77.00	51.32	72.76
Sum	782.00	1842.00	389.71	882.46
Confidence Level (95.0%)	15.00	35.00	15.00	35.00

For the parameters shell width (Wd, mm) and aperture length (AL, mm), the percentage differences between male and female individuals were 0.17 % and 0.44 %, respectively (Table 34).

Table 34

Summarized statistic of the biological parameters - shell width (Wd, mm) and aperture length (aperture length, AL, mm) by sex in the sample from port Kavarna, 28.05.2021

	Wd, mm		Al,mm	
	Females	Males	Females	Males
Mean	39.53	39.46	36.33	36.49
Standard Error	1.20	0.98	1.17	0.93
Median	38.00	38.00	35.00	35.00
Mode	39.00	38.00	35.00	35.00
Standard Deviation	4.64	5.77	4.51	5.51
Sample Variance	21.55	33.31	20.38	30.37
Kurtosis	2.37	2.98	2.00	2.94
Skewness	1.37	1.58	1.31	1.58
Range	19.00	27.00	18.00	26.00
Minimum	32.00	30.00	29.00	28.00
Maximum	51.00	57.00	47.00	54.00
Sum	593.00	1381.00	545.00	1277.00
Count	15.00	35.00	15.00	35.00
Confidence Level(95.0%)	2.57	1.98	2.50	1.89

3.2.7. GONADOSOMATIC INDEX (GSI)

The summary statistics about the dynamics of the gonadosomatic index (GSI) in the first half of 2021 are presented in Table 35. On average for the period, the GSI was 18.57% BW.

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Table 35

Summarized statistics of GSI (% BW) by ports during the first half of 2021

	10.03.2021 Sozopol	29.03.2021 Nesebar	21.04.2021 Kavarna	26.05.2021 Kavarna	27.05.2021 Kavarna	28.05.2021 Kavarna
Mean	18.77	19.06	19.52	18.47	17.59	17.99
Standard Error	0.49	0.49	0.59	0.73	0.52	0.44
Median	18.56	19.00	18.17	18.06	17.05	18.27
Mode	#N/A	18.40	#N/A	#N/A	16.13	#N/A
Standard Deviation	3.44	3.47	4.20	5.16	3.67	3.11
Sample Variance	11.85	12.03	17.61	26.67	13.44	9.70
Kurtosis	0.72	2.44	2.03	1.78	1.39	0.26
Skewness	0.23	-0.55	1.29	0.18	0.82	-0.64
Range	17.10	20.41	21.52	29.99	19.02	14.32
Minimum	9.88	8.29	12.24	4.30	10.81	9.30
Maximum	26.98	28.70	33.76	34.29	29.83	23.63
Sum	938.62	953.00	975.95	923.60	879.37	899.48
Count	50.00	50.00	50.00	50.00	50.00	50.00
Confidence Level (95.0%)	0.98	0.99	1.19	1.47	1.04	0.89

3.2.8. SUMMARISED RESULTS ABOUT SEX STRUCTURE

For all studied ports, the average sex ratio was 61 % ♂: 39 % ♀ (Fig. 12). No imposex *Rapana* individulas were found in the first half of 2021.

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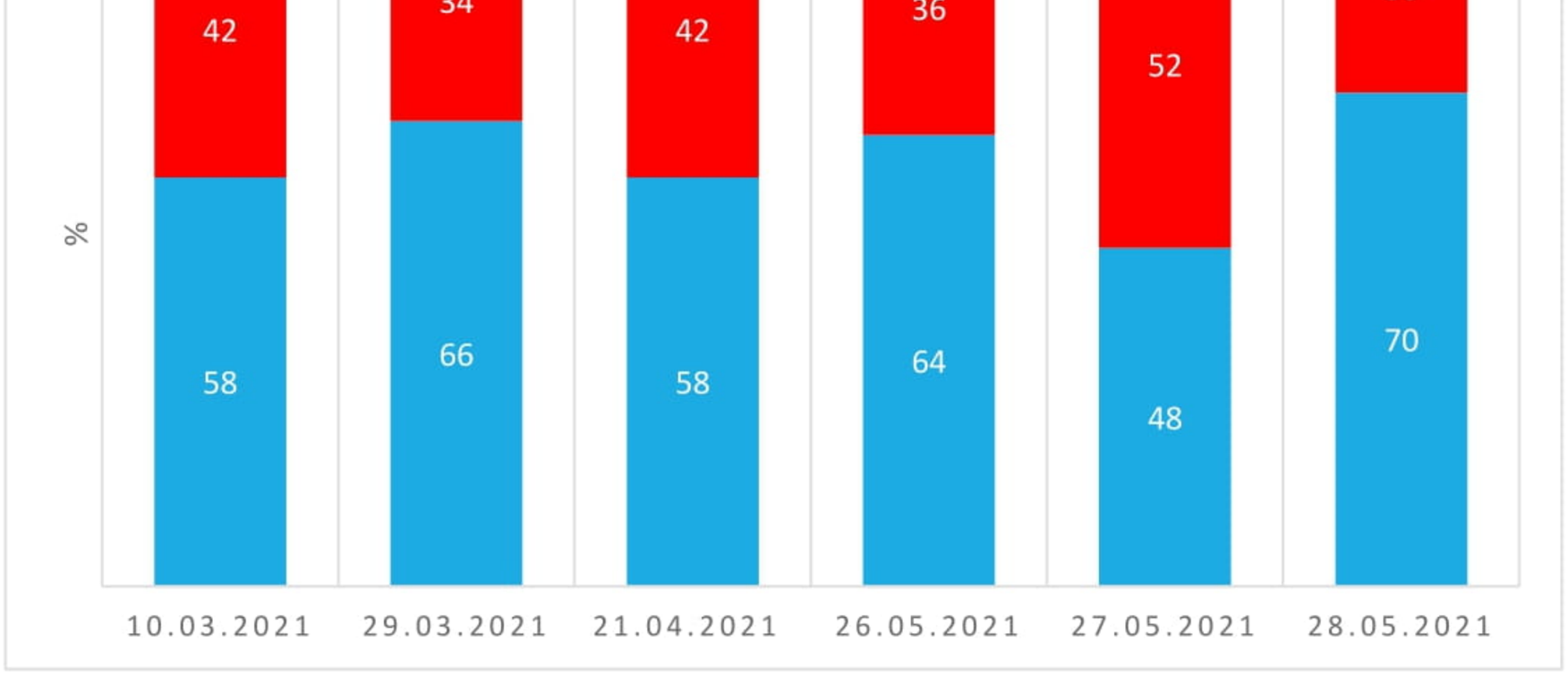

