



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

SCIENTIFIC REPORT

FOR THE 1ST AND 2ND QUARTERS OF 2025



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This study is carried out by researchers from the Institute of Fish Resources – Varna, Agricultural Academy (AA), within Contract EAFA - 155 /27.03.2025 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 2025.

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 2025 and represents the dynamics of the biological parameters of *Rapana venosa* from the landed catch at four ports "Ada Bahcha", "Balchik", "Kavarna" and "Rodopa 1", based on the biometric measurements and analysis of 600 specimens of the target species.

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Petrova E., Mihneva V., Stoykov S., Tserkova F., Valchev S., Stefanova R., Penchev Ph. 2025. BIOLOGICAL MONITORING (BIOLOGICAL SAMPLES COLLECTION) OF THE LANDED RAPANA CATCH BY THE BULGARIAN FISHING FLEET FOR 1st and 2nd QUARTERS OF 2025, Report under Contract with the Executive Agency for Fisheries and Aquaculture, National Fisheries Data Collection Program., p. 60



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1. INTRODUCTION

The current report is representative for the first half of 2025 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 ports – Ada bahcha, Balchik, Kavarna and Rodopa 1.

1.1. COLLECTED DATA

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

1. Data about the fishing vessels' activity

- Fishery 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* – lengths, 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*, all from beam trawl) was carried out by landings in 4 ports, as the samples are collected from four ports - in the northern marine waters. The survey covers 5 days in the period Mar – June 2025, while the surveyed ports are - "Ada bahcha", "Balchik", "Kavarna" and "Rodopa 1". The summary of the collected data is presented in Table 1.

Table 1 Vessels and ports, where biological samples were taken from *Rapana venosa* landings

Date	Landing port	Fishing vessel	Fishing method	Catch/day in kg	Technical specifications
25.03.2025	Rodopa 1	Korsar 2	beam trawl	503	26,11 GT, 14.7 m, 147.1 kW
05.04.2025	Kavarna	Viking	beam trawl	2720	30.6 GT, 14.52 m, 132.39 kW
30.04.2025	Rodopa 1	Korsar 2	beam trawl	1950	26,11 GT, 14.7 m, 147.1 kW
02.05.2025	Balchik	Hermes-4	beam trawl	2600	24,62 GT, 14.95 m, 280 kW
01.06.2025	Ada bahcha	Tesi	beam trawl	2278	15,51 GT, 15.73 m, 133,86 kW
01.06.2025	Kavarna	NEPTUN-70	beam trawl	500	31,35 GT, 17.18 m, 103 kW



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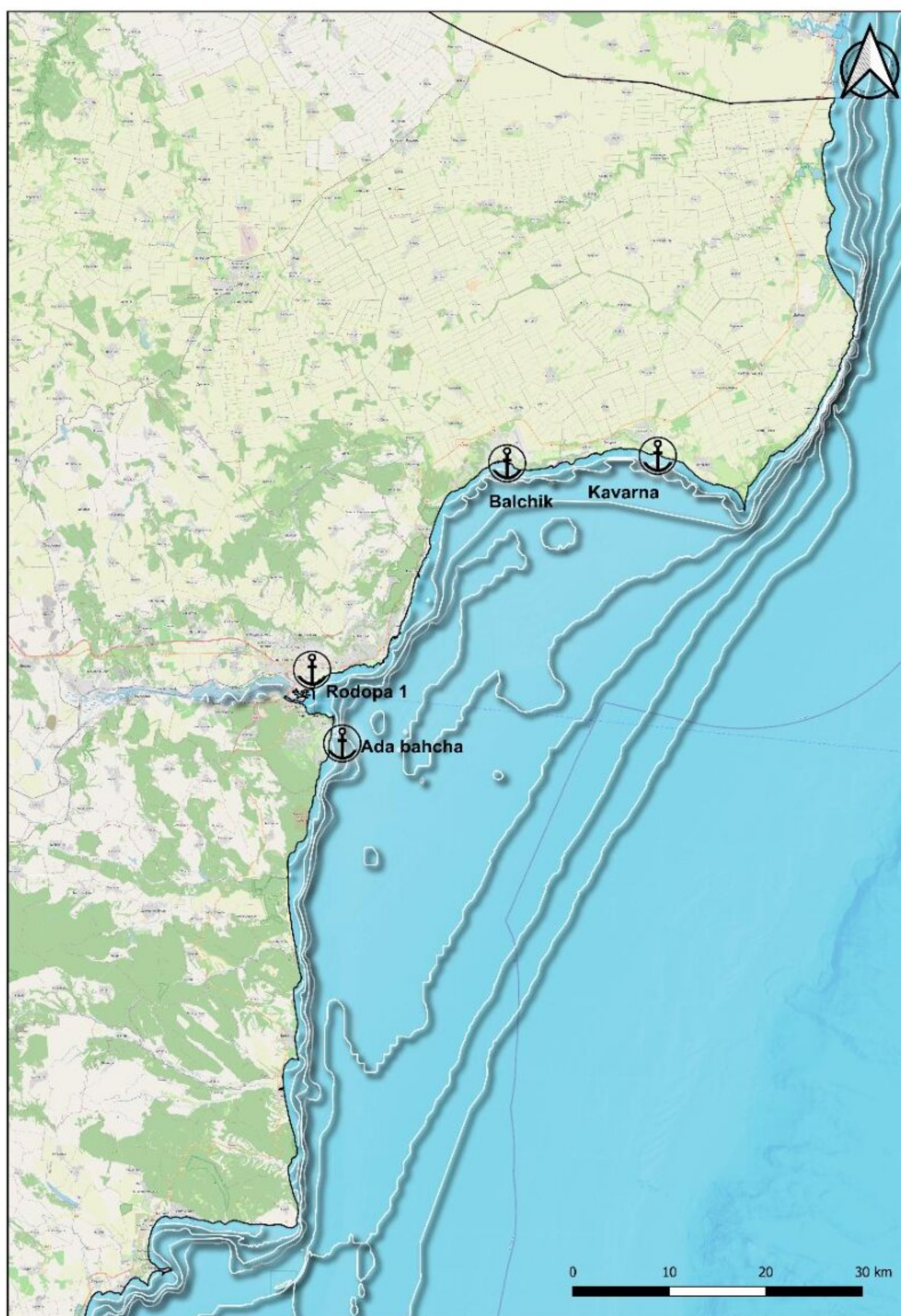


Figure 1 Landing ports for the first half of 2025

The beam-trawl has the following parameters – maximum width - 5.3 m, maximum depth - 6 m; 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. This particular beam trawl was used for rapa fishing in all observed landing ports.



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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:

- "Report of the Workshop on Sampling and Calculation Methodology for Fisheries Data" (WKSCMFD) (ICES 2004):

<https://www.ices.dk/sites/pub/CM%20Documents/2004/ACFM/ACFM1204.pdf>

- Report SGPIDS (ICES, 2011a):

<https://www.ices.dk/community/Documents/PGCCDBS/SGPIDS%202011.pdf>

- Report of the Study Group on Practical Implementation of Discard Samples (SGPIDS)

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), body weight (BW), shell length (SL), shell width (Wd), aperture length (AL) was analyzed based on classical allometric models. The least squares method was used to estimate the linear - weight relationships (**LWR**), based on the following equation:

$W(g) = a \cdot L(mm)^b$, 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:

$GSI = [\text{gonad weight} / \text{body weight}] \times 100$.



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When estimating the percentage difference between two values, a and b, the used formula was $= |\text{Absolute difference between the two values} / \text{Average of both the values}| \times 100\%$

The XLSTAT software product, together with the statistical libraries of programming language JULIA 1.11.7, were 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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3. RESULTS

3.1. BIOMETRIC MEASUREMENTS AND LENGTH-WEIGHT RELATIONSHIPS

3.1.1. Port Rodopa 1, 25.03.2025

The sample consists of 100 individuals rapa whelk, weighing 2.51 kg, from a total landing of 503 kg rapa whelks at port Rodopa 1 (from the fishing vessel).

The mean weight of the measured specimens reaches $25.13 \text{ g} \pm 7.94 \text{ SD}$, at a mean shell length of $51.32 \text{ mm} \pm 5.55 \text{ SD}$, shell width $38.9 \text{ mm} \pm 4.17 \text{ SD}$ and aperture length $36.71 \text{ mm} \pm 4.05 \text{ SD}$. The mean body weight without shell (BW, g) is $8.03 \text{ g} \pm 2.69 \text{ SD}$ forming $29.83\% \pm 3.59 \text{ SD}$ from the total weight, varying between 21.24% and 37.72% from the total weight. (Table 2)

Table 2

Summarized statistics of the biological parameters - total weight (TW, g), body weight (BW, g), percentage ratio of BW (% TW), shell length (SL, mm), shell width (Wd, mm) and aperture length (aperture length, AL, mm) at port Rodopa 1, 25.03.2025

	TW g	SL mm	Wd mm	Al mm	BW g	BW% TW
Sample size	100	100	100	100	50	50
Mean	25.13	51.32	38.9	36.71	8.03	29.83
Standard deviation	7.94	5.55	4.17	4.05	2.69	3.59
Minimum	12.11	39	28	26	4.4	21.24
50% (median)	23.68	51	38	36	7.15	29.67
Maximum	52.36	68	50	48	17.26	37.72
Sum	2513.33	5132	3890	3671	401.56	1491.67
Mode	25.01	48	38	36	7.13	30.11
Sample variance	63.01	30.79	17.36	16.39	7.26	12.89
Kurtosis	2.2	0.08	0.25	0.37	2.78	-0.04
Skewness	1.29	0.42	0.34	0.4	1.64	0.03
Range	40.25	29	22	22	12.86	16.49
Confidence level 95%	(23.58, 26.69)	(50.23, 52.41)	(38.08, 39.72)	(35.92, 37.5)	(7.28, 8.78)	(28.84, 30.83)

The dominant size classes from the sample are 50mm - 60 mm (51% of the measured individuals). As for the weight structure, the dominant weight class (TW, g) is 20-30 g (58% of the measured individuals).



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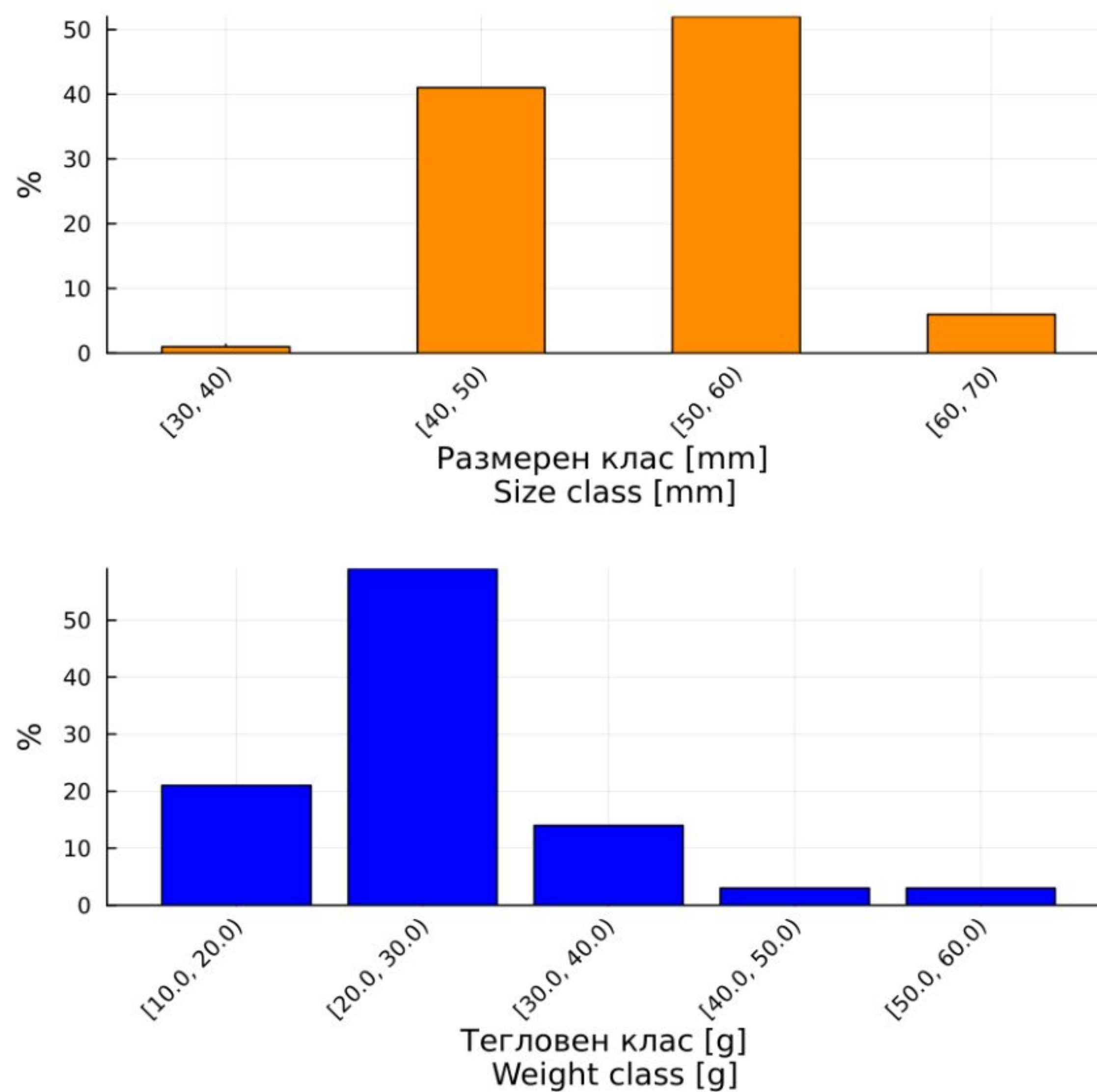


Figure 2 Size structure [mm] and weight structure [g] of the sample from port Rodopa 1, 25.03.2025

The mean ratio between the shell width (Wd, mm)/shell length (SL, mm) is $75.86\% \pm 3.01$ SD, while AL/SL (%) is $71.57\% \pm 2.87$ SD, and the ratio between AL/Wd (%) was calculated at $-94.35\% \pm 1.61$ SD (Table 3).



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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 Rodopa 1, 25.03.2025

	Wd/SL%	Al/SL%	Al/Wd%
Sample size	100	100	100
Mean	75.86	71.57	94.35
Standard deviation	3.01	2.87	1.61
Minimum	69.49	65.38	90.62
50% (median)	76.04	71.87	94.59
Maximum	84.44	80	97.73
Sum	7586.27	7157.07	9435.41
Mode	75	75	94.74
Sample variance	0.09	0.08	0.03
Kurtosis	-22.23	-6.36	-45.25
Skewness	23.63	10.45	-2.43
Range	14.95	14.62	7.1
Confidence level 95%	(0.75, 0.76)	(0.71, 0.72)	(0.94, 0.95)

The L-W ratios have been calculated in Figure 3. 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 the L-W ratios and values of R^2 for the sample from port Rodopa 1, 25.03.2025

Parameters	$TW(g) = a.SL(mm)^b$	$TW(g) = a.Wd(mm)^b$	$W(g) = a.AL(mm)^b$
a	0.0005	0.0011	0.0016
b	2.7488	2.7442	2.6726
R²	0.93	0.91	0.92



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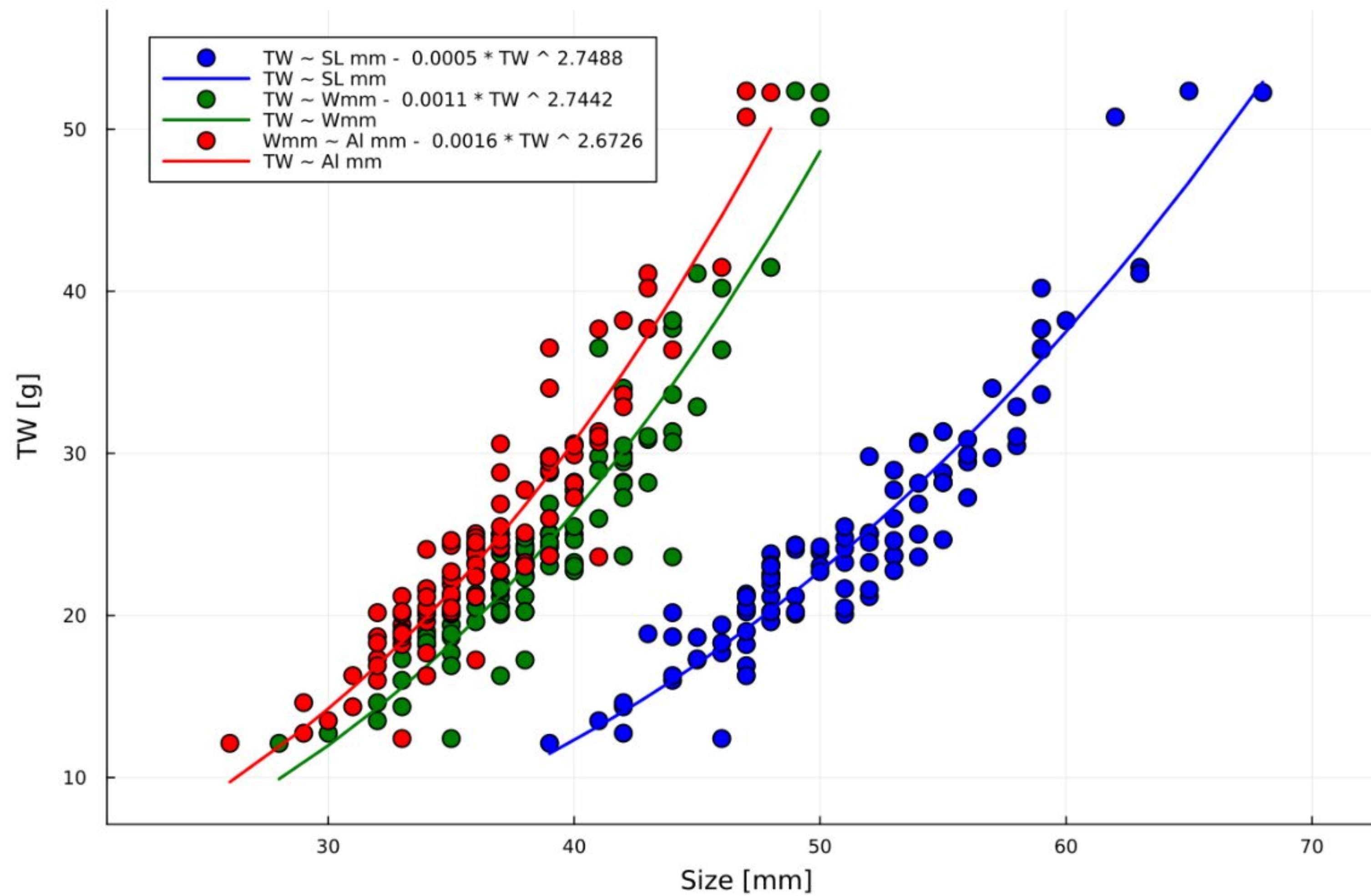


Figure 3 L-W ratios for the sampled individuals, port Rodopa 1, 25.03.2025(1) ratio between total weight (TW, g) and shell length (SL, mm); (2) relationship between total weight (TW, g) and shell width (Wd, mm); (3) relationship between total weight (TW, g) and aperture length (AL, mm)



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3.1.2. Port Kavarna, 05.04.2025

The sample consists of 100 individuals, weighing 3.3 kg, from a total landing of 2720 kg rapa whelks at port Kavarna (from the fishing vessel)

The mean weight of the measured specimens reaches $32.97 \text{ g} \pm 15.69 \text{ SD}$, at a mean shell length of $56.56 \text{ mm} \pm 8.03 \text{ SD}$, shell width $42.58 \text{ mm} \pm 6.1 \text{ SD}$ and aperture length $40.02 \text{ mm} \pm 5.94 \text{ SD}$. The mean body weight without shell (BW, g) is $11.82 \text{ g} \pm 7.91 \text{ SD}$ forming $35.22\% \pm 4.72 \text{ SD}$ from the total weight, varying between 22.13% and 48.38% from the total weight (Table 5).