Figure 12. Summarized data about the sex structure of *R. venosa* during the first half of 2021.

The average length (SL, mm) of the male specimens, according to data from the beam trawls, is 53.44 mm ± 7.42 SD, and the largest average length - 54.91 mm is estimated for the sample from the port of Kavarna (26.05.2021) (Table 36.1, Fig.13.1). The average length of the female specimens was 49.39 mm ± 6.01 SD for the period, with a percentage difference of 7.58 % compared to the average length of the male specimens. Accordingly, the average weight of males was 38.60 g ± 17.66 SD for the period, and for females - 31.37 g ± 10.46 SD, with a percentage difference of 20.67 % between the sexes (Table 36.2, Fig.13.2).

Table 36

Statistical data about the distribution of size (SL, mm, 1) and weight (TW, g, 2) by sex for the samples from the first half of 2021 (with grey are marked data from beam trawlers)

1. Shell length (SL, mm)

Date	Port	Sex	Minimum SL, mm	Maximum SL, mm	Mean SL, mm	Std. deviation
10.03.2021	Sozopol	M	53	75	61.21	5.07
		F	52	71	61.86	5.70
29.03.2021	Nessebar	M	50	71	59.88	5.35
		F	55	68	60.53	4.11

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21.04.2021	Kavarna	M	46	72	53.79	5.98
		F	43	60	50.14	3.90
26.05.2021	Kavarna	M	39	77	54.91	8.06
		F	42	70	51.83	6.39
27.05.2021	Kavarna	M	43	77	52.25	8.56
		F	35	56	45.50	5.66
28.06.2021	Kavarna	M	44	77	52.63	7.13
		F	44	63	52.13	5.51

2. Total weight (TW, g)

Date	Port	Sex	Minimum TW, g	Maximum TW, g	Mean weight TW, g	Std. deviation
10.03.2021	Sozopol	M	30.60	72.45	43.07	9.99
		F	28.23	69.47	44.36	10.30
29.03.2021	Nessebar	M	28.42	61.57	40.82	8.87
		F	31.73	59.11	44.05	8.23
21.04.2021	Kavarna	M	14.48	73.92	28.25	11.78
		F	15.25	38.66	23.00	5.77
26.05.2021	Kavarna	M	12.60	74.16	29.61	13.51
		F	14.79	66.21	26.10	11.74
27.05.2021	Kavarna	M	15.27	82.69	26.14	15.52
		F	8.56	27.02	17.70	5.20
28.05.2021	Kavarna	M	13.38	72.76	25.21	11.44
		F	15.78	51.32	25.98	9.44