Table 5

Summary statistics of the biological parameters – total weight (TW, g), body weight (BW, g), percentage ratio BW (% TW), shell length (SL, mm), shell width (Wd, mm) and aperture length (aperture length, AL, mm) from port Kavarna, 05.04.2025

	TW g	SL mm	Wd mm	Al mm	BW g	BW% TW
Sample size	100	100	100	100	50	50
Mean	32.97	56.56	42.58	40.02	11.82	35.22
Standard deviation	15.69	8.03	6.1	5.94	7.91	4.72
Minimum	11.55	40	30	28	3.93	22.13
50% (median)	27.8	55	42	39.5	9.93	35.66
Maximum	107.86	88	65	62	52.18	48.38
Sum	3297.36	5656	4258	4002	590.96	1761.1
Mode	17.13	52	40	38	7.31	48.38
Sample variance	246.32	64.49	37.2	35.31	62.52	22.32
Kurtosis	4.9	2.02	1.49	1.5	12.33	1.5
Skewness	1.9	1.14	0.95	0.93	3.13	-0.47
Range	96.31	48	35	34	48.25	26.24
Confidence level 95%	(29.9, 36.05)	(54.99, 58.13)	(41.38, 43.78)	(38.86, 41.18)	(9.63, 14.01)	(33.91, 36.53)

The dominant size classes from the sample are 50 - 60 mm (51% of the measured individuals). As for the weight structure, the dominant weight class (TW, g) is 20-30 g (41% of the measured individuals).



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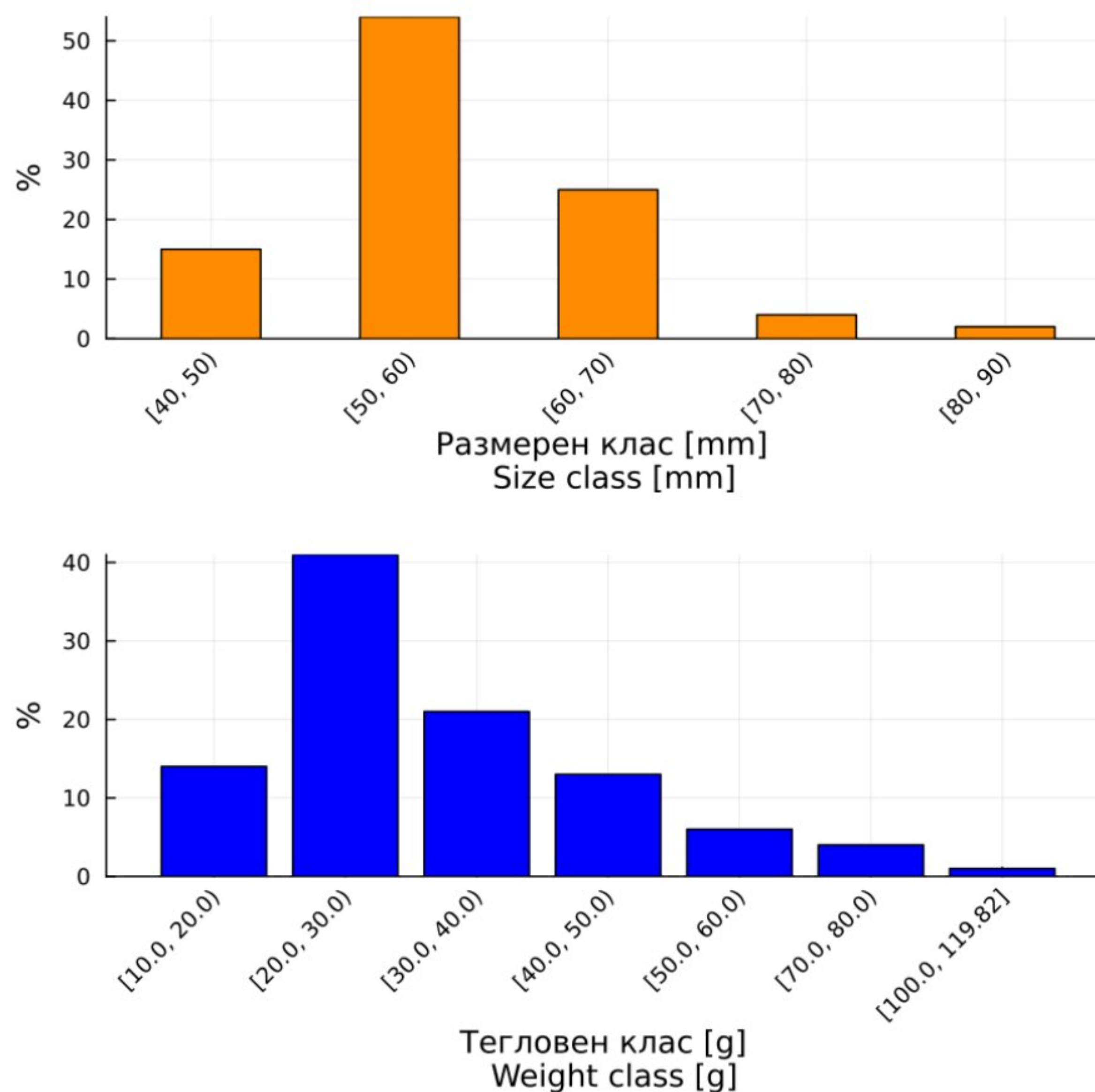


Figure 4 Size structure [mm] and weight structure [g] of the sample from port Kavarna, 05.04.2025

The mean ratio between the shell width (Wd, mm)/shell length (SL, mm) is $75.32\% \pm 3.09$ SD, while AL/SL (%) is $70.74\% \pm 2.87$ SD, and the ratio between AL/Wd (%) was calculated at $93.94\% \pm 2.02$ SD (Table 6).



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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,%) of the individuals from the sample from port Kavarna, 05.04.2025

	Wd/SL%	Al/SL%	Al/Wd%
Sample size	100	100	100
Mean	75.32	70.74	93.94
Standard deviation	3.09	2.87	2.02
Minimum	67.86	64.29	80
50% (median)	75	70.97	94.06
Maximum	85.11	80	97.96
Sum	7532.17	7074.06	9394.24
Mode	75	68.75	95
Sample variance	0.1	0.08	0.04
Kurtosis	46.64	57.12	2081.31
Skewness	23.06	18.38	-306.88
Range	17.25	15.71	17.96
Confidence level 95%	(0.75, 0.76)	(0.7, 0.71)	(0.94, 0.94)

The L-W ratios are calculated in Figure 3. 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 the L-W ratios and values of R^2 for the sample from port of Kavarna, 05.04.2025

Parameters	$TW(g) = a \cdot SL(mm)^b$	$TW(g) = a \cdot Wd(mm)^b$	$W(g) = a \cdot AL(mm)^b$
a	0.0003	0.0006	0.001
b	2.8395	2.901	2.8088
R²	0.96	0.95	0.95



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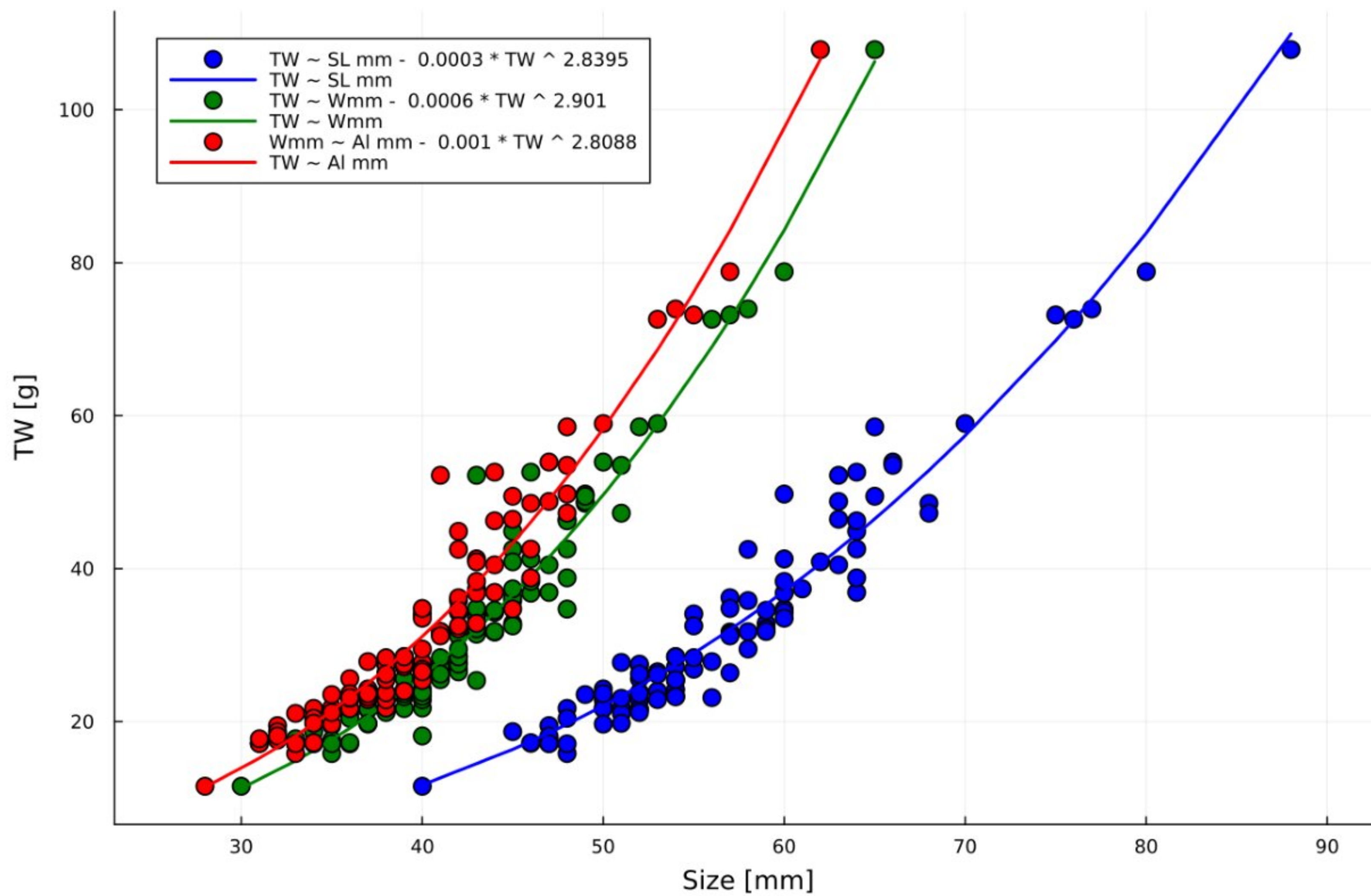


Figure 5 L-W ratios for the sampled individuals, port Kavarna, 05.04.2025: (1) Total weight (TW, g) from the shell length (SL, mm); (2) Total weight (TW, g) from the shell width (Wd, mm); (3) total weight (TW, g) and aperture length (AL, mm)



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3.1.3. Port Rodopa 1, 30.04.2025

The sample consists of 100 individuals rapa whelk, weighing 3.46 kg, from a total landing of 1950 kg rapa whelks at port Rodopa 1 (from the fishing vessel).

The mean weight of the measured specimens reaches $34.61 \text{ g} \pm 7.76 \text{ SD}$, at a mean shell length of $58.55 \text{ mm} \pm 4.67 \text{ SD}$, shell width – $43.07 \text{ mm} \pm 4.02 \text{ SD}$ and aperture length $40.57 \text{ mm} \pm 3.72 \text{ SD}$. The mean body weight without shell (BW, g) is $12.02 \text{ g} \pm 3.1 \text{ SD}$ forming $34.33\% \pm 3.86 \text{ SD}$ from the total weight, varying between 23.51% and 43.86% from the total weight. (Table 8)

Table 8

Summary statistics of the biological parameters – total weight (TW, g), body weight (BW, g), percentage ratio BW (% TW), shell length (SL, mm), shell width (Wd, mm) and aperture length (aperture length, AL, mm) from port Rodopa 1, 30.04.2025

	TW g	SL mm	Wd mm	Al mm	BW g	BW% TW
Sample size	100	100	100	100	50	50
Mean	34.61	58.55	43.07	40.57	12.02	34.33
Standard deviation	7.76	4.67	4.02	3.72	3.1	3.86
Minimum	18	48	34	32	5.97	23.51
50% (median)	34.26	58	43	41	11.48	33.98
Maximum	65.39	73	53	50	18.87	43.86
Sum	3460.59	5855	4307	4057	600.88	1716.34
Mode	34.26	63	43	40	8.11	35.54
Sample variance	60.18	21.81	16.19	13.84	9.6	14.89
Kurtosis	1.37	-0.06	-0.48	-0.48	-0.76	0.69
Skewness	0.66	0.16	-0.01	-0.08	0.24	0.21
Range	47.39	25	19	18	12.9	20.34
Confidence level 95%	(33.09, 36.13)	(57.63, 59.47)	(42.28, 43.86)	(39.84, 41.3)	(11.16, 12.88)	(33.26, 35.4)

The dominant size classes from the sample are 50 - 60 mm (58% of the measured individuals). As for the weight structure, the dominant weight class (TW, g) is 30-40 g (51% of the measured individuals).



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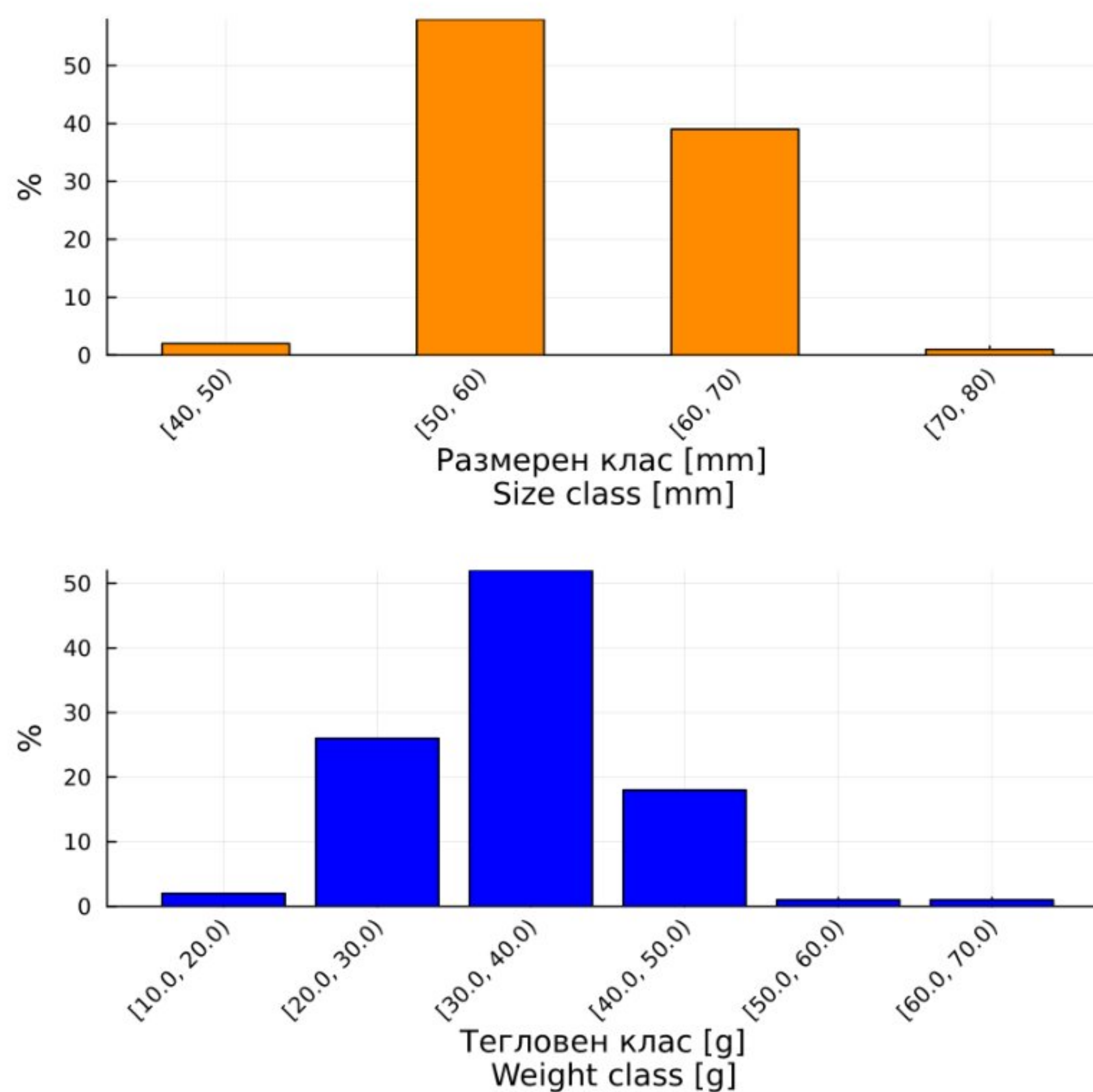


Figure 6 Size structure [mm] and weight structure [g] of the sample from port Rodopa 1, 30.04.2025

The mean ratio between the shell width (Wd, mm)/shell length (SL, mm) is $73.63\% \pm 3.31$ SD, while AL/SL (%) is $68.19\% \pm 3.42$ SD, and the ratio between AL/Wd (%) was calculated at $-92.61\% \pm 1.78$ 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/total shell width (AL/Wd,%) of the individuals from the sample from port Rodopa 1, 30.04.2025

	Wd/SL%	Al/SL%	Al/Wd%
Sample size	100	100	100
Mean	73.55	69.29	94.22
Standard deviation	3.37	3.15	1.52
Minimum	66.67	62.96	89.8
50% (median)	73.15	68.63	94.31
Maximum	86.27	80.39	97.73
Sum	7354.65	6928.62	9422.08
Mode	70	66.67	93.48
Sample variance	0.11	0.1	0.02
Kurtosis	143.73	93.38	-6.64
Skewness	84.3	75.21	2.01
Range	19.61	17.43	7.93
Confidence level 95%	(0.73, 0.74)	(0.69, 0.7)	(0.94, 0.95)