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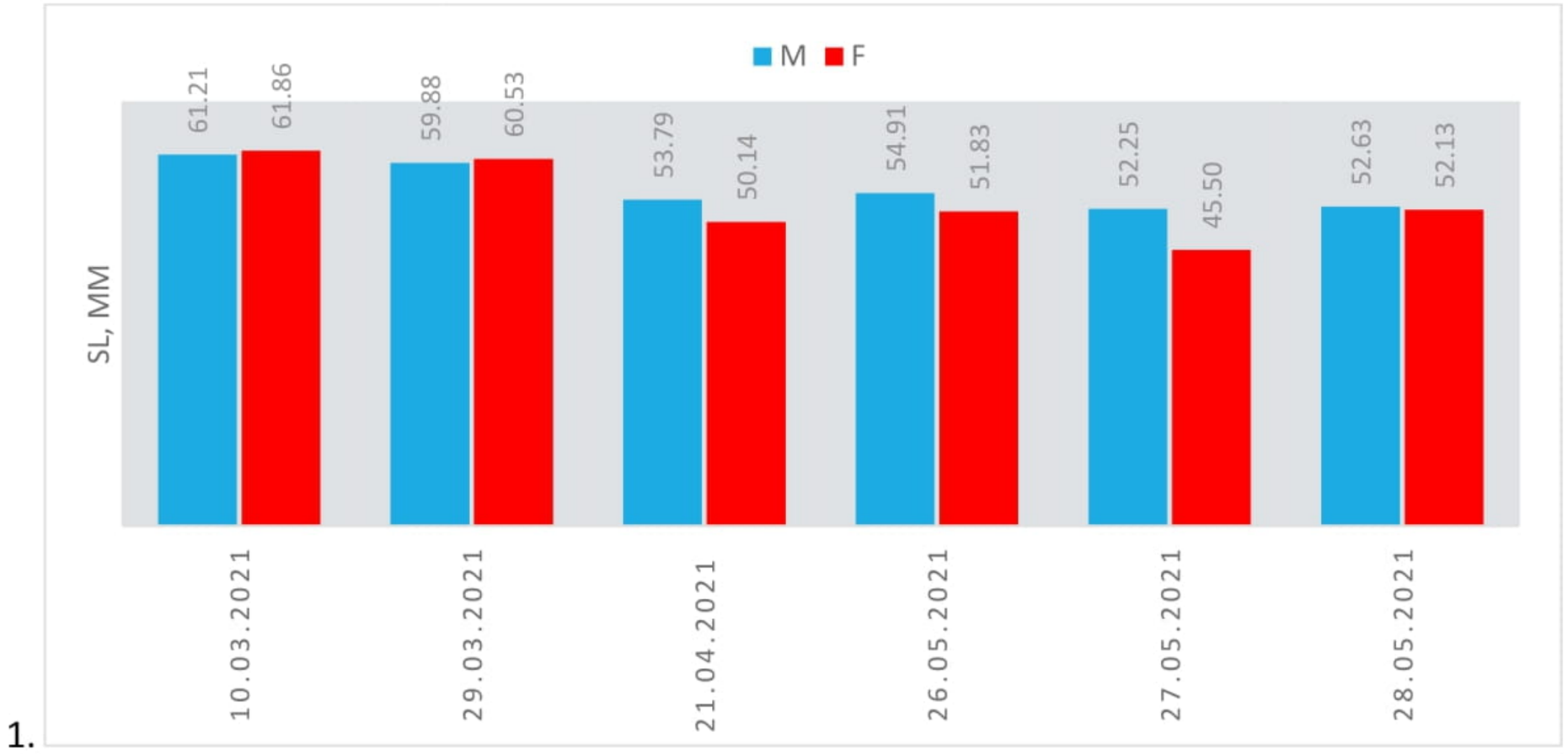
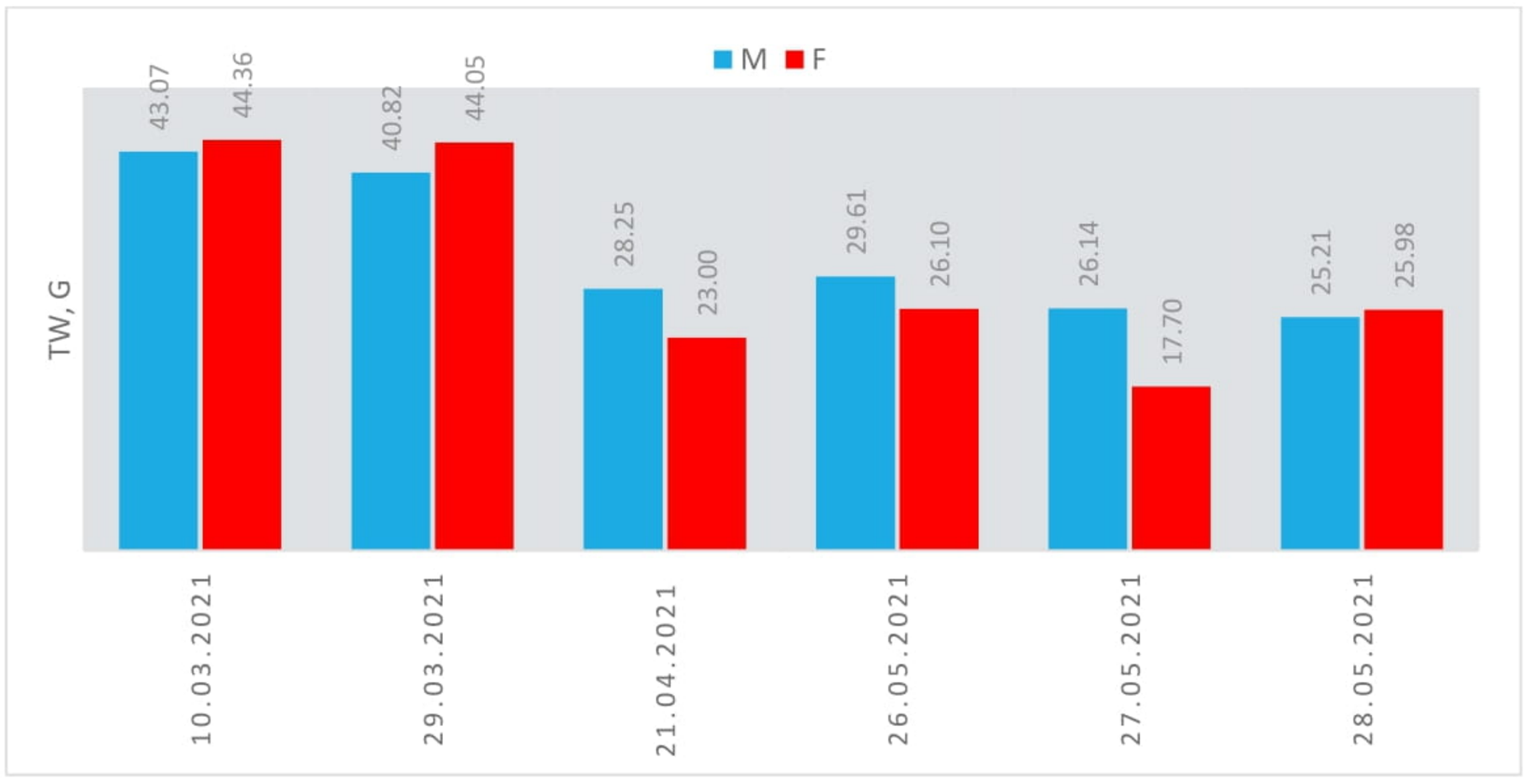


1.



2.

Figure 13. Summarized data for (1) average size of *R. venosa* (SL, mm) by sex and (2) average total weight (TW, g) by sex for the landings in the first half of 2021.

The analysis of the dynamics of the length classes by sex shows that in the catches with beam trawl, the length class - 47 - 56 mm was presented predominantly, with a share – 64 % of the total number of measured male specimens. In these samples, 47.5 % of the measured female individuals belonged to the length class 43 - 54 mm (Fig. 14.1). In the beam trawl catches, large size classes > 71 mm formed only 5 % by males and were completely absent for females. In the catches by selective

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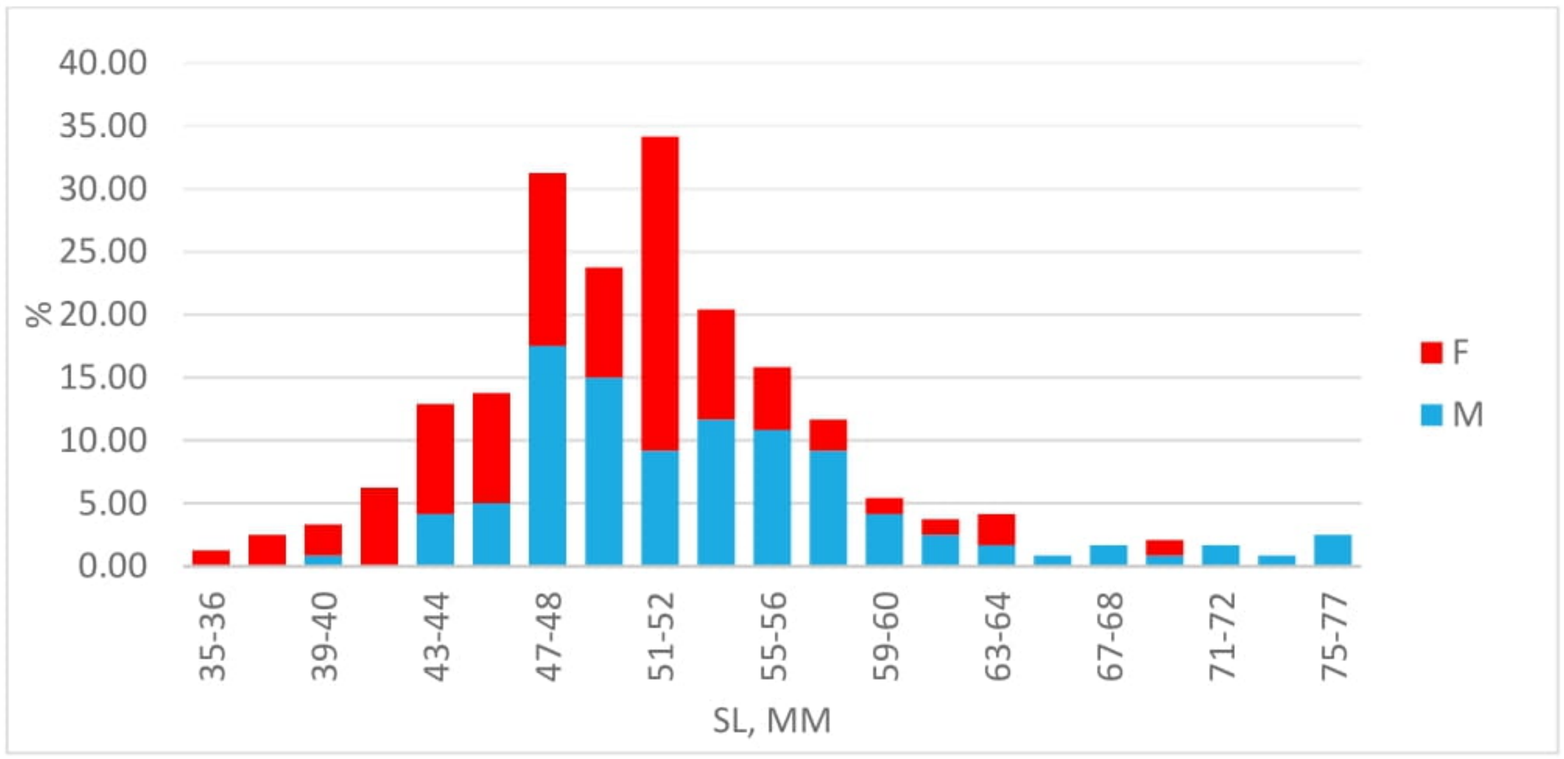
scuba diving method (Fig. 14.2), the male specimens are dominated by length classes - 45 - 50 mm (45%), and the most common length gropus for females were 41 - 50 mm (66 %).

1.