The L-W ratios are calculated, Figure 7. 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 the L-W ratios and values of R^2 for the sample from port Rodopa 1, 30.04.2025

Parameters	$TW(g) = a.SL(mm)^b$	$TW(g) = a.Wd(mm)^b$	$W(g) = a.AL(mm)^b$
a	0.0011	0.0068	0.0006
b	2.534	2.266	2.3341
R²	0.88	0.92	0.93



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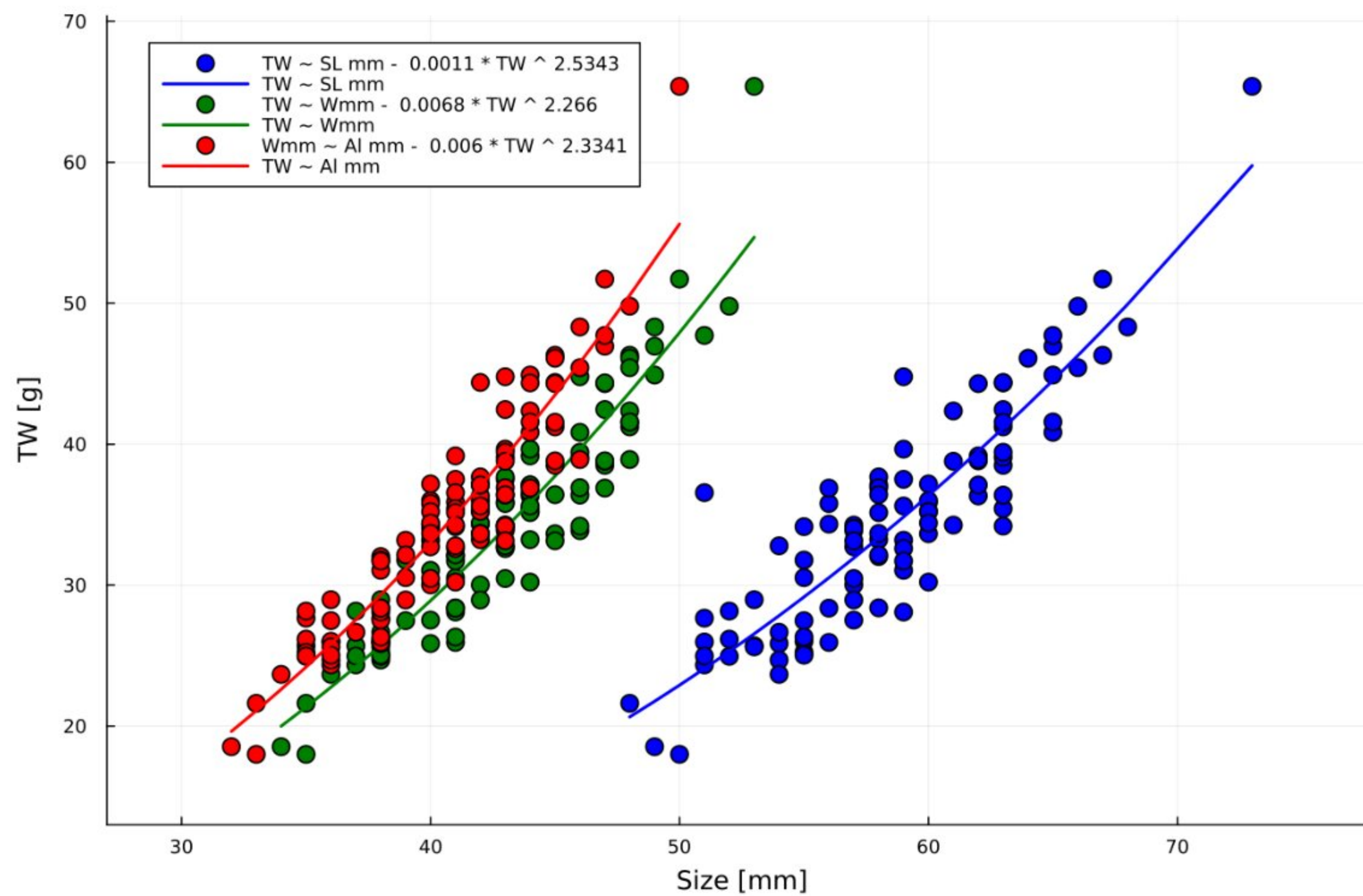


Figure 7 L-W ratios for the sampled individuals, port Rodopa 1, 30.04.2025: (1) ratio between total weight (TW, g) and shell length (SL, mm); (2) relationship between total weight (TW, g) and shell width (Wd, mm); (3) relationship between total weight (TW, g) and aperture length (AL, mm)



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3.1.4. PORT BALCHIK, 02.05.2025

The sample consists of 100 individuals rapa whelk, weighing 5.16 kg, from a total landing of 2600 kg rapa whelks at port Balchik (from the fishing vessel).

The mean weight of the measured specimens reaches $51.61 \text{ g} \pm 15.82 \text{ SD}$, at a mean shell length of $66.48 \text{ mm} \pm 6.02 \text{ SD}$, shell width - $49.91 \text{ mm} \pm 4.92 \text{ SD}$ and aperture length $47.46 \text{ mm} \pm 4.83 \text{ SD}$. The mean body weight without shell (BW, g) is $19.95 \text{ g} \pm 5.99 \text{ SD}$ forming $39.18\% \pm 15.96 \text{ SD}$ from the total weight, varying between 17.34% и 115.39% from the total weight (Table 11).

Table 11

Summarized statistics of the biological parameters - total weight (TW, g), body weight (BW, g), percentage ratio of BW (% TW), shell length (SL, mm), shell width (Wd, mm) and aperture length (AL, mm) at port Balchik, 02.05.2025

	TW g	SL mm	Wd mm	Al mm	BW g	BW% TW
Sample size	100	100	100	100	50	50
Mean	51.61	66.48	49.91	47.46	19.95	39.18
Standard deviation	15.82	6.02	4.92	4.83	5.99	15.96
Minimum	22.03	52	38	36	11.17	17.34
50% (median)	49.06	66	50	47.5	18.08	35.36
Maximum	109.55	82	62	60	36.69	115.39
Sum	5160.86	6648	4991	4746	997.57	1958.91
Mode	41.88	65	48	49	14.54	31.73
Sample variance	250.16	36.27	24.16	23.3	35.84	254.7
Kurtosis	1.62	0.42	0.01	0.06	0.47	8.8
Skewness	1.08	0.34	0.2	0.23	1.02	2.39
Range	87.52	30	24	24	25.52	98.05
Confidence level 95%	(48.51, 54.71)	(65.3, 67.66)	(48.95, 50.87)	(46.51, 48.41)	(18.29, 21.61)	(34.75, 43.6)

The dominant size classes from the sample are 60-70 mm (60% of the measured individuals). As for the weight structure, the dominant weight class (TW, g) is 40-50 g (31% of the measured individuals).



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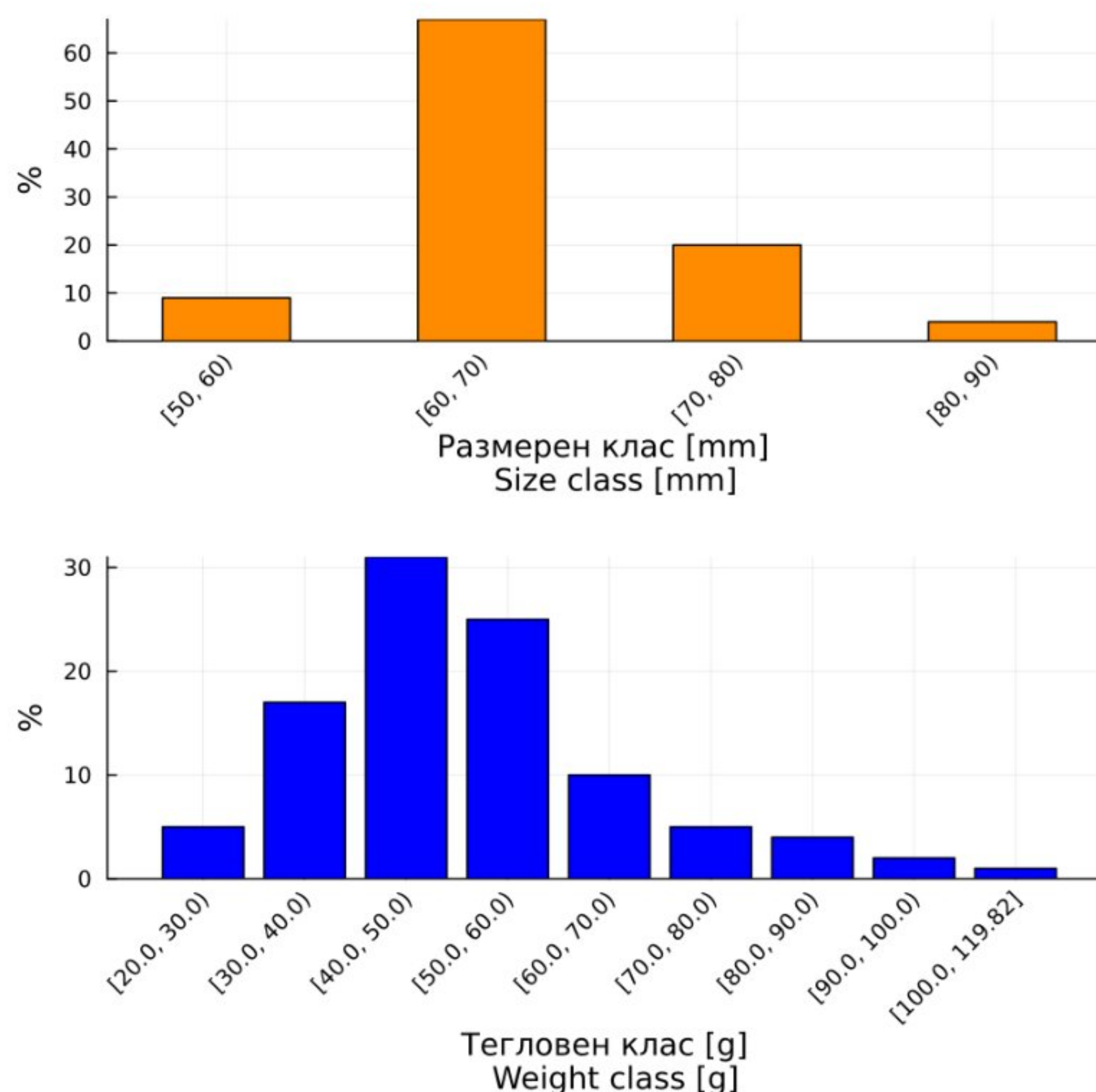


Figure 8 Size structure [mm] and weight structure [g] of the sample from port Balchik, 02.05.2025

The mean ratio between the shell width (Wd, mm)/shell length (SL, mm) is $75.09\% \pm 3.37$ SD, while AL/SL (%) is $71.38\% \pm 3.24$ SD, and the ratio between AL/Wd (%) was calculated at $-95.07\% \pm 1.54$ SD (Table 12).



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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,%) of the individuals from the sample from port Balchik, 02.05.2025

	Wd/SL%	Al/SL%	Al/Wd%
Sample size	100	100	100
Mean	75.09	71.38	95.07
Standard deviation	3.37	3.24	1.54
Minimum	64.86	62.16	91.49
50% (median)	74.65	71.43	95.29
Maximum	84.48	81.03	98.08
Sum	7509.2	7138.5	9507.38
Mode	78.46	71.43	95.83
Sample variance	0.11	0.1	0.02
Kurtosis	42.48	52.83	-49.54
Skewness	13.57	17.41	-10.24
Range	19.62	18.87	6.59
Confidence level 95%	(0.74, 0.76)	(0.71, 0.72)	(0.95, 0.95)

The L-W ratios are calculated (Figure 9). The parameters a , b of the derived L-W ratio and the value of the coefficient of determination R^2 are presented in Table 13.

Table 13

Parameters a , b of the L-W ratios and values of R^2 for the sample from port Balchik, 02.05.2025

Parameters	$TW(g) = a \cdot SL(mm)^b$	$TW(g) = a \cdot Wd(mm)^b$	$W(g) = a \cdot AL(mm)^b$
a	0.0043	0.00275	0.0318
b	2.33	1.925	1.913
R²	0.74	0.76	0.77



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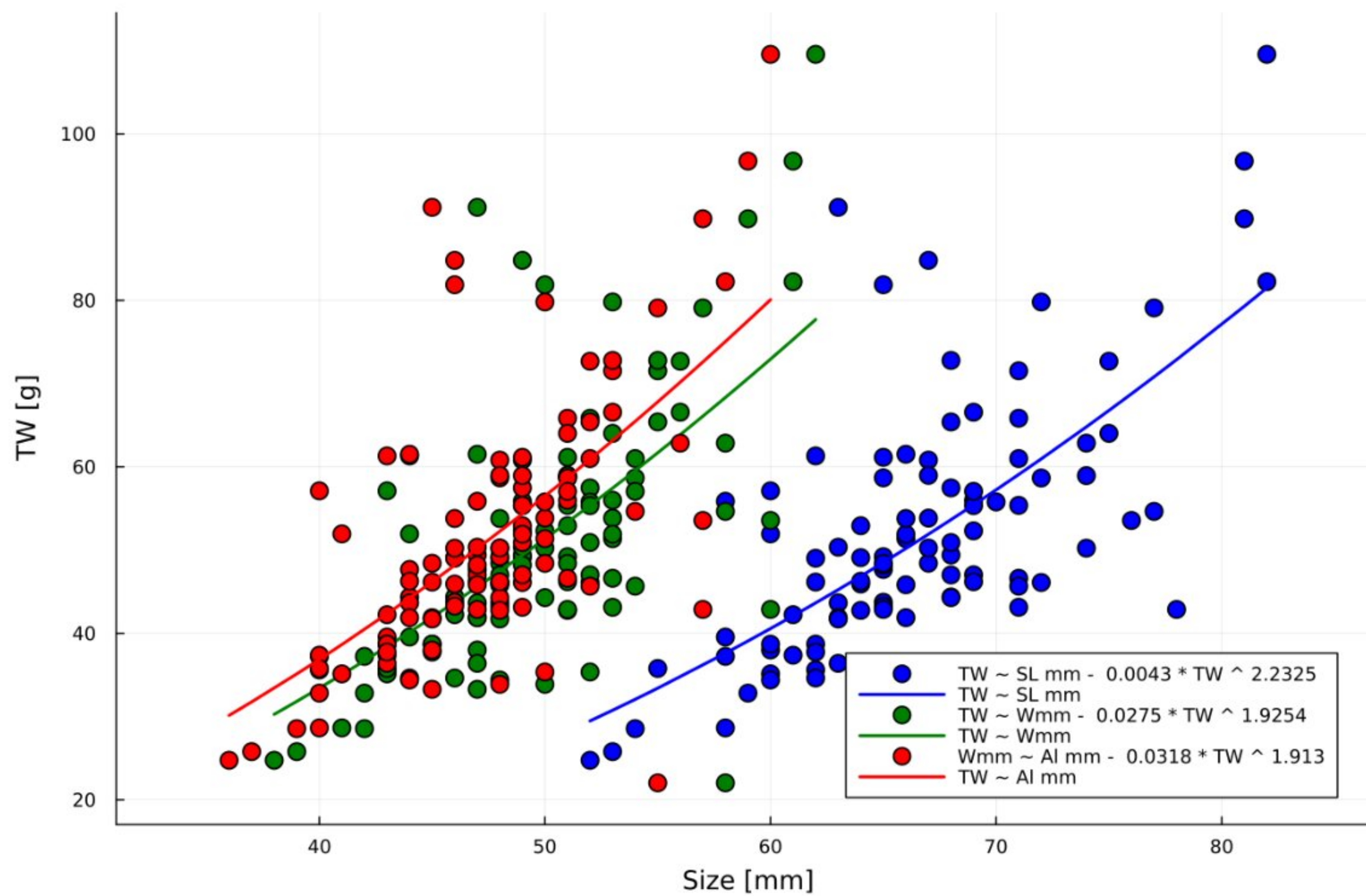


Figure 9 L-W ratios for the sampled individuals, port Balchik, 02.05.2025: (1) ratio between total weight (TW, g) and shell length (SL, mm); (2) relationship between total weight (TW, g) and shell width (Wd, mm); (3) relationship between total weight (TW, g) and aperture length (AL, mm)



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3.1.5. PORT ADA BAHCHA, 01.06.2025

The sample consists of 100 individuals (from scuba diving) with a total weight of 4.65 kg, from a total landing of 2278 kg rapa whelks at port Ada bahcha (from the fishing vessel).

The mean weight of the measured specimens reaches $46.48 \text{ g} \pm 25.26 \text{ SD}$ at a mean shell length of $62.54 \text{ mm} \pm 12.41 \text{ SD}$, shell width $48.49 \text{ mm} \pm 10.28 \text{ SD}$ and aperture length $46.08 \text{ mm} \pm 9.9 \text{ SD}$. The mean body weight without shell (BW, g) is $19.89 \text{ g} \pm 8.82 \text{ SD}$, which is $34.34\% \pm 3.07 \text{ SD}$ from the total weight, varying between 24.75% и 39.21% from the total weight (Table 14).

Table 14

Summarized statistics of the biological parameters - total weight (TW, g), body weight (BW, g), percentage ratio of BW (% TW), shell length (SL, mm), shell width (Wd, mm) and aperture length (AL, mm) at port Ada bahcha, 01.06.2025

	TW g	SL mm	Wd mm	Al mm	BW	BW% TW
Sample size	100	100	100	100	50	50
Mean	46.48	62.54	48.49	46.08	19.89	34.34
Standard deviation	25.26	12.41	10.28	9.9	8.82	3.07
Minimum	10.46	37	28	26	4.14	24.75
50% (median)	43.76	63	48	45	19.75	35.01
Maximum	119.82	94	73	69	45.83	39.21
Sum	4648.44	6254	4849	4608	994.3	1717.11
Mode	39.58	58	48	53	15.43	38.25
Sample variance	638.18	154.09	105.69	98.05	77.81	9.44
Kurtosis	0.16	-0.8	-0.74	-0.82	0.33	1.02
Skewness	0.75	0.04	0.18	0.14	0.58	-1.04
Range	109.36	57	45	43	41.69	14.45
Confidence level 95%	(41.53, 51.44)	(60.11, 64.97)	(46.48, 50.5)	(44.14, 48.02)	(17.44, 22.33)	(33.49, 35.19)

The dominant size classes from the sample are 50 -70 mm (48% of the measured individuals). As for the weight structure, there is no dominant weight class.