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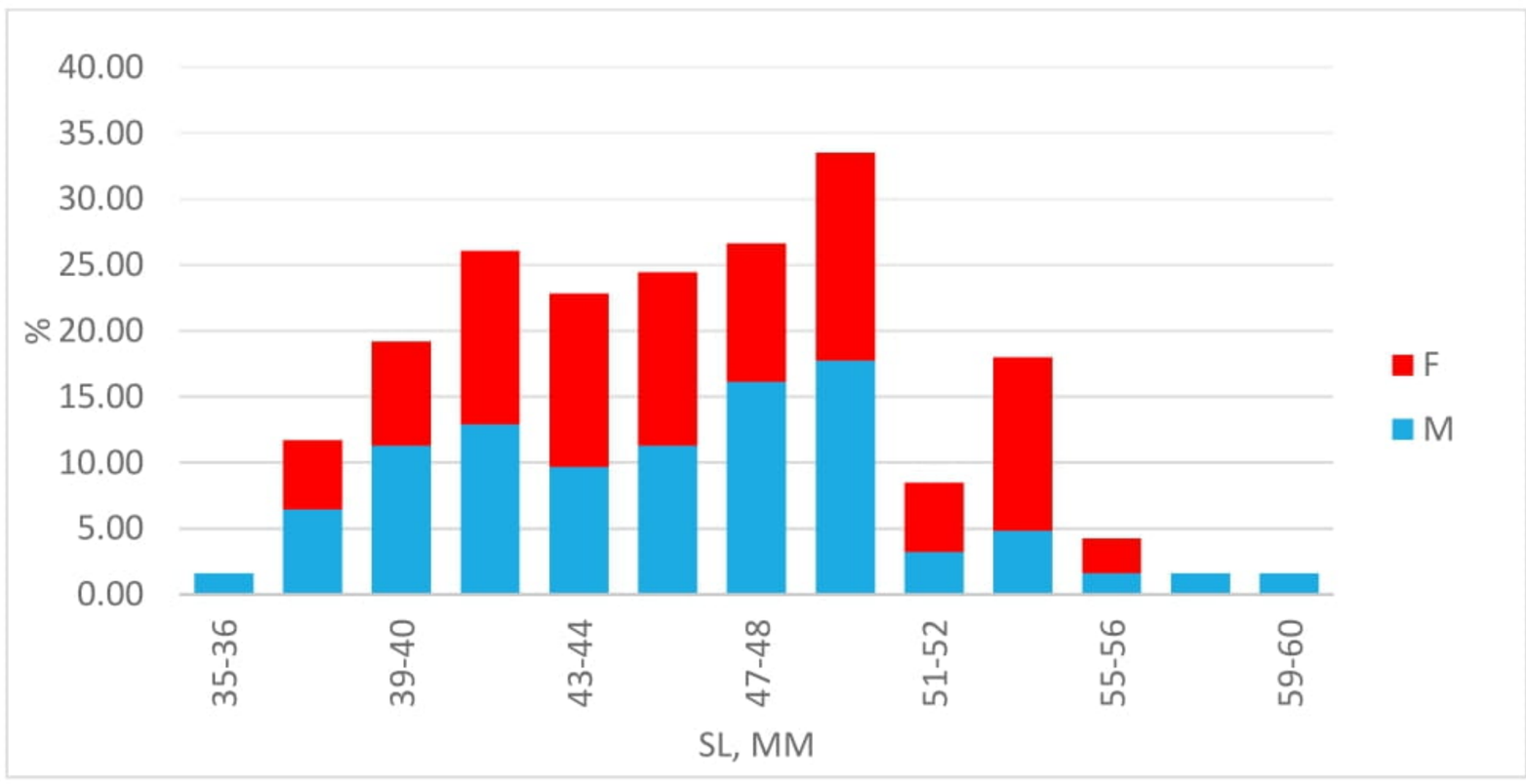

Figure 14. Distribution by length classes (SL, mm) of males (M) and females (F) in the first half of 2021: (1) in beam trawl samples and (2) in scuba diving samples.

In the weight structure of beam trawl catches (Fig. 15.1), the dominant weight class for both sexe were 14.5 - 29.5 g, found in 67.5 % of the measured males and 81.3 % of females. Respectively, in the catches by scuba diving method (Fig. 15.2) there were two dominant classes, for the male specimens these were - 11.5 - 17.5 g (31 %) and 23.5 - 29.5 g (23 %), and for the female individuals - 11.5 - 23.5 g. (47 %) and 26.5 - 35.5 g (32 %).

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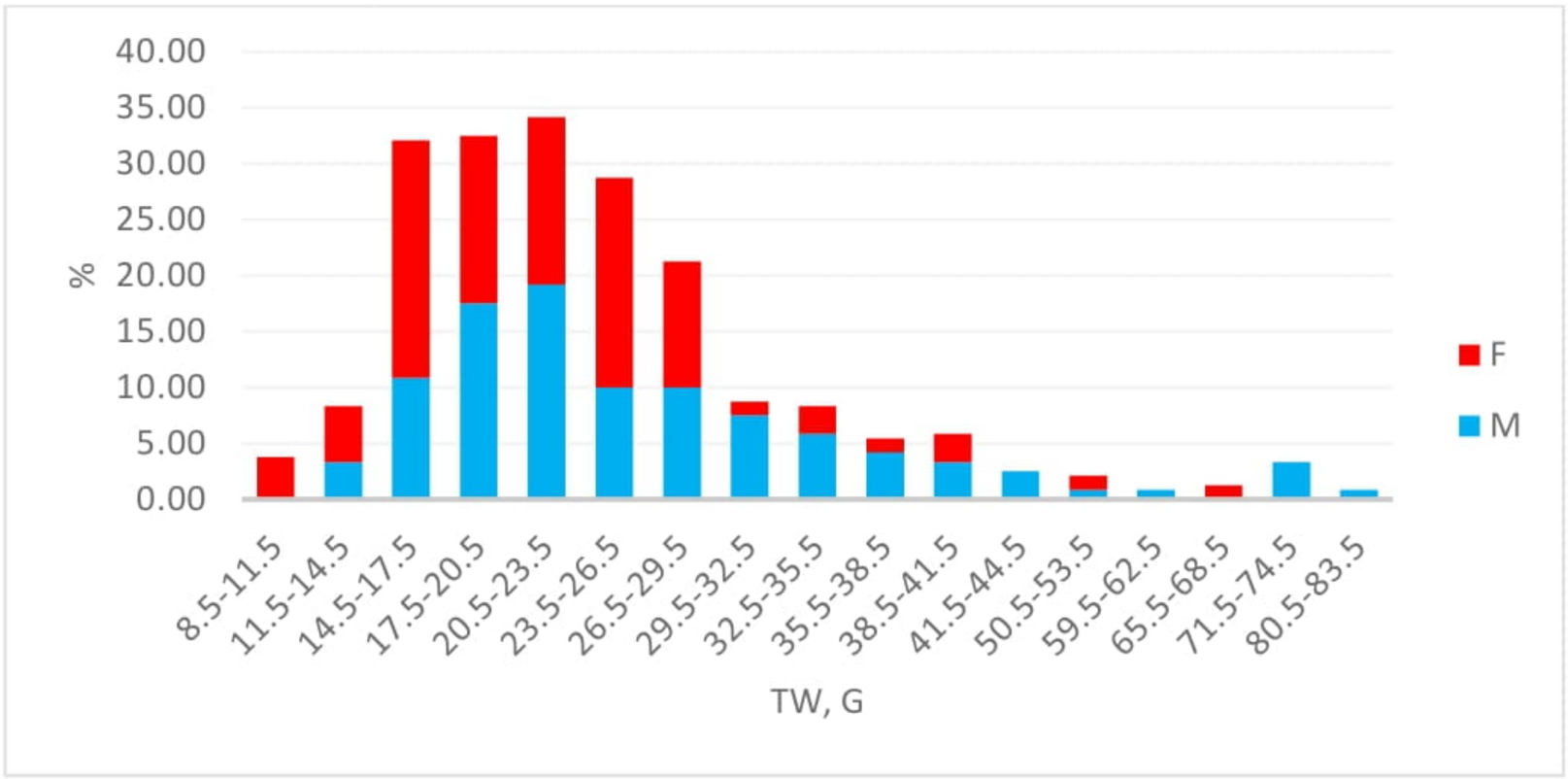
1.



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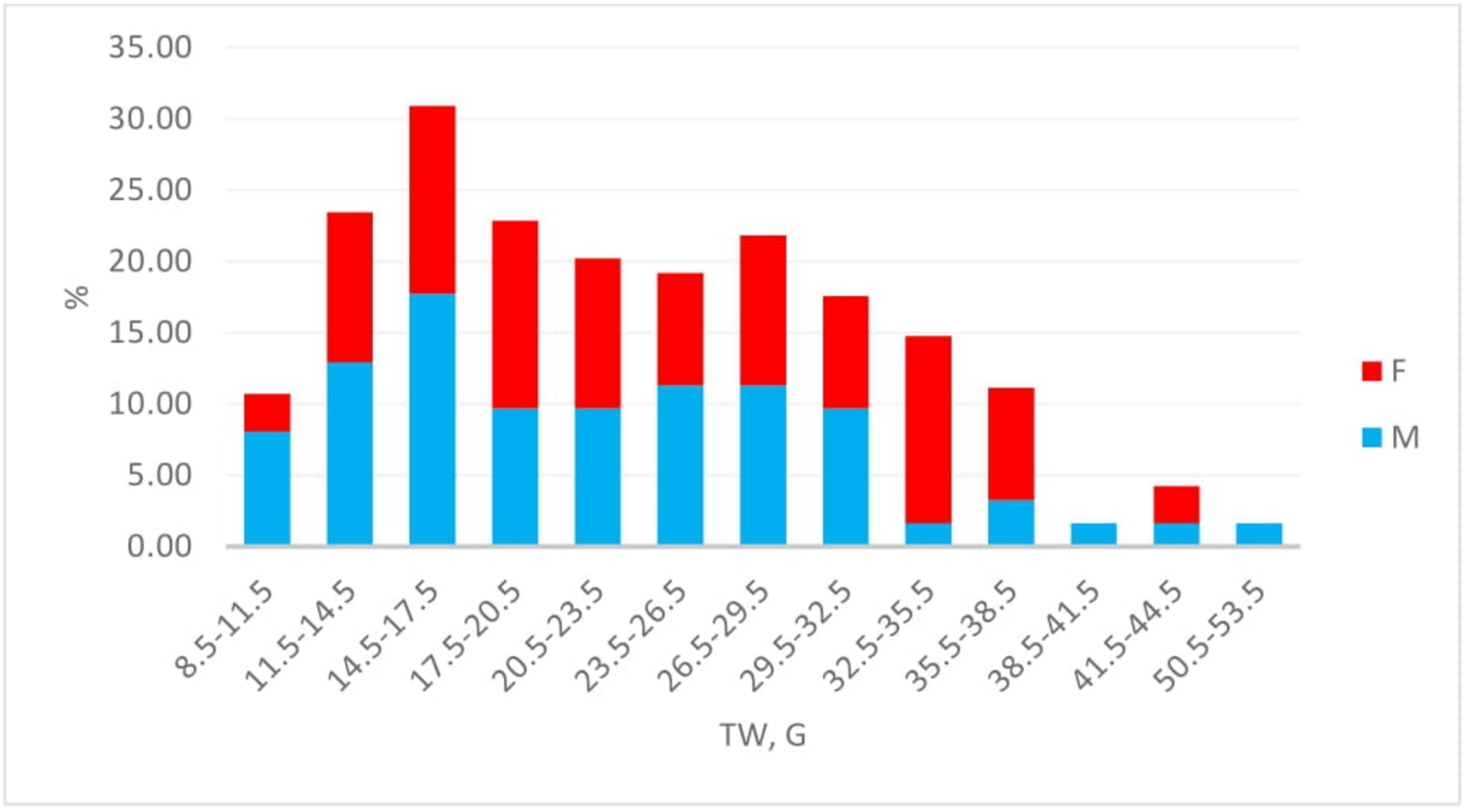