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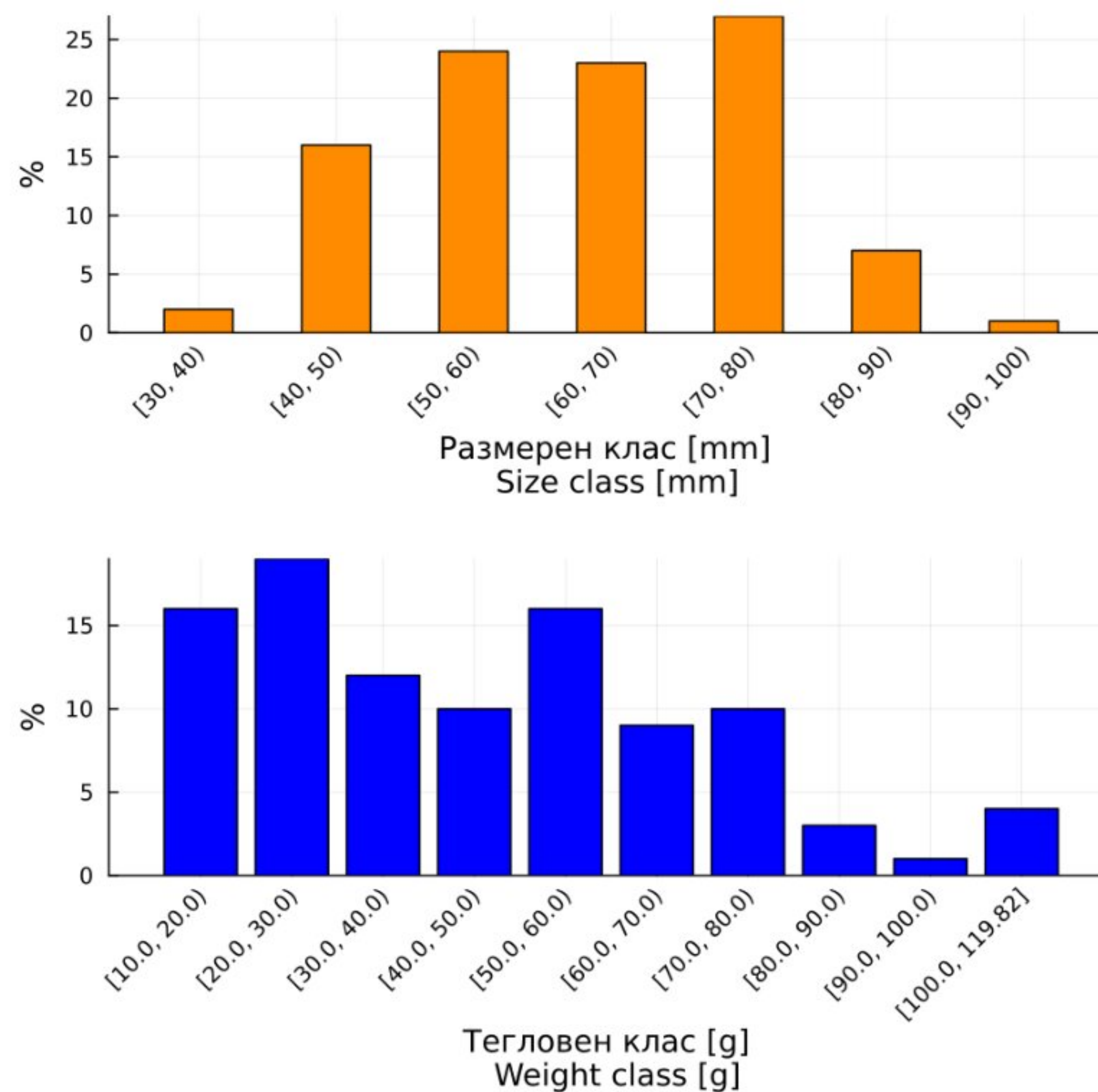


Figure 10 Size structure [mm] and weight structure [g] of the sample from port Ada bahcha, 01.06.2025

Percentage ratios between shell width and length (Wd/SL,%), aperture length/total shell length (AL/SL,%) and aperture length/total shell width are presented in Table 15. (AL/Wd,%)

The mean ratio between the shell width (Wd, mm)/shell length (SL, mm) is $77.41\% \pm 3.29$ SD, while AL/SL (%) is $73.51\% \pm 3.22$ SD, and the ratio between AL/Wd (%) was calculated at $-94.97\% \pm 1.50$ SD.



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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,%) of the individuals from the sample from port Ada bahcha, 01.06.2025

	Wd/SL%	Al/SL%	Al/Wd%
Sample size	100	100	100
Mean	77.41	73.51	94.97
Standard deviation	3.29	3.22	1.5
Minimum	61.73	59.26	91.67
50% (median)	77.27	73.37	94.94
Maximum	85.25	80.72	98.15
Sum	7741.18	7351.24	9496.98
Mode	76.19	75	93.75
Sample variance	0.11	0.1	0.02
Kurtosis	453.09	293.69	-39.51
Skewness	-93.97	-80.21	-4.8
Range	23.52	21.46	6.48
Confidence level 95%	(0.77, 0.78)	(0.73, 0.74)	(0.95, 0.95)

The L-W ratios are calculated (Figure 11). The parameters a , b of the linear-weight relationships and the values of the correlation coefficient R^2 are presented in Table 16.

Table 16

Parameters a , b of the L-W ratios and values of R^2 for the sample from port Ada bahcha, 01.06.2025

Parameters	$TW(g) = a.SL(mm)^b$	$TW(g) = a.Wd(mm)^b$	$W(g) = a.AL(mm)^b$
a	0.0004	0.0022	0.0026
b	2.7887	2.5478	2.5331
R²	0.96	0.97	0.96



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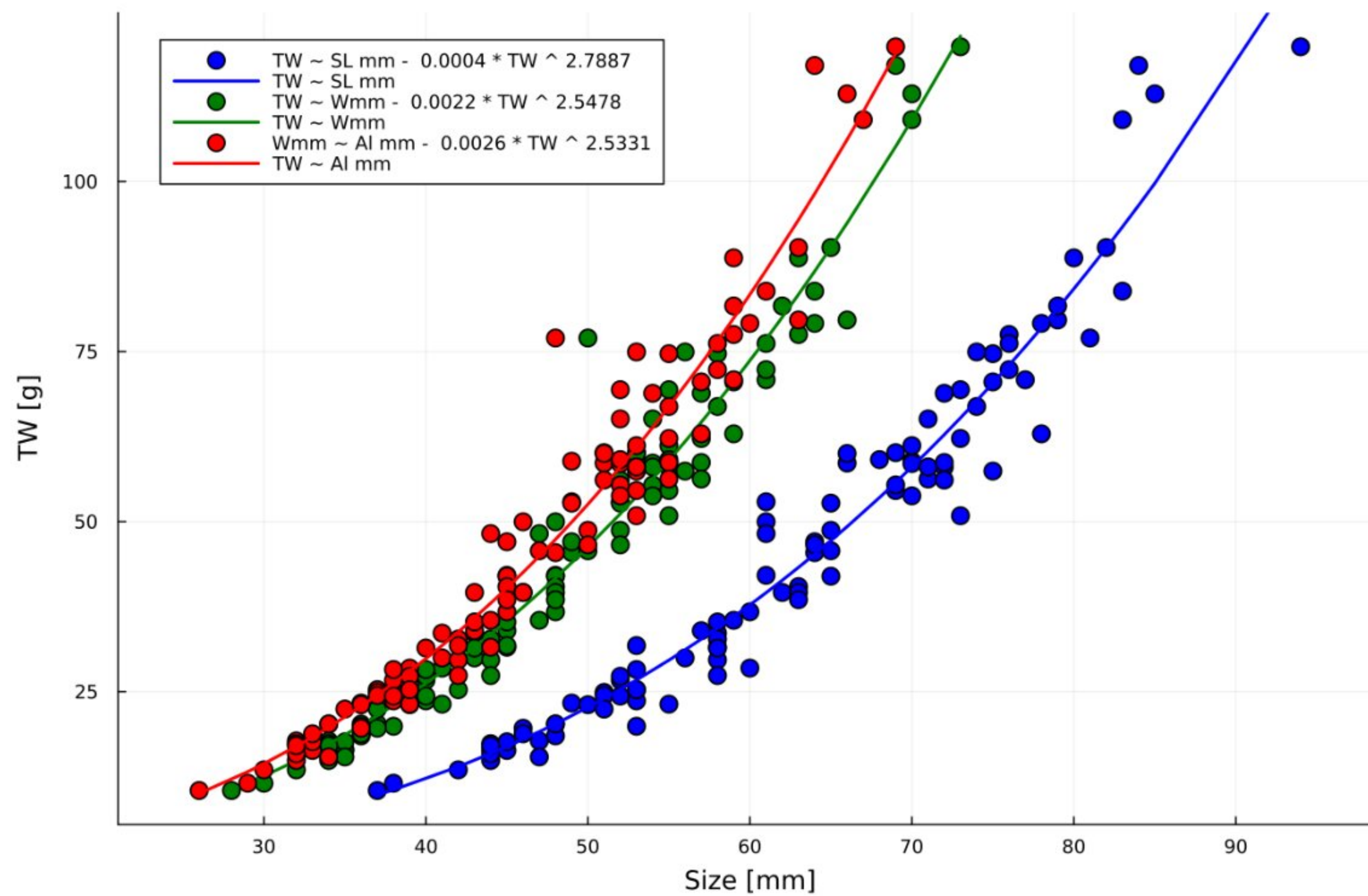


Figure 11 L-W ratios for the sampled individuals, port Ada Bahcha, 01.06.2025: (1) ratio between total weight (TW, g) and shell length (SL, mm); (2) relationship between total weight (TW, g) and shell width (Wd, mm); (3) relationship between total weight (TW, g) and aperture length (AL, mm).



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3.1.6. PORT KAVARNA, 01.06.2025

The sample consists of 100 individuals (from scuba diving) with a total weight of 3.05 kg, from a total landing of 500 kg rapa whelks at port Kavarna (from the fishing vessel)

The mean weight of the measured specimens reaches $30.5 \text{ g} \pm 11.31 \text{ SD}$ at a mean shell length of $53.24 \text{ mm} \pm 6.35 \text{ SD}$, shell width $41.27 \text{ mm} \pm 5.06 \text{ SD}$ and aperture length $38.84 \text{ mm} \pm 4.87 \text{ SD}$. The mean body weight without shell (BW, g) is $11.24 \text{ g} \pm 2.98 \text{ SD}$, which is $32.57\% \pm 3.94 \text{ SD}$ from the total weight, varying between 23.06% и 39.77% from the total weight (Table 17).

Table 17

Summarized statistics of the biological parameters - total weight (TW, g), body weight (BW, g), percentage ratio of BW (% TW), shell length (SL, mm), shell width (Wd, mm) and aperture length (AL, mm) at port Kavarna, 01.06.2025

	TW g	SL mm	Wd mm	Al mm	BW g	BW% TW
Sample size	100	100	100	100	50	50
Mean	30.5	53.24	41.27	38.84	11.24	32.57
Standard deviation	11.31	6.35	5.06	4.87	2.98	3.94
Minimum	15.37	42	33	30	6.45	23.06
50% (median)	27.88	53	40.5	38	10.58	32.97
Maximum	77.44	74	58	56	19.15	39.77
Sum	3050.48	5324	4127	3884	561.9	1628.46
Mode	28.54	53	39	36	8.44	32.44
Sample variance	127.81	40.37	25.57	23.67	8.88	15.52
Kurtosis	3.02	0.87	0.91	1.25	0.28	-0.14
Skewness	1.56	0.77	0.89	0.96	0.85	-0.47
Range	62.07	32	25	26	12.7	16.71
Confidence level 95%	(28.29, 32.72)	(51.99, 54.49)	(40.28, 42.26)	(37.89, 39.79)	(10.41, 12.06)	(31.48, 33.66)

The dominant size classes from the sample are 50—60 mm (58% of the measured individuals). As for the weight structure, the dominant weight class (TW, g) is 30-40 g (43% of the measured individuals).



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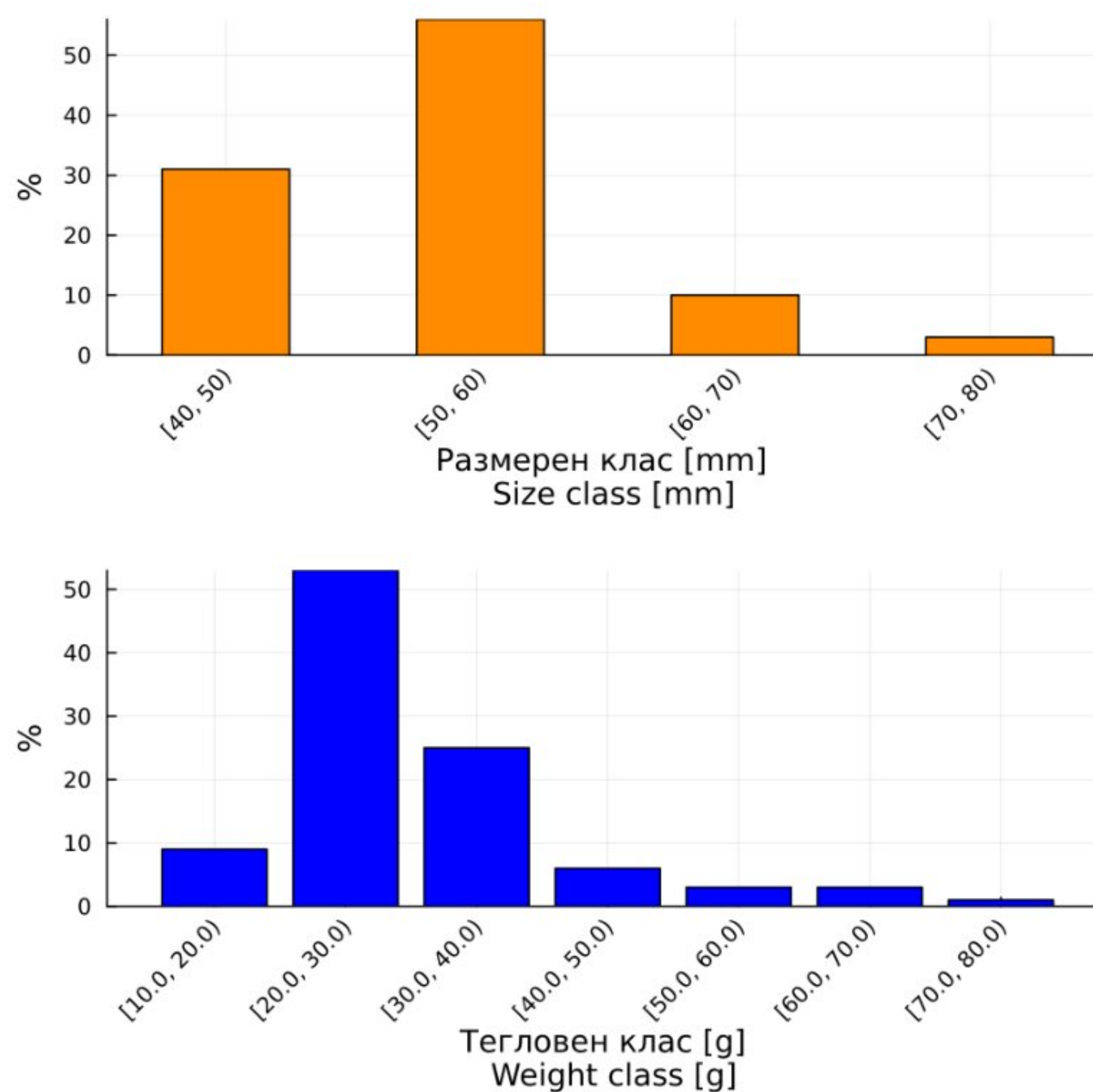


Figure 12 Size structure [mm] and weight structure [g] of the sample from port Kavarna, 01.06.2025

The mean ratio between the shell width (Wd, mm)/shell length (SL, mm) is $74.8\% \pm 3.55$ SD, while AL/SL (%) is $70.09\% \pm 3.58$ SD, and the ratio between AL/Wd (%) was calculated at $-93.71\% \pm 2.05$ SD (Table 18).



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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,%) of the individuals from the sample from port Kavarna, 01.06.2025

	Wd/SL%	Al/SL%	Al/Wd%
Sample size	100	100	100
Mean	77.55	72.97	94.1
Standard deviation	3.09	2.98	1.61
Minimum	70.18	66.67	90
50% (median)	77.36	72.97	94.44
Maximum	85.71	80.33	97.62
Sum	7755.49	7297.05	9409.87
Mode	77.78	75	94.74
Sample variance	0.1	0.09	0.03
Kurtosis	-25.64	-26.64	-15.48
Skewness	33.7	17.4	-21.23
Range	15.54	13.66	7.62
Confidence level 95%	(0.77, 0.78)	(0.72, 0.74)	(0.94, 0.94)

The L-W ratios are calculated (Figure 13). The parameters a , b of the linear-weight relationships and the values of the correlation coefficient R^2 are presented in Table 19.

Table 19

Parameters a , b of the L-W ratios and values of R^2 for the sample from port Port Kavarna, 01.06.2025

Parameters	$TW(g) = a \cdot SL(mm)^b$	$TW(g) = a \cdot Wd(mm)^b$	$W(g) = a \cdot AL(mm)^b$
a	0.00043	0.0012	0.0021
b	2.8043	2.7078	2.607
R²	0.82	0.83	0.82



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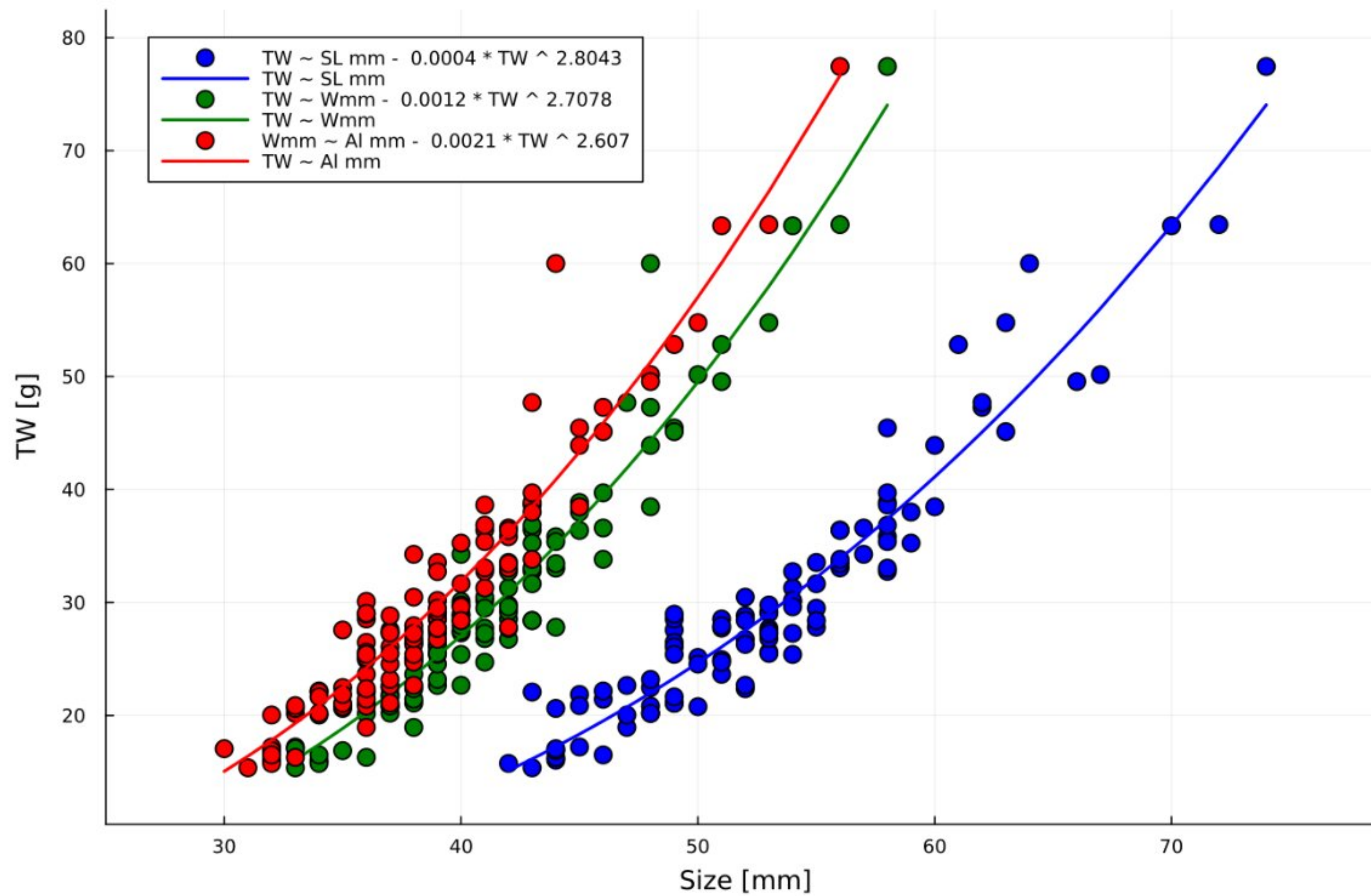


Figure 13 L-W ratios for the sampled individuals, port Kavarna, 01.06.2025: (1) ratio between total weight (TW, g) and shell length (SL, mm); (2) relationship between total weight (TW, g) and shell width (Wd, mm); (3) relationship between total weight (TW, g) and aperture length (AL, mm).