Figure 15. Distribution by weight class (TW, g) of males (M) and females (F) in the first half of 2021: (1) in beam trawl samoles and (2) in scuba diving samples.

According to the summarized data from the surveyed ports during the first half of 2021, it can be concluded that the growth of both sexes is allometric with coefficient b ≠ 3, (the parameters of the LW equation for both sexes are presented in Fig. 16 and Table 37)..

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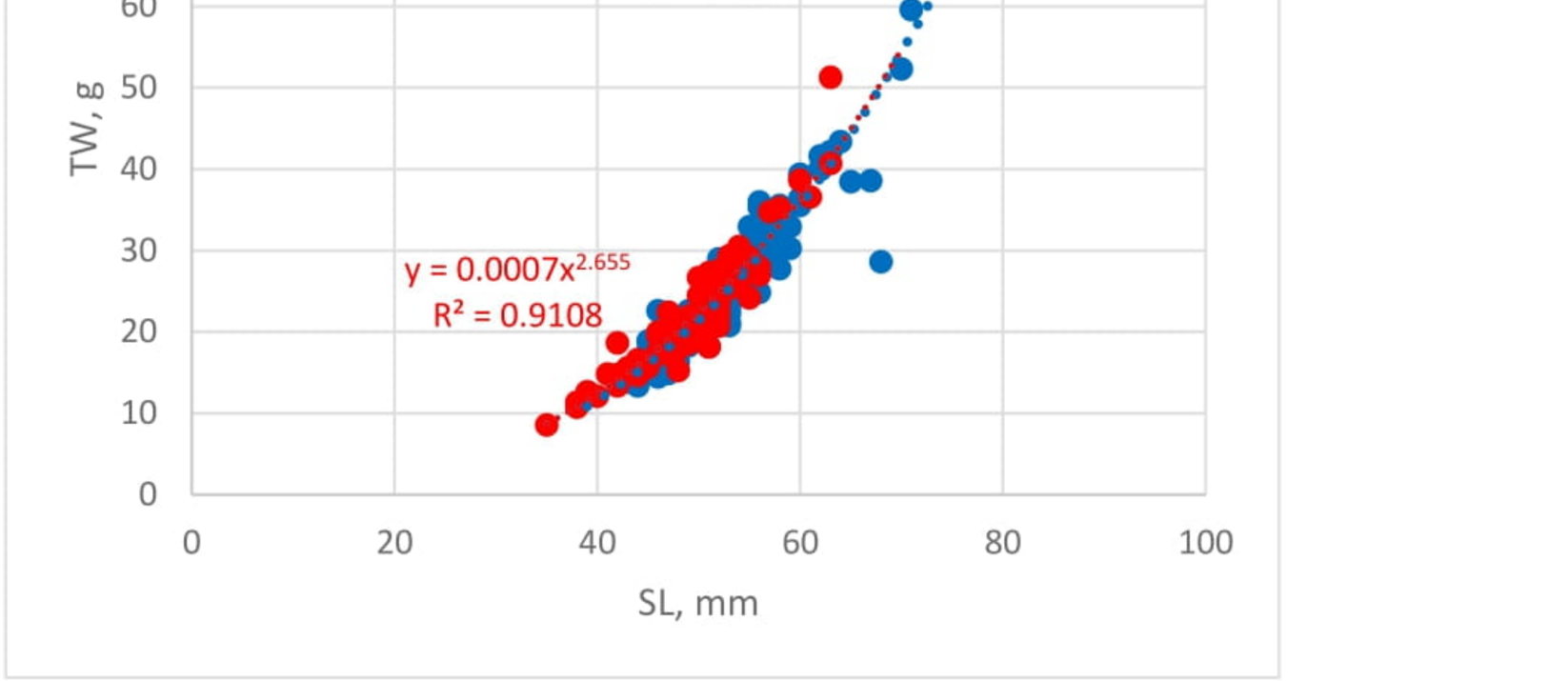

Figure 16. Relationship between the total weight (TW, g) and shell length (SL, mm) for the two sexes, based on the summarized data from beam trawl samples during the first half of 2021 (M-males, F-females).