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3.1.9. SUMMARIZED RESULTS FOR THE FIRST HALF OF 2025

The rapa whelk landings for the period March – June 2025 vary between 500 and 2720 kg/day for all observed ports. The most significant landing from beam trawl fishing was registered at port Kavarna in April 2025. (Table 20)

Table 20

Summarized data about the landings by days and ports from different fishing vessels and fishing methods for the first half of 2025

Date	Landing port	Fishing vessel	Fishing method	Catch (kg)	Sample weight (per 100 ind) (kg)
25.03.2025	Rodopa 1	Korsar 2	beam trawl	503	2.51
05.04.2025	Kavarna	Viking	beam trawl	2720	3.30
30.04.2025	Rodopa 1	Korsar 2	beam trawl	1950	3.46
02.05.2025	Balchik	Hermes-4	beam trawl	2600	5.16
01.06.2025	Ada bahcha	Tesi	beam trawl	2278	4.65
01.06.2025	Kavarna	Neptun-70	beam trawl	500	3.06

The mean size (SL, mm) of the specimens, caught by beam trawl, for the first half of 2025 is 58.20 mm $\pm$ 9.19 SD. In general, the size varies by ports and is dependent on the fishing method - in the beam trawl samples the variations are between 57 – 68 mm. (**Table 21.1**) Respectively, the mean weight (TW, g) from beam trawl is 36.88 g $\pm$ 17.71 SD, (**Table 21.2**), with a variation between 36-60g.

In the first half of 2025, the mean body weight (BW, g) from beam trawl samples is 13.82 g $\pm$ 7.31 SD (**Table 21.3**), forming 34.34% of the individuals' weight in the observed period, as the mean percentage by ports varies from 33.9 to 38.86%.



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Table 21

Statistical data about the distribution of the shell length (SL, mm, 1), total weight (TW, g, 2) and body weight (BW, g, 3) in the samples from all ports for the first half of 2025

1. Size (SL, mm)

Port	Sample size	Mean SL, mm	Standard deviation	Minimum SL, mm	Maximum SL, mm
Rodopa 1	100	60.71	6.62303	47	80
Kavarna	100	59.29	11.8537	41	95
Rodopa 1	100	65.663	8.5899	48	96
Balchik	100	68.05	10.5585	50	104
Ada bahcha	100	64.41	9.49438	46	84
Kavarna	100	57.95	5.0179	45	72

2. Total weight (TW, g)

Port	Sample size	Mean TW, g	Standard deviation	Minimum TW, g	Maximum TW, g
Rodopa 1	100	36.5833	11.5631	16.5	76.21
Kavarna	100	38.2178	28.0375	10.5	156.0
Rodopa 1	100	50.7266	22.8991	20.46	163.34
Balchik	100	59.5376	30.7862	20.41	197.94
Ada bahcha	100	49.0271	19.3341	16.24	102.87
Kavarna	100	35.7395	8.93398	14.28	63.08

3. Body weight (BW, g)

Port	Sample size	Mean BW, g	Standard deviation	Minimum BW, g	Maximum BW, g
Rodopa 1	50	12.2862	3.27611	6.79	19.74
Kavarna	50	13.5286	11.7901	5.3	66.98
Rodopa 1	50	19.1821	7.29316	8.41	36.85
Balchik	50	24.3198	14.5572	7.82	80.4
Ada bahcha	50	17.4688	7.69962	4.08	37.71
Kavarna	50	13.7452	4.08727	2.9	24.91

The weight and size classes distributions from beam trawl fishing and by ports are presented on Figure 14. Regarding the size structure, most individuals fall into the size class - 50 - 60 SL mm, while in terms of weight composition (TW, g), the predominant weight class is < 60 g (90 % of the total number of measured specimens).



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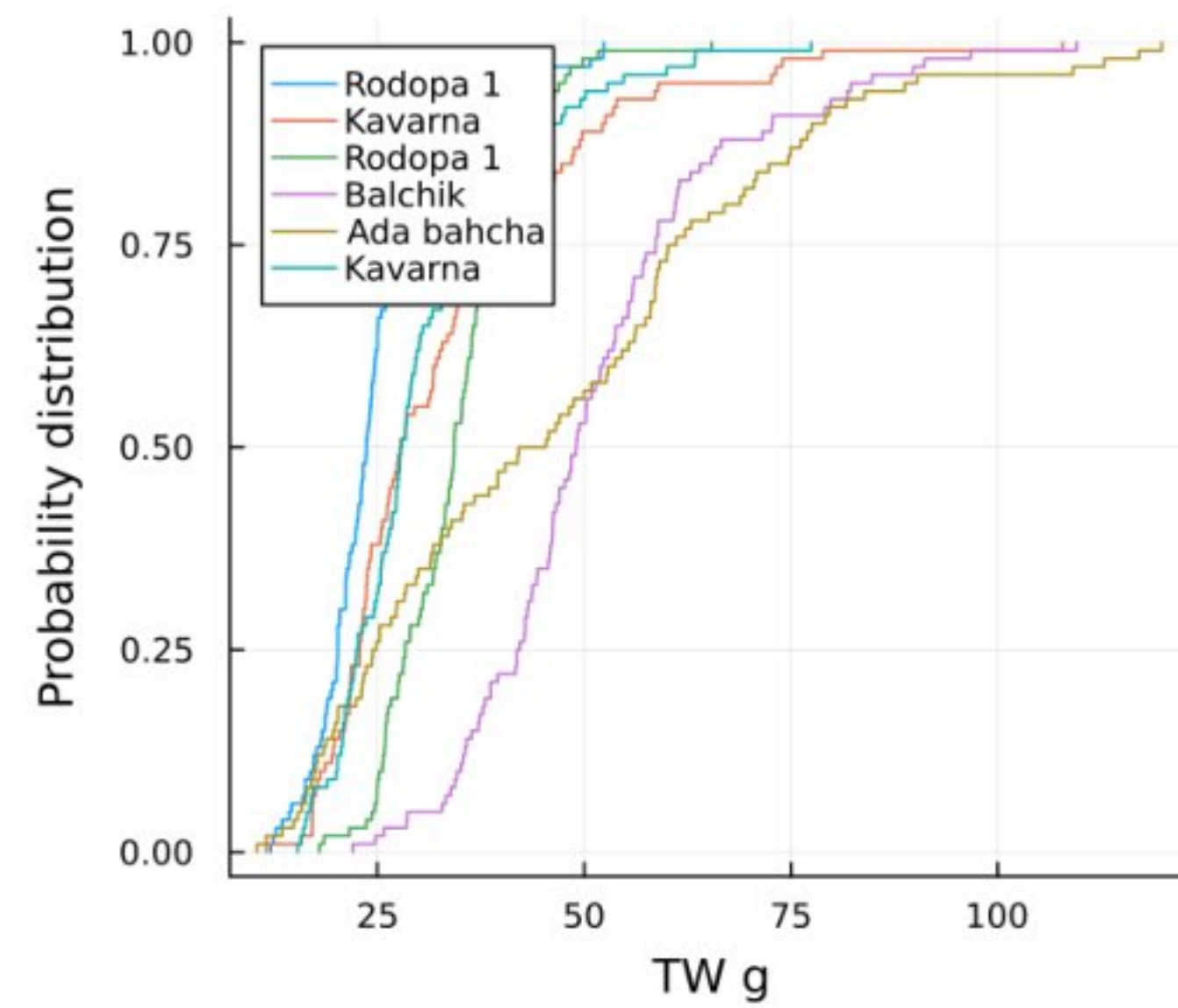
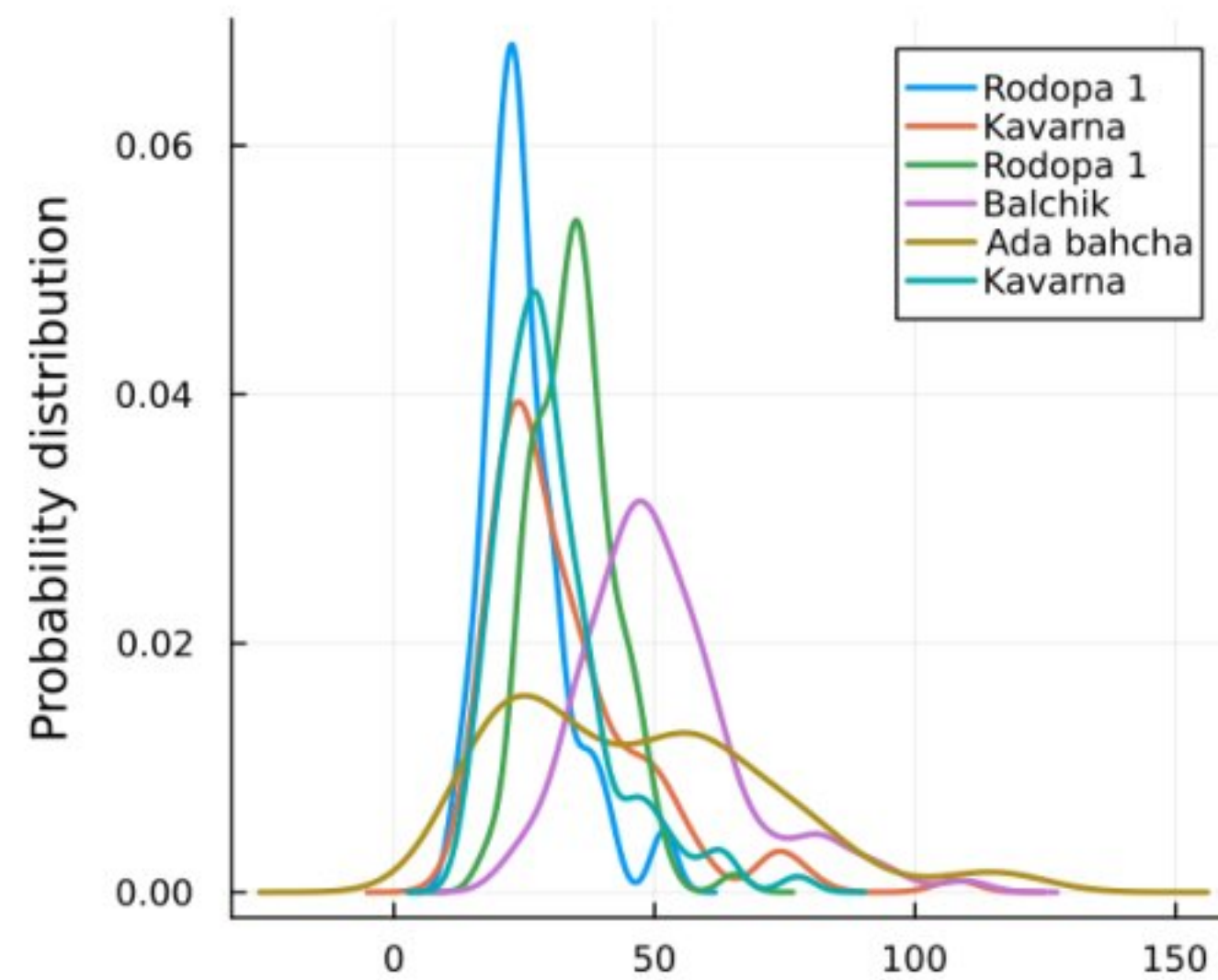


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1 SL mm



2 TW g

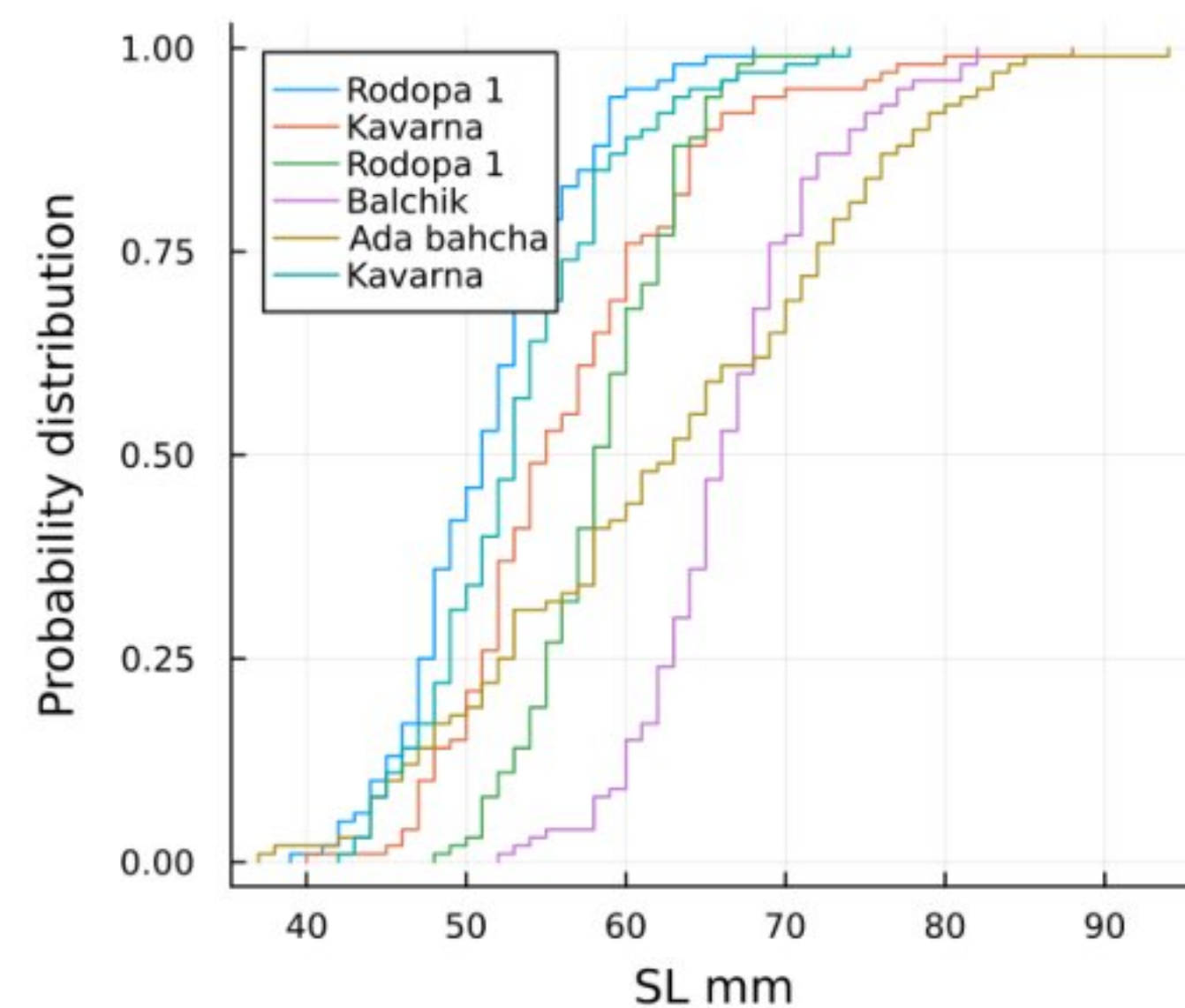
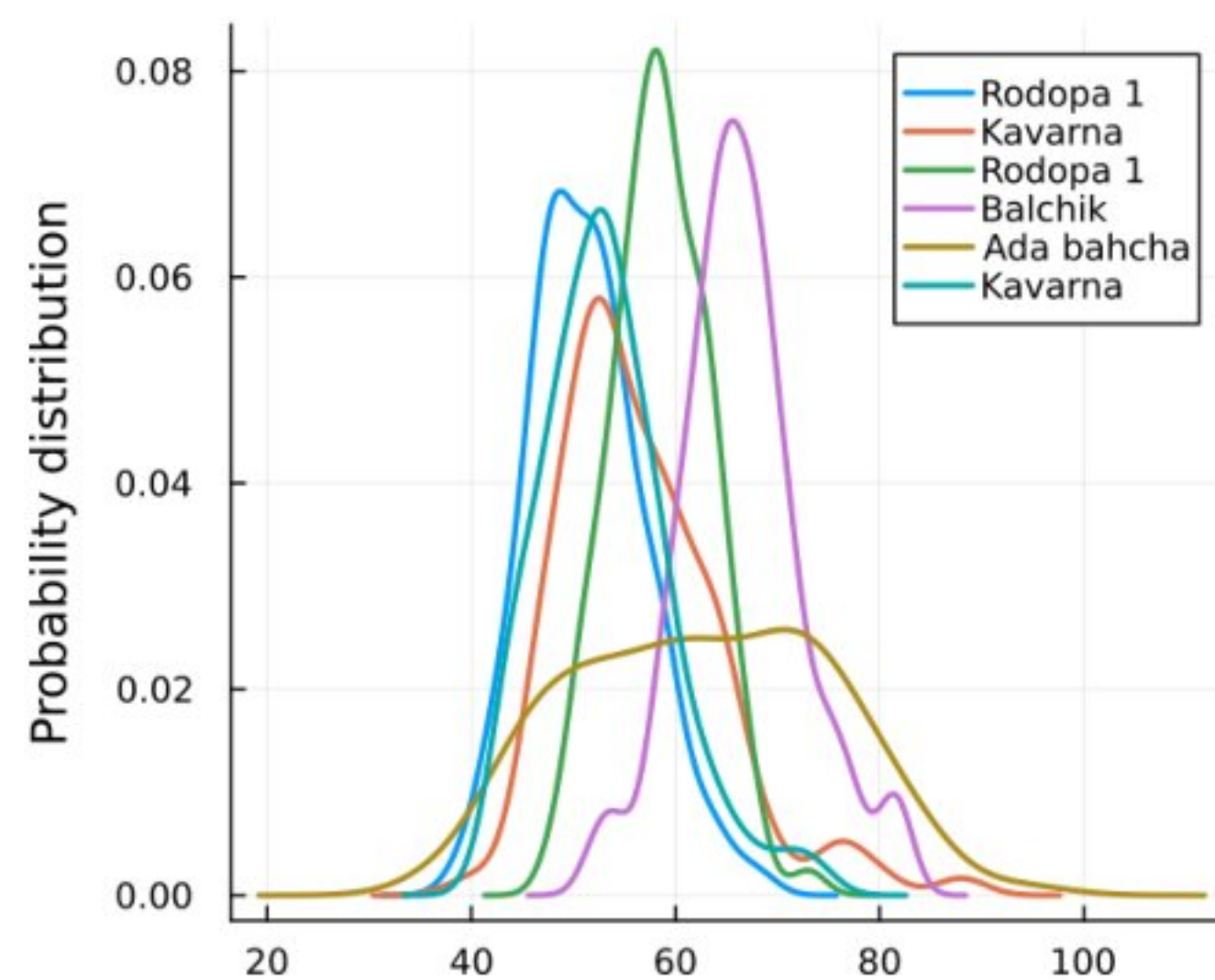


Figure 14 Distribution of the shell length (SL, mm, 1) and total weight (TW, g, 2) by classes and cumulative distribution by classes for the samples from beam trawl for the first half of 2025

Detailed data about the percentage distribution of the size and weight classes for the observed individuals in the first half of 2025 is presented on Figure 15 and Figure 16.

The dominant size classes in the beam trawl samples are 50 - 60 mm SL (42%), followed by the 60 – 70 mm SL (28%) group. The individuals in the 40-50 mm (17%) interval have smaller share, while specimens over 70 mm are presented to a limited extent. (<15% of all individuals) (Figure 15).

As for the weight structure, the dominant weight class for the beam trawl samples is < 50 g TW (71% of the measured individuals). The highest relative shares are in the 20–30 g (33%) and 30–40 g (24%) groups. Specimens over 70 g make up less than 10% of the total. (Figure 16)



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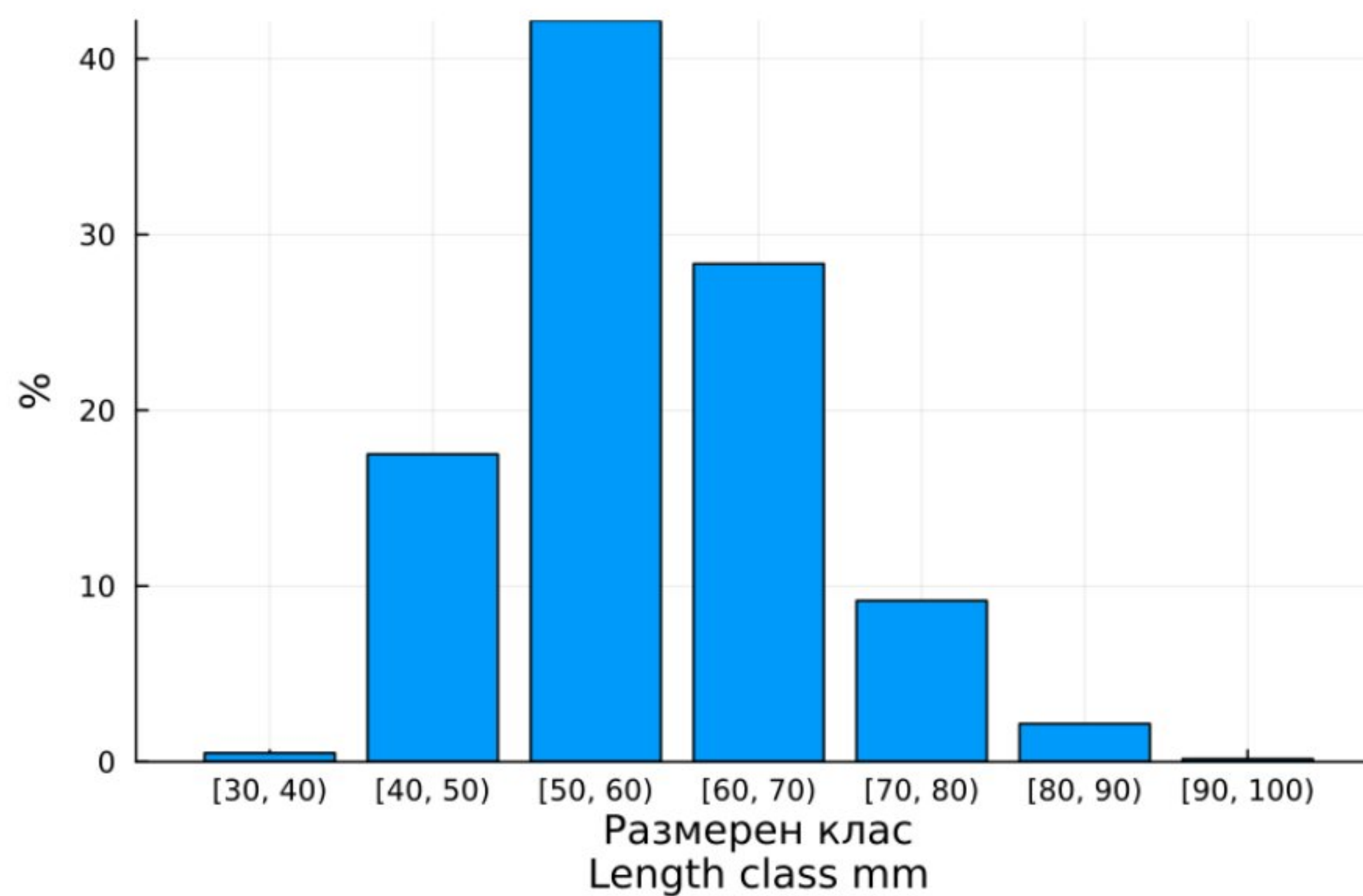


Figure 15 Distribution in% by size class (SL, mm), based on the summarized data for the first half of 2025

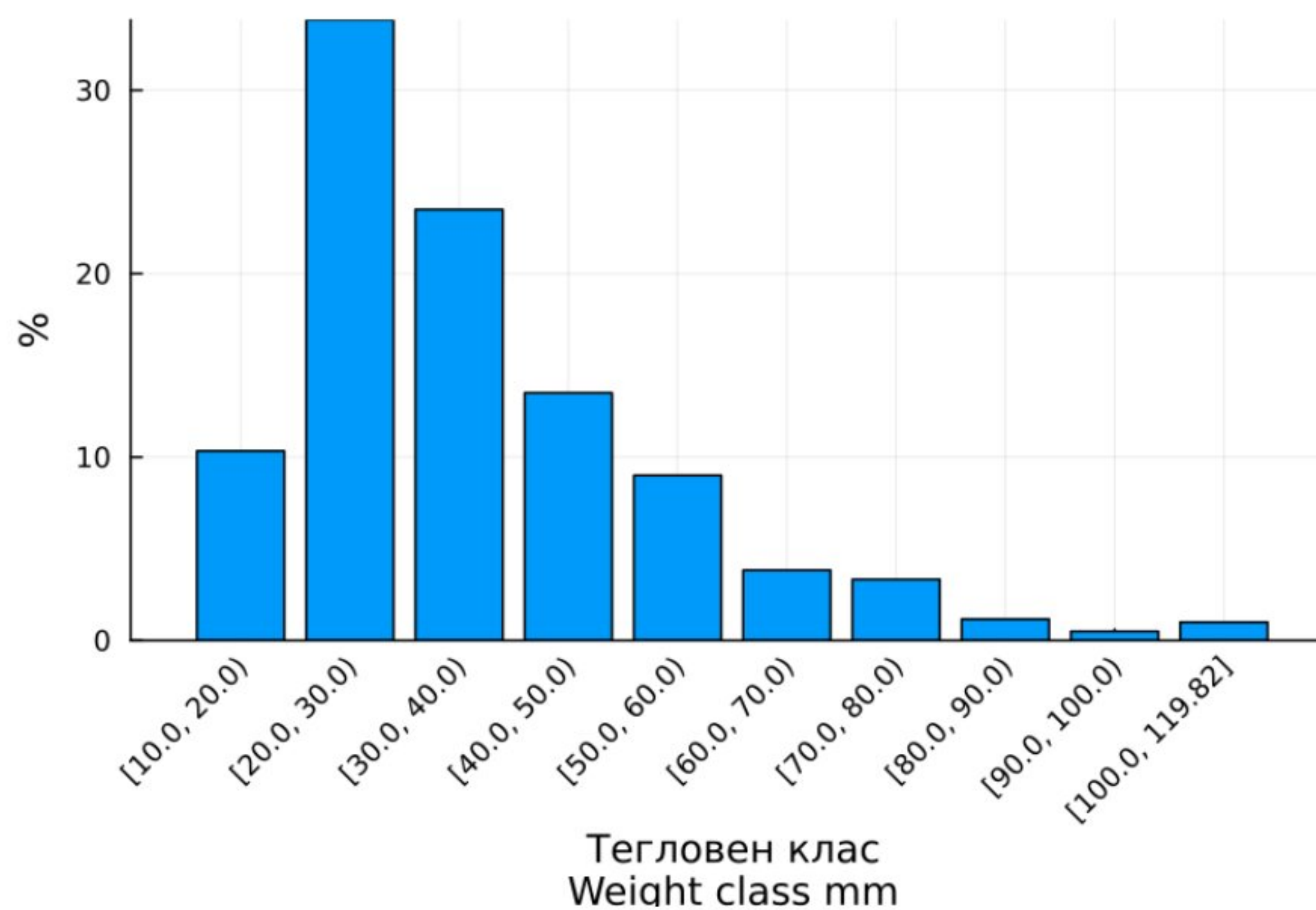


Figure 16 Distribution in% by weight class (TW, g) based on the summarized data for the first half of 2025



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The comparison analysis of the parameters a and b of the L-W ratio: $TW(g) = a \cdot SL(mm)^b$ shows there is mostly allometric growth of *R. venosa* in all samples with a coefficient $b \neq 3$ (Figure 17).

The coefficient $b < 3$ is an indicator for a negative allometric growth, which means **that the bigger individuals grow faster in length (size) than in weight**. The minimum value of the coefficient $b=2.24$ was registered in the sample from port Balchik, 02.05.2025

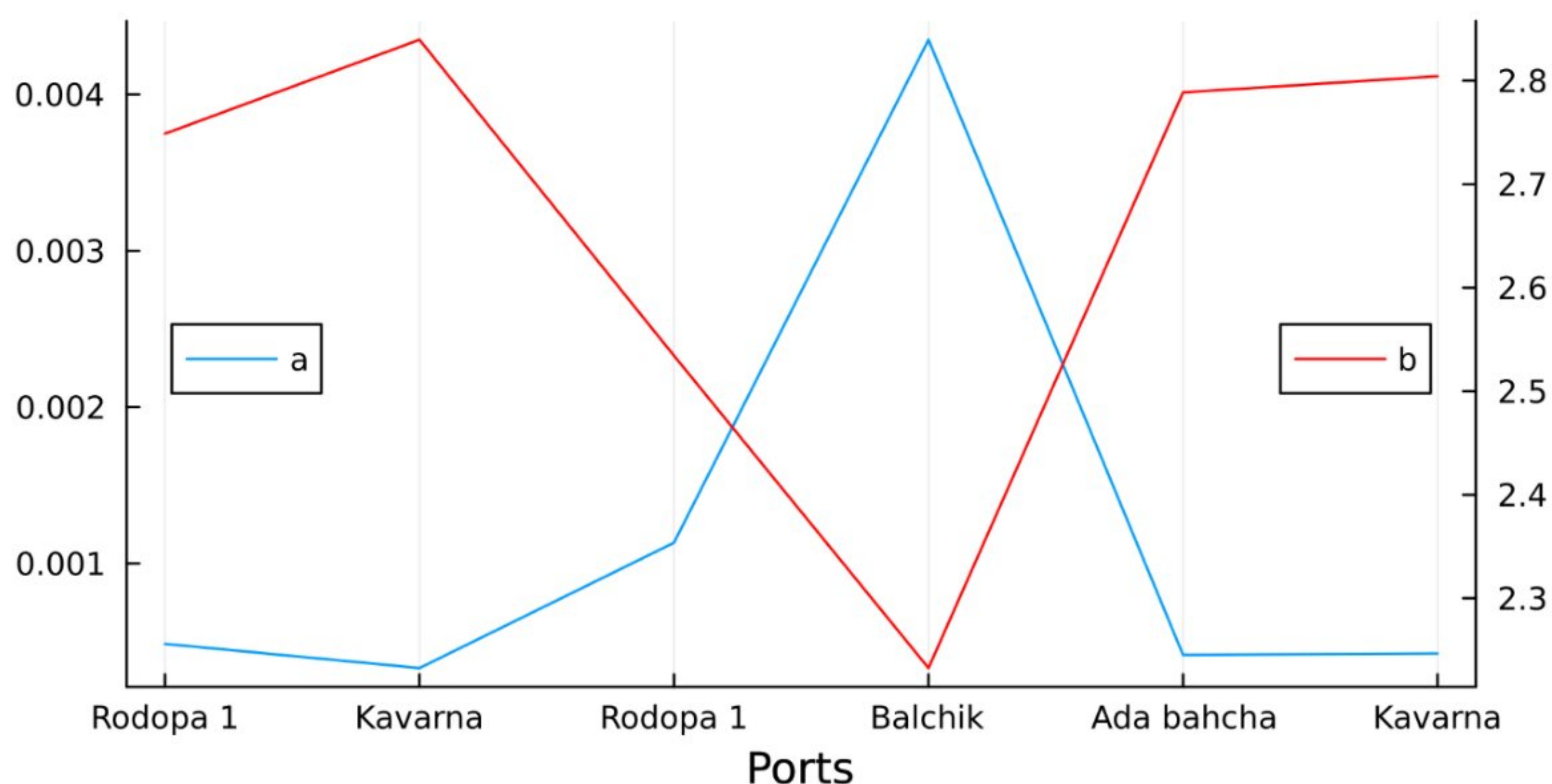


Figure 17 Parameters a , b of the L-W ratios for the equation $TW(g) = a \cdot SL(mm)^b$ for all landing ports for the first half of 2025

The mean ratios of the width/length of the shells (Wd/SL,%) of *R. venosa*, the aperture length to the shell length (AL/SL,%) and aperture length/total shell width (AL/Wd,%) by ports for the first half of 2025 are presented on Figure 18.



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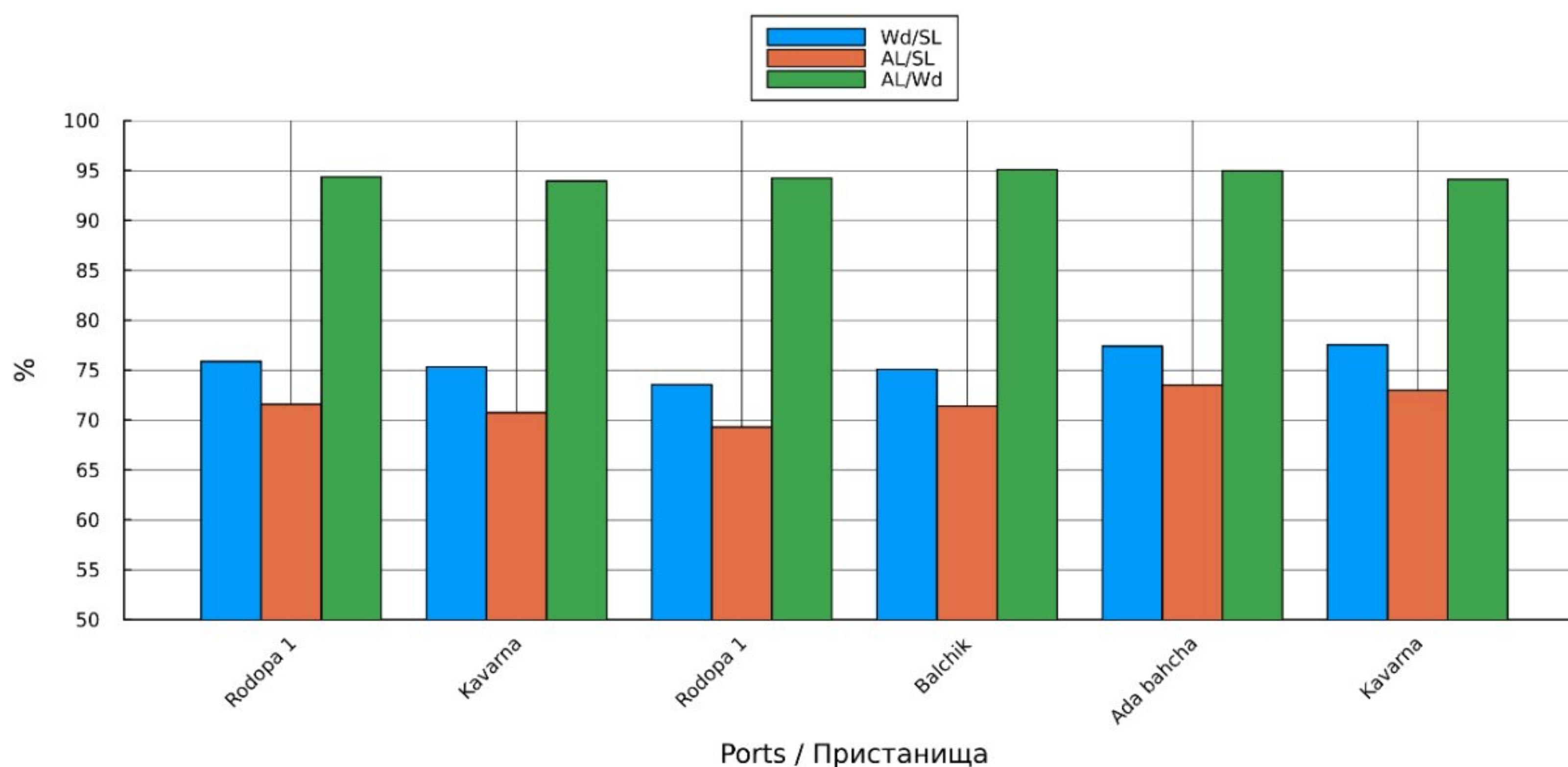


Figure 18 The mean ratios of the width/length of the shells (Wd/SL,%) of *R. venosa*, aperture length/shell length (AL/SL,%) and aperture length/total shell width (AL/Wd,%) by ports for the first half of 2025

The mean ratio Wd/SL reaches 75% in the first half of 2025, with very little variations between the different samples. Respectively, the ratio AL/SL is 71%, on average, varying between 59% and 81%. The mean value of the ratio AL/Wd (%) for the first half of 2025 is 94%.