Table 37

Parameters *a, b* of the L-W relationships and values of R^2 by sex, based on the summarized data from beam trawl samples during the fisrt half of 2021

Параметри $TW(g) = a.SL(mm)^b$	♀	♂
a	0.0007	0.0004
b	2.655	2.7564
R^2	0.91	0.92

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4. CONCLUSIONS

- The analyzes in this report are based on biometric measurements of 600 specimens of R. venosa, including 400 specimens, collected from beam trawl catches and 200 specimens from scuba diving catches. The landings samples were collected at three ports - Sozopol, Nesebar and Kavarna. In the case of the beam-trawls fishery, the total daily quantities of landings at the observed ports vary between 2933 - 8246 kg/day, as the most significant quantities were landed in April at the port of Kavarna (April 21, 2021). When fishing by scuba diving, landings in March vary between 43 - 120 kg/day, with the highest value at the port of Sozopol (10.03.2021).
- The variations of the average sizes of *Rapana venosa* by ports depend mostly on the fishing method - for beam trawl fishery, the average lengths of the specimens are between 49.66 - 52.44 mm, and for scuba diving samples - between 60.38 - 60.81 mm. The mean length of specimens, collected by beam trawl in this period, is 50.895 mm ± 6.91 SD, with an average weight of 24.54 g ± 10.51 SD. By the scuba diving fishery, the average weight of the Rapa whelk is 42.44 g ± 8.79 SD and the average length is - 60.60 mm. The average body weight (BW) in the beam trawl samples is 10.324 g ± 4.196 SD, forming 41.16 % of the weight of individuals, and by ports, the average percentage varies slightly between 40 % - 42 %. In the case of scuba diving fishery, the mean body weight of Rapa whelk is 12.827 g ± 3.64 SD, or 30 % of the total weight.
- The beam trawls catches are dominated by the specimens from the length group of 36 - 56 mm SL (78 % of the measured specimens), while the predominant group in the catches by scuba diving method was with larger sizes - 46 - 66 mm SL (84 %). Respectively, most specimens with low weights < 51.2 g TW (97 % of the total number) were found in the first type of samples, while in the landings from Sozopol and Nessebar (collected by the scuba diving method) the dominant weight class is 25.6 - 76.8 g TW (99.5 % of the measured specimens).
- For beam trawl catches in the first half of 2021, the Wd/SL percentage ratio averaged at 74.51 %, with minimal variations between samples. The average share of AL/SL (%) is 68.93%, varing between 68.5% - 69.5%. The average value of the AL/Wd ratio (%) was 95.53%, with variations from 92 % to 93.5 %. When fishing by scuba diving, the average values are respectively - 72.24% Wd/SL, 67.42% AL/SL and 93.33% AL/Wd.
- The comparative analysis of the parameters *a* and *b* of the LWR: W (g) = a x L (mm) ^{b} shows predominant allometric growth of *R. venosa* at a coefficient $b \neq 3$ (b <3).
- In the first half of 2021, on average for all surveyed areas, the sex ratio is 61 ♂: 39 % ♀. The gonadosomatic index is on average 18.657 % BW, with highest value in the sample from Kavarna in April (April 21, 2021) - 19.52% BW ± 4.20 SD.

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Проект № BG14MFOP001-3.003-0002 „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, съфинансиран от Европейския съюз чрез Европейския фонд за морско дело и рибарство.

- The average length of the male specimens from the beam trawl samples is 53.44 mm ± 7.42 SD, and the largest average length (54.91 mm) was registered in a sample from the port of Kavarna from May (26.05.2020). The average length of the female specimens was 49.39 mm ± 6.01 SD, giving a percentage difference of 7.58 % compared to the male specimens. The average weight of males was 38.60 g ± 17.66 SD, and of females - 31.37 g ± 10.46 SD, with a percentage difference of 21 % between the two sexes. By scuba diving fishery, the average length of males increased to 60.55 mm ± 5.21 SD, by an average weight of 41.95 g ± 9.43 SD, and the average length of females was 61.20 mm ± 4.91 SD, by an average weight of 44.21 g ± 9.27 SD.
- In the beam trawl catches, the length class - 47 - 56 mm is represented by a share - 64 % of the total number of males, while 47.5 % of the measured females belong to size class 43 - 54 mm. In catches by the selective scuba diving method, the length classes of 45 - 50 mm dominated for the male specimens (45 %), while the most common size classes for females are 41 - 50 mm (66 %). The weight structure of the beam trawl catches is dominated by the class - 14.5 - 29.5 g, found in 68 % of the measured males and 81 % of females. There are two dominant weight classes for scuba diving catches, for males - 11.5 - 17.5 g (31 %) and 23.5 - 29.5 g (23 %), and for females - 11.5 - 23.5 g (47 %) and 26.5 - 35.5 g (32 %).

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5. REFERENCES

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3. ICES. 2013. Report of the Study Group on Practical Implementation of Discard Sampling Plans (SGPIDS), 24 June – 28 June 2013, Lysekil, Sweden. ICES CM 2013/ACOM:56. 142pp

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Проект № BG14MFOP001-3.003-0002 „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, съфинансиран от Европейския съюз чрез Европейския фонд за морско дело и рибарство.