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3.2. SEX STRUCTURE

3.2.1. Port Rodopa 1, 25.03.2025

The sex ratio in the sample is 78% ♂ : 22% ♀ or 1 : 0.28.

The mean size of the females' shell length in the sample is 50.36 mm $\pm$ 3.53 SD, while for the males the mean size is slightly bigger – 53.77 mm $\pm$ 4.77 SD. In regard to the parameter total weight (TW, g), the mean weight of the male individuals 27.96 g $\pm$ 8.11 SD, while for the females it is 22.76 g $\pm$ 3.58 SD. (Table 22)

Table 22

Summarized statistics of the biological parameters - shell length (SL, mm) and total weight (TW, g) by sex in the sample from port Rodopa 1, 25.03.2025

	TW g		SL mm	
Sex	M	F	M	F
Number	39	11	39	11
Mean	27.96	22.76	53.77	50.36
Standard deviation	8.11	3.58	4.77	3.53
Minimum	16.28	16.29	44	44
50% (median)	26.88	22.76	54	51
Maximum	52.36	30.59	65	55
Sum	1090.62	250.38	2097	554
Mode	29.9	23.68	59	53
Sample variance	65.81	12.83	22.76	12.45
Kurtosis	1.53	0.76	-0.54	-1.13
Skewness	1.2	0.43	0.11	-0.32
Range	36.08	14.3	21	11
Confidence level 95%	(25.42, 30.51)	(20.64, 24.88)	(52.27, 55.27)	(48.28, 52.45)

Looking at the parameters shell width (Wd, mm) and aperture length (aperture length, AL, mm), the percentage differences are insignificantly small, around 5-6% in favor of the male individuals (Table 23).



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Table 23

Summarized statistics of the biological parameters - shell width (Wd, mm) and aperture length (aperture length, AL, mm) by sex in the sample from port Rodopa 1, 25.03.2025

	Wd mm		Al mm	
Sex	M	F	M	F
Number	39	11	39	11
Mean	40.64	38.64	38.31	35.82
Standard deviation	3.62	2.46	3.73	2.36
Minimum	35	34	32	31
50% (median)	40	38	38	36
Maximum	50	42	47	39
Sum	1585	425	1494	394
Mode	37	38	40	37
Sample variance	13.13	6.05	13.9	5.56
Kurtosis	-0.12	-0.65	-0.31	-0.25
Skewness	0.57	-0.28	0.39	-0.44
Range	15	8	15	8
Confidence level 95%	(39.5, 41.78)	(37.18, 40.09)	(37.14, 39.48)	(34.42, 37.21)



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3.2.2. Port Kavarna, 05.04.2025

The sex ratio in the sample is 72% ♂ : 28% ♀ or 1 : 0.39.

The mean size of the females' shell length in the sample is 50.57 mm $\pm$ 6.15 SD, while for the males the mean size is 58.81 mm $\pm$ 8.98 SD. In regard to the parameter total weight (TW, g), the mean weight of the male individuals is 36.73 g $\pm$ 19.03 SD, while for the females it is 23.63 g $\pm$ 10.25 SD. (**Table 24**).

Table 24

Summarized statistics of the biological parameters - shell length (SL, mm) and total weight (TW, g) by sex in the sample from port Kavarna, 05.04.2025

	TW g		SL mm	
Sex	M	F	M	F
Number	36	14	36	14
Mean	36.73	23.63	58.81	50.57
Standard deviation	19.03	10.25	8.98	6.15
Minimum	17.25	11.55	46	40
50% (median)	31.96	19.27	57.5	48
Maximum	107.86	48.79	88	63
Sum	1322.25	330.82	2117	708
Mode	107.86	17.13	59	47
Sample variance	362.03	104.97	80.68	37.8
Kurtosis	4.05	0.61	2.03	-0.27
Skewness	1.89	1.2	1.31	0.58
Range	90.61	37.24	42	23
Confidence level 95%	(30.51, 42.94)	(18.26, 29.0)	(55.87, 61.74)	(47.35, 53.79)

For the parameters shell width (Wd, mm) and aperture length (aperture length, AL, mm), the percentage differences between the male and female individuals varies around 10-11% in favor of the male individuals (**Table 25**).



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Table 25

Summarized statistics of the biological parameters - shell width (Wd, mm) and aperture length (aperture length, AL, mm) by sex in the sample from port Kavarna, 05.04.2025

	Wd mm		Al mm	
Sex	M	F	M	F
Number	36	14	36	14
Mean	43.67	38.29	41.08	35.5
Standard deviation	6.82	5.17	6.58	5.08
Minimum	33	30	31	28
50% (median)	43	37	40.5	34
Maximum	65	49	62	47
Sum	1572	536	1479	497
Mode	43	35	37	34
Sample variance	46.57	26.68	43.28	25.81
Kurtosis	1.61	-0.3	1.84	0.12
Skewness	1.19	0.56	1.24	0.86
Range	32	19	31	19
Confidence level 95%	(41.44, 45.9)	(35.58, 40.99)	(38.93, 43.23)	(32.84, 38.16)



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3.2.3. Port Rodopa 1, 30.04.2025

The sex ratio in the sample is 54% ♂ : 46% ♀ or 1 : 0.85.

The mean size of the females' shell length in the sample is 57.43 mm $\pm$ 3.8 SD, while for the males the mean size is 60.48 mm $\pm$ 4.69 SD. In regard to the parameter total weight (TW, g), the mean weight of the male individuals is 36.72 g $\pm$ 8.64 SD, while for the females it is 32.83 g $\pm$ 6.28 SD (**Table 26**).

Table 26

Summarized statistics of the biological parameters - shell length (SL, mm) and total weight (TW, g) by sex in the sample from port Rodopa 1, 30.04.2025

	TW g		SL mm	
Sex	M	F	M	F
Number	27	23	27	23
Mean	36.72	32.83	60.48	57.43
Standard deviation	8.64	6.28	4.69	3.8
Minimum	18.54	23.67	49	51
50% (median)	36.92	32.79	62	58
Maximum	51.71	45.43	68	66
Sum	991.42	754.98	1633	1321
Mode	30.47	32.72	63	59
Sample variance	74.64	39.44	22.03	14.44
Kurtosis	-0.8	-0.38	-0.27	-0.33
Skewness	-0.11	0.53	-0.56	0.24
Range	33.17	21.76	19	15
Confidence level 95%	(33.46, 39.98)	(30.26, 35.39)	(58.71, 62.25)	(55.88, 58.99)

As for the parameters shell width (Wd, mm) and aperture length (aperture length, AL, mm), the percentage differences between the males and the females are 4% and 6% in favor of the male individuals (**Table 27**).



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Table 27

Summarized statistics of the biological parameters - shell width (Wd, mm) and aperture length (aperture length, AL, mm) by sex in the sample from port Rodopa 1, 30.04.2025

	Wd mm		Al mm	
Sex	M	F	M	F
Number	27	23	27	23
Mean	44.74	42.3	41.89	39.74
Standard deviation	4.47	3.59	4.13	3.39
Minimum	34	36	32	34
50% (median)	45	43	43	40
Maximum	52	48	48	46
Sum	1208	973	1131	914
Mode	48	43	45	43
Sample variance	19.97	12.86	17.03	11.47
Kurtosis	-0.36	-1.07	-0.32	-1.05
Skewness	-0.53	-0.25	-0.65	-0.17
Range	18	12	16	12
Confidence level 95%	(43.06, 46.43)	(40.84, 43.77)	(40.33, 43.45)	(38.35, 41.12)



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3.2.4. PORT BALCHIK, 02.05.2025

The sex ratio in the sample is 74% ♂ : 26% ♀ or 1 : 0.35.

The mean size of the females' shell length in the sample is 65.15 mm $\pm$ 4.1 SD, while for the males the mean size is 68.3 mm $\pm$ 5.49 SD. In regard to the parameter total weight (TW, g), the mean weight of the male individuals is 53.1 g $\pm$ 16.27 SD, while for the females it is 58.1 g $\pm$ 17.92 SD (**Table 28**).

Table 28

Summarized statistics of the biological parameters - shell length (SL, mm) and total weight (TW, g) by sex in the sample from port Balchik, 02.05.2025

	TW g		SL mm	
Sex	M	F	M	F
Number	37	13	37	13
Mean	53.1	58.1	68.3	65.15
Standard deviation	16.27	17.92	5.49	4.1
Minimum	22.03	34.39	58	60
50% (median)	51.94	55.37	67	65
Maximum	109.55	91.17	82	71
Sum	1964.79	755.32	2527	847
Mode	42.87	51.9	69	60
Sample variance	264.59	321	30.1	16.81
Kurtosis	2.8	-0.75	0.25	-1.16
Skewness	1.29	0.63	0.75	0.19
Range	87.52	56.78	24	11
Confidence level 95%	(47.86, 58.34)	(48.36, 67.84)	(66.53, 70.07)	(62.93, 67.38)

As for the parameters shell width (Wd, mm) and aperture length (aperture length, AL, mm), the percentage differences between the males and the females are with 6% in favor of the male individuals (**Table 29**).



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Table 29

Summarized statistics of the biological parameters - shell width (Wd, mm) and aperture length (aperture length, AL, mm) by sex in the sample from port Balchik, 02.05.2025

	Wd mm		Al mm	
Sex	M	F	M	F
Number	37	13	37	13
Mean	51.92	48.85	49.38	46.15
Standard deviation	4.52	3.56	4.47	3.44
Minimum	44	43	41	40
50% (median)	51	49	49	46
Maximum	62	54	60	52
Sum	1921	635	1827	600
Mode	51	53	49	49
Sample variance	20.41	12.64	20.02	11.81
Kurtosis	-0.56	-1.13	-0.32	-0.89
Skewness	0.5	-0.16	0.47	0.02
Range	18	11	19	12
Confidence level 95%	(50.46, 53.37)	(46.91, 50.78)	(47.94, 50.82)	(44.29, 48.02)



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3.2.5. PORT ADA BAHCHA, 01.06.2025

The sex ratio in the sample is 82% ♂ : 18% ♀ or 1 : 0.22.

The mean size of the females' shell length in the sample is 61.22 mm $\pm$ 10.93 SD, while for the males the mean size is with 10% bigger - 69.93 mm $\pm$ 9.93 SD. In regard to the parameter total weight (TW, g), the mean weight of the male individuals is 60.55 g $\pm$ 23.95 SD, while for the females it is 42.95 g $\pm$ 18.93 SD (**Table 30**).

Table 30

Summarized statistics of the biological parameters - shell length (SL, mm) and total weight (TW, g) by sex in the sample from port Ada Bahcha, 01.06.2025

	TW g		SL mm	
Sex	M	F	M	F
Number	41	9	41	9
Mean	60.55	42.95	69.93	61.22
Standard deviation	23.95	18.93	9.93	10.93
Minimum	18.8	15.4	46	44
50% (median)	57.43	48.23	71	61
Maximum	119.82	62.91	94	78
Sum	2482.6	386.56	2867	551
Mode	119.82	40.44	65	61
Sample variance	573.72	358.32	98.52	119.44
Kurtosis	0.08	-1.38	0.02	-0.75
Skewness	0.58	-0.41	-0.22	-0.16
Range	101.02	47.51	48	34
Confidence level 95%	(53.22, 67.88)	(30.58, 55.32)	(66.89, 72.97)	(54.08, 68.36)

As for the parameters shell width (Wd, mm) and aperture length (aperture length, AL, mm), the percentage differences between the males and the females are with 12% in favor of the male individuals (**Table 31**).



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Table 31

Summarized statistics of the biological parameters - shell width (Wd, mm) and aperture length (aperture length, AL, mm) by sex in the sample from port Ada Bahcha, 01.06.2025

	Wd mm		Al mm	
Sex	M	F	M	F
Number	41	9	41	9
Mean	54.85	47.67	52.1	45.44
Standard deviation	8.28	8.83	8.05	8.62
Minimum	36	34	33	32
50% (median)	55	48	52	45
Maximum	73	59	69	57
Sum	2249	429	2136	409
Mode	52	48	59	45
Sample variance	68.63	78	64.74	74.28
Kurtosis	-0.31	-1.01	-0.3	-1.03
Skewness	-0.02	-0.41	-0.16	-0.28
Range	37	25	36	25
Confidence level 95%	(52.32, 57.39)	(41.9, 53.44)	(49.63, 54.56)	(39.81, 51.08)



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3.2.6. PORT KAVARNA, 01.06.2025

The sex ratio in the sample is 84% ♂ : 16% ♀ or 1 : 0.19.

The mean size of the females' shell length in the sample is 53.62 mm $\pm$ 2.83 SD, while for the males the mean size is 57.12 mm $\pm$ 5.39 SD. In regard to the parameter total weight (TW, g), the mean weight of the male individuals is 35.78 g $\pm$ 10.86 SD, while for the females it is 30.53 g $\pm$ 5.55 SD (**Table 32**).

Table 32

Summarized statistics of the biological parameters - shell length (SL, mm) and total weight. (TW, g) by sex in the sample from port Kavarna, 01.06.2025

	TW g		SL mm	
Sex	M	F	M	F
Number	42	8	42	8
Mean	35.78	30.53	57.12	53.62
Standard deviation	10.86	5.55	5.39	2.83
Minimum	22.68	21.65	49	49
50% (median)	33.05	29.7	56	53.5
Maximum	63.45	39.71	72	58
Sum	1502.69	244.24	2399	429
Mode	35.26	27.71	53	53
Sample variance	117.96	30.83	29.03	7.98
Kurtosis	0.43	-0.49	0.34	-0.68
Skewness	1.14	0.2	0.9	-0.12
Range	40.77	18.06	23	9
Confidence level 95%	(32.49, 39.06)	(26.68, 34.38)	(55.49, 58.75)	(51.67, 55.58)

As for the parameters shell width (Wd, mm) and aperture length (aperture length, AL, mm), the percentage differences between the males and the females are with 5% in favor of the male individuals (**Table 33**).



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Table 33

Summarized statistics of the biological parameters - shell width (Wd, mm) and aperture length (aperture length, AL, mm) by sex in the sample from port Kavarna, 01.06.2025

	Wd mm		Al mm	
Sex	M	F	M	F
Number	42	8	42	8
Mean	44	42.25	41.4	39.62
Standard deviation	4.4	2.71	4.2	2.67
Minimum	39	37	36	34
50% (median)	43	42	41	40
Maximum	56	46	53	43
Sum	1848	338	1739	317
Mode	43	42	38	40
Sample variance	19.37	7.36	17.61	7.12
Kurtosis	0.19	0.07	0.33	0.74
Skewness	0.95	-0.56	0.99	-1.02
Range	17	9	17	9
Confidence level 95%	(42.67, 45.33)	(40.37, 44.13)	(40.14, 42.67)	(37.78, 41.47)



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3.2.7. GONADOSOMATIC INDEX (GSI)

The summarized statistics of the dynamics of the gonadosomatic index (GSI) for the first half of 2025 is presented in **Table 34**. The mean ratio of the index is 15.47% BW.

Highest mean value for the index is observed in the sample from port Rodopa 1 (25.03.2025)

Table 34

Summarized statistics of GSI (% BW) by ports for the first half of 2025:

	Port	number	mean	std.	min	median	max
1	Rodopa 1	50	17.08	3.55	10.86	17.24	25.07
2	Kavarna	50	15.45	3.71	9.02	14.88	32.42
3	Rodopa 1	50	15.28	2.63	7.78	15.37	20.92
4	Balchik	50	15.44	2.21	9.98	15.10	20.57
5	Ada Bahcha	50	13.96	4.36	9.01	12.59	31.50
6	Kavarna	50	15.61	2.61	9.73	15.26	22.99



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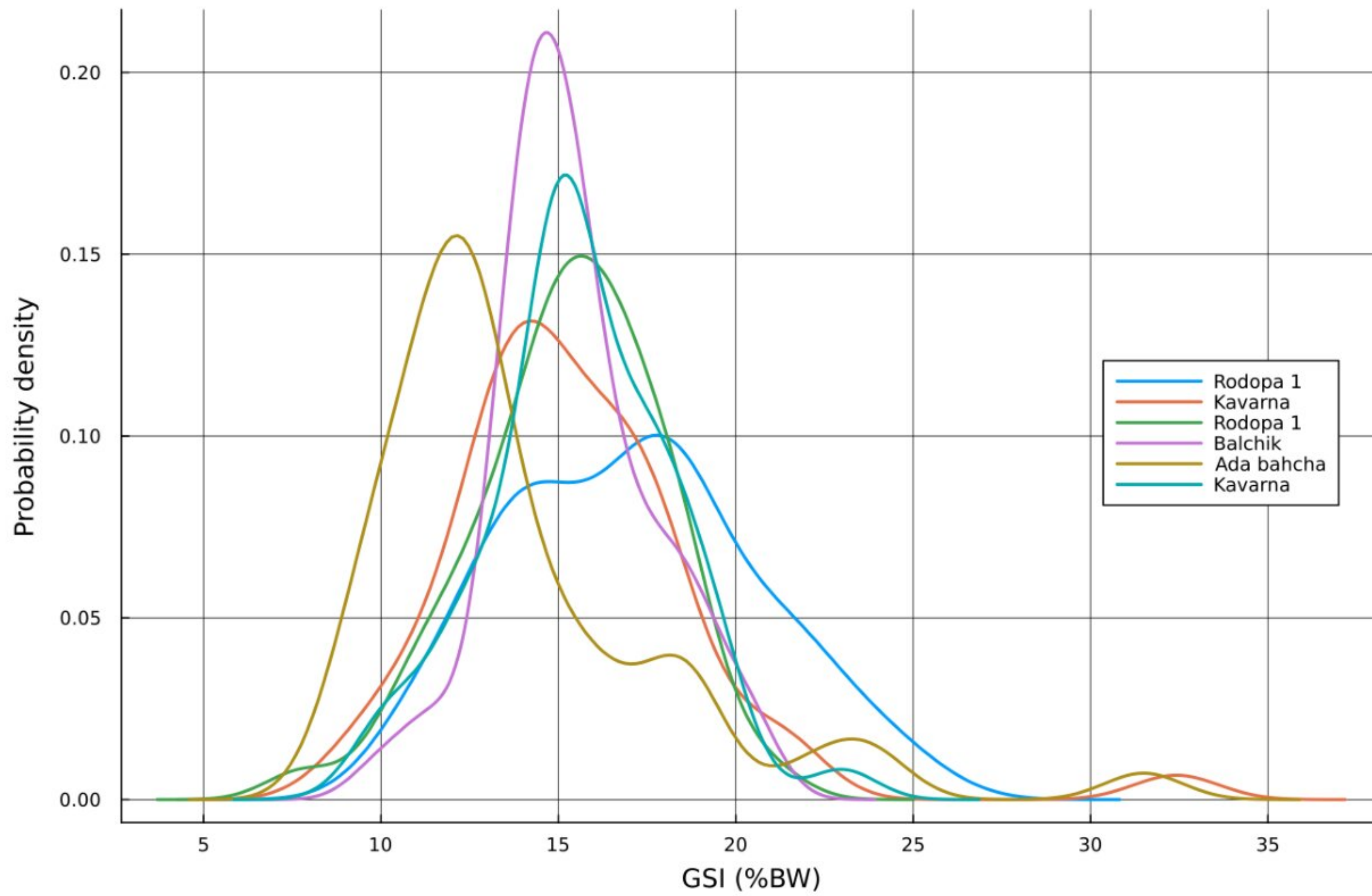


Figure 19 Gonadosomatic index (GSI) by ports for the first half of 2025



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3.2.8. SUMMARIZED RESULTS ABOUT SEX STRUCTURE

The sex ratio for all observed ports is 74% ♂: 26% ♀ (Figure 20). No imposex forms were identified in the first half of 2025.

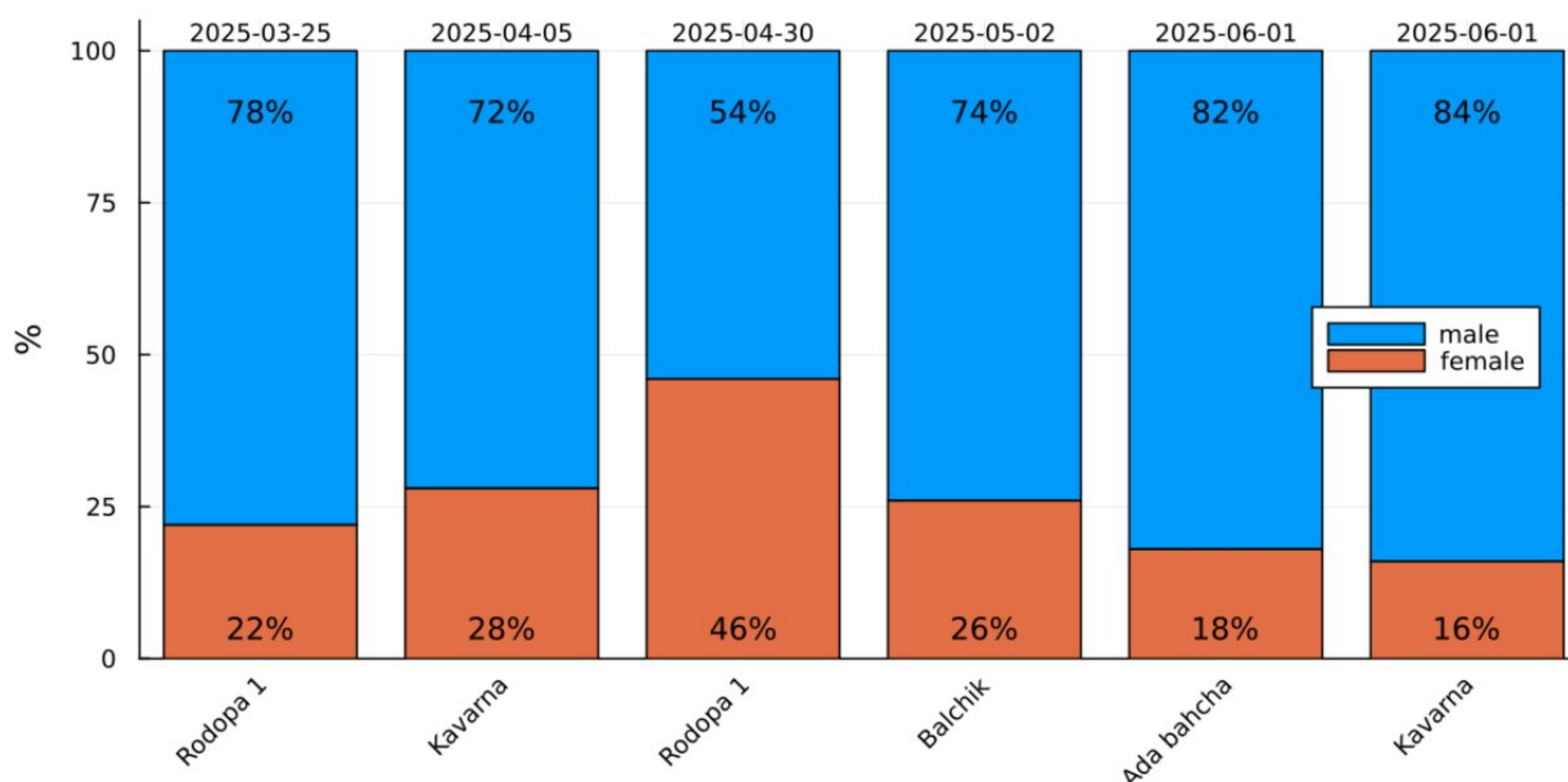


Figure 20 Summarized data about the sex structure of *R. venosa* by ports for the first half of 2025

The mean shell length (SL, mm) of the male individuals, caught by beam trawl, is 60.17 mm $\pm$ 9.0 SD, with the longest mean size of 68.36 mm – in the sample from June at port Ada Bahcha (01.06.2025). The mean length of the female individuals reached 56.53 mm $\pm$ 7.48 SD for the period, with a percentage difference of 7.97% $\downarrow$ compared to the mean length of the male specimens. Accordingly, the mean weight of the males for the period is 42.13 g $\pm$ 19.51 SD, and for females – 34.90 g $\pm$ 16.32 SD, with a percentage difference of 17.17% between the two sexes (**Table 35, Figure 21.2**).



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Table 35

Statistical data about the distribution of the size (SL, mm, 1) and weight (TW, g, 2) by sex and ports for the first half of 2025:

1. Size (SL, mm)	Port	sex	Mean	std	min	median	max
	Rodopa 1	M	53.77	4.77	44.00	54.00	65.00
		F	50.36	3.53	44.00	51.00	55.00
	Kavarna	M	58.81	8.98	46.00	57.50	88.00
		F	50.57	6.15	40.00	48.00	63.00
	Rodopa 1	M	60.48	4.69	49.00	62.00	68.00
		F	57.43	3.80	51.00	58.00	66.00
	Balchik	M	68.30	5.49	58.00	67.00	82.00
		F	65.15	4.10	60.00	65.00	71.00
	Ada Bahcha	M	69.93	9.93	46.00	71.00	94.00
		F	61.22	10.93	44.00	61.00	78.00
	Kavarna	M	57.12	5.39	49.00	56.00	72.00
		F	53.62	2.83	49.00	53.50	58.00
2. Total weight (TW, g)	Port	sex	Mean	std	min	median	max
	Rodopa 1	M	27.96	8.11	16.28	26.88	52.36
		F	22.76	3.58	16.29	22.76	30.59
	Kavarna	M	36.73	19.03	17.25	31.96	107.86
		F	23.63	10.25	11.55	19.27	48.79
	Rodopa 1	M	36.72	8.64	18.54	36.92	51.71
		F	32.83	6.28	23.67	32.79	45.43
	Balchik	M	53.10	16.27	22.03	51.94	109.55
		F	58.10	17.92	34.39	55.37	91.17
	Ada Bahcha	M	60.55	23.95	18.80	57.43	119.82
		F	42.95	18.93	15.40	48.23	62.91
	Kavarna	M	35.78	10.86	22.68	33.05	63.45
		F	30.53	5.55	21.65	29.70	39.71



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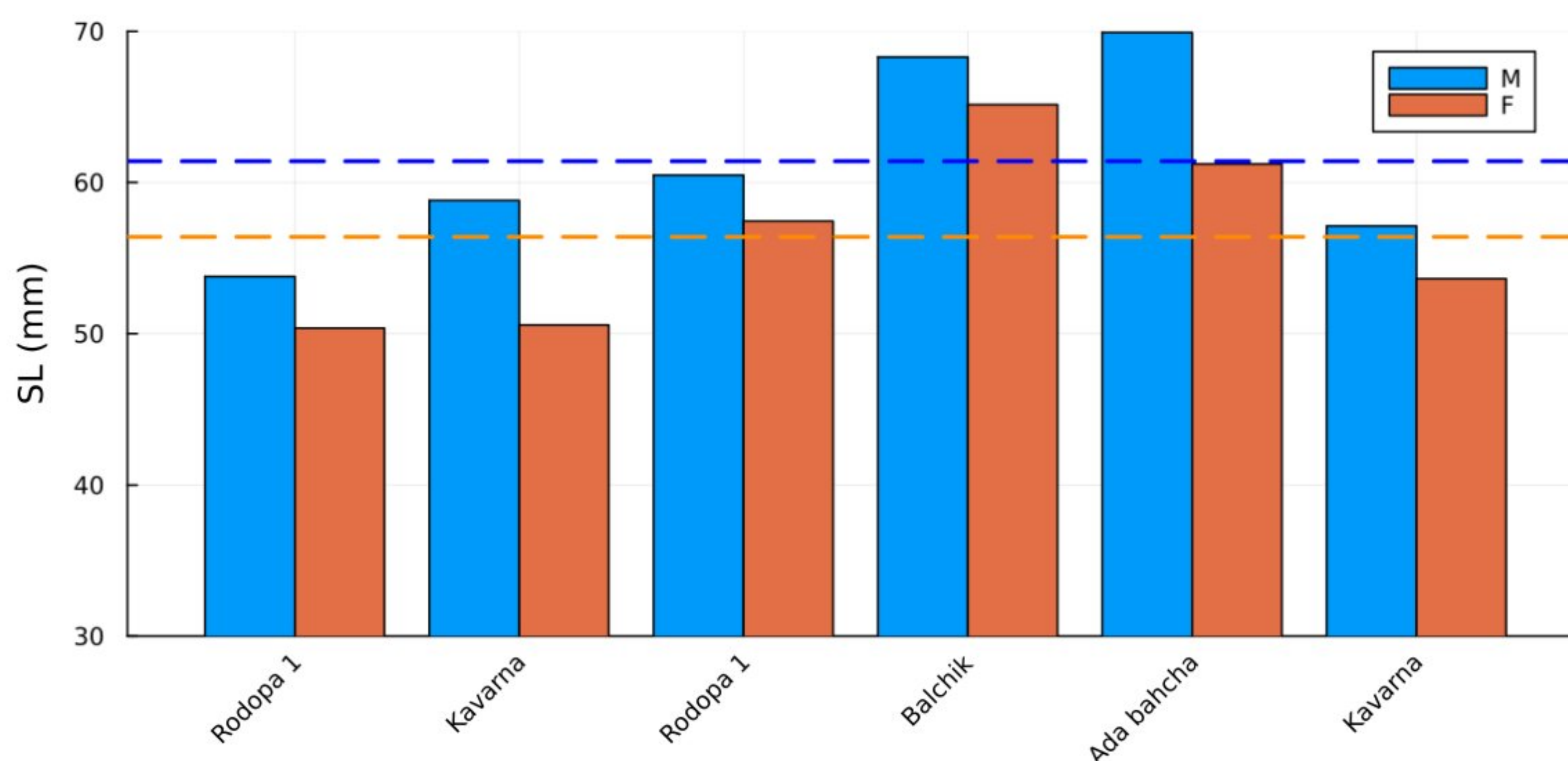


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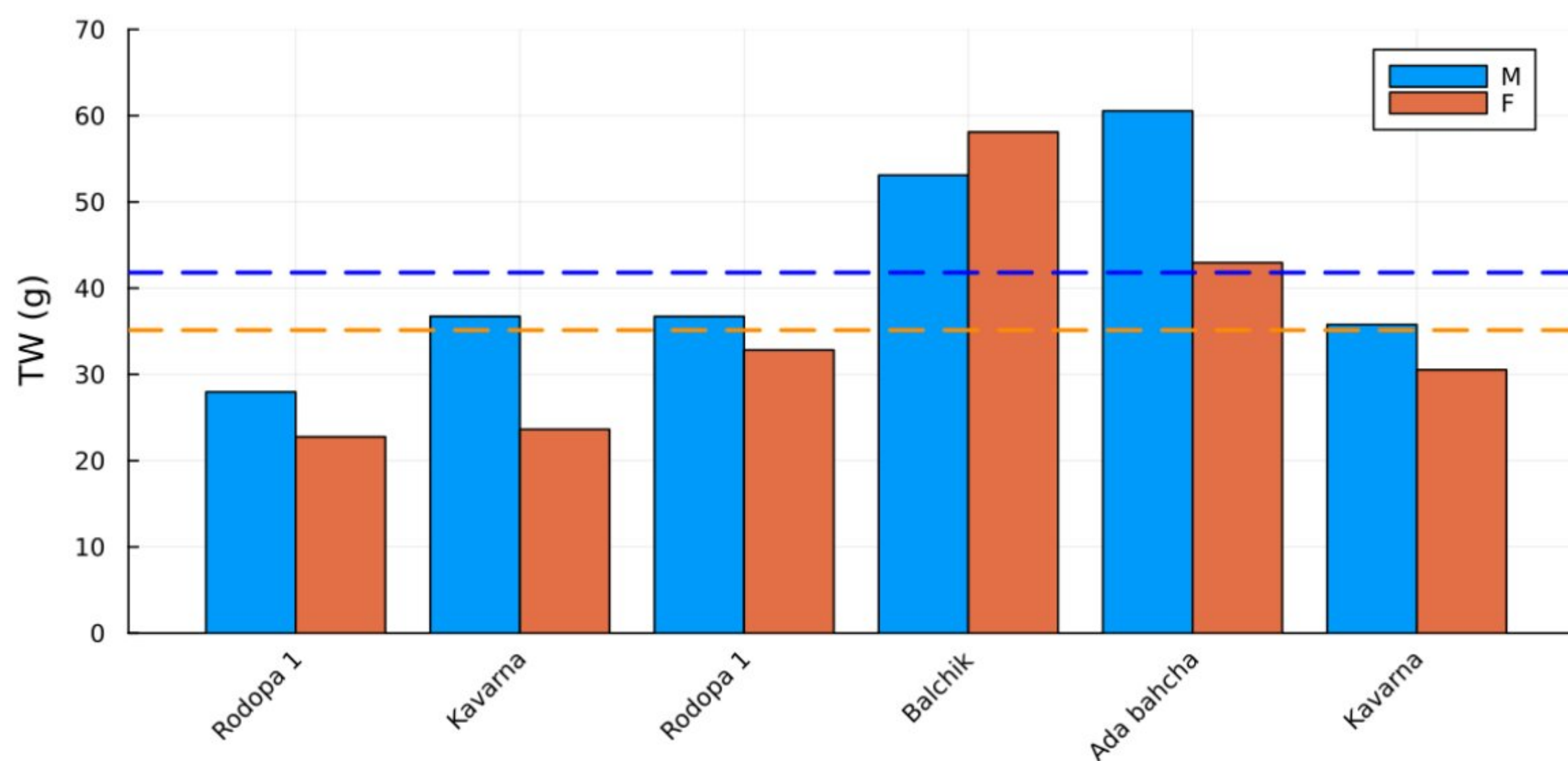
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Mean SL by Sex



1.

Mean TW by Sex



2.

Figure 21 Summarized data for the (1) mean size (SL, mm) of *R. venosa* by sex and (2) mean weight (TW, g) by sex for the first half of 2025



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The analysis of the size class dynamics by sex shows that in beam trawl catches, the size class - 50 - 60 mm is the dominant one or 42% from all the male individuals. The female individuals that fall into this size class are 41% from the observed individuals. (Figure 22). The bigger size classes > 80 mm in the beam trawl catches form only 4% of the male individuals and they are not observed in the females.

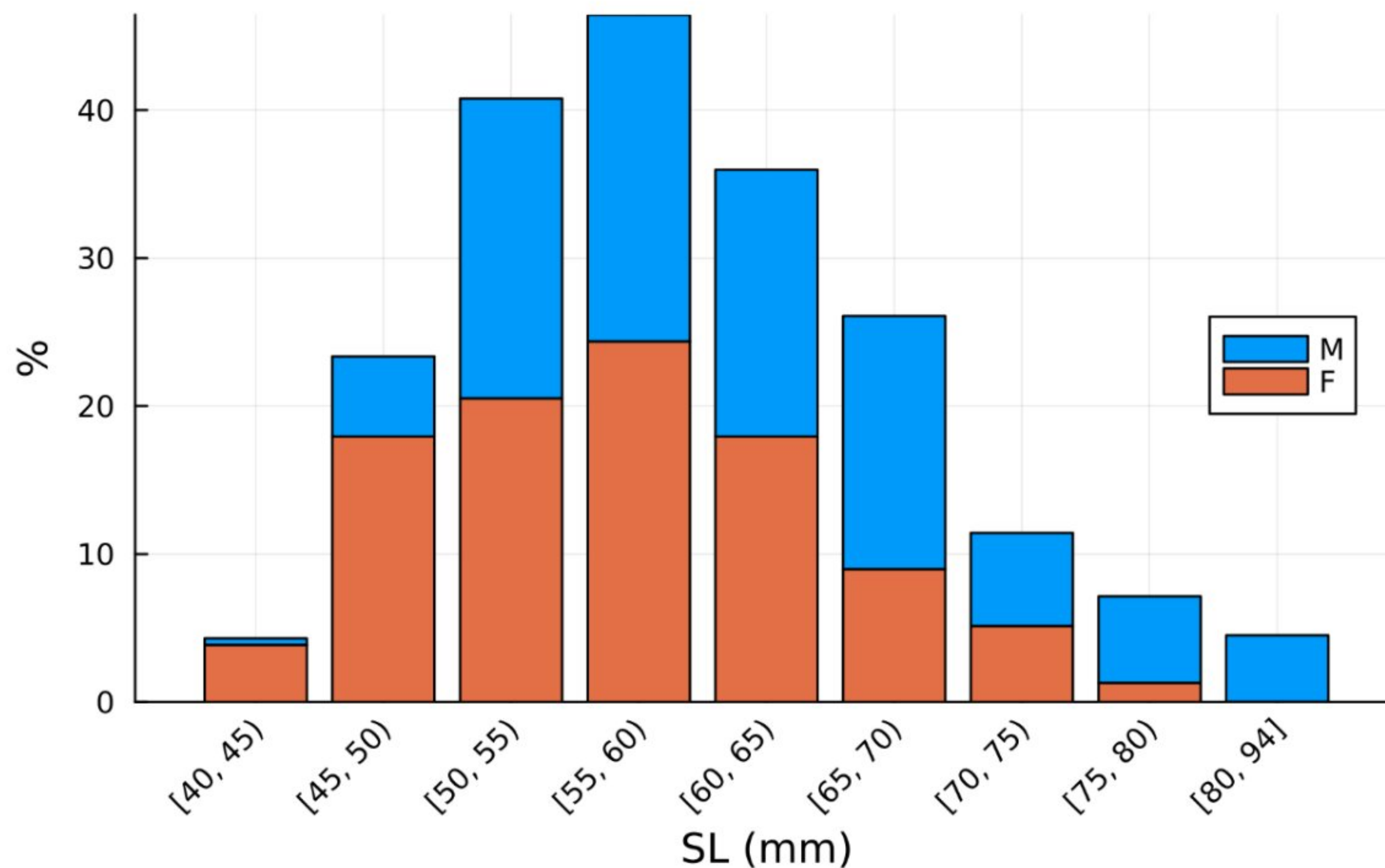


Figure 22 Percentage distribution by size class (SL, mm) of males (M) and females (F) for the first half of 2025

The most common weight class in the samples from beam trawl (**Figure 23**), for both sexes is 20 – 40 g, which was observed in 53% of the males and 57% of the females.



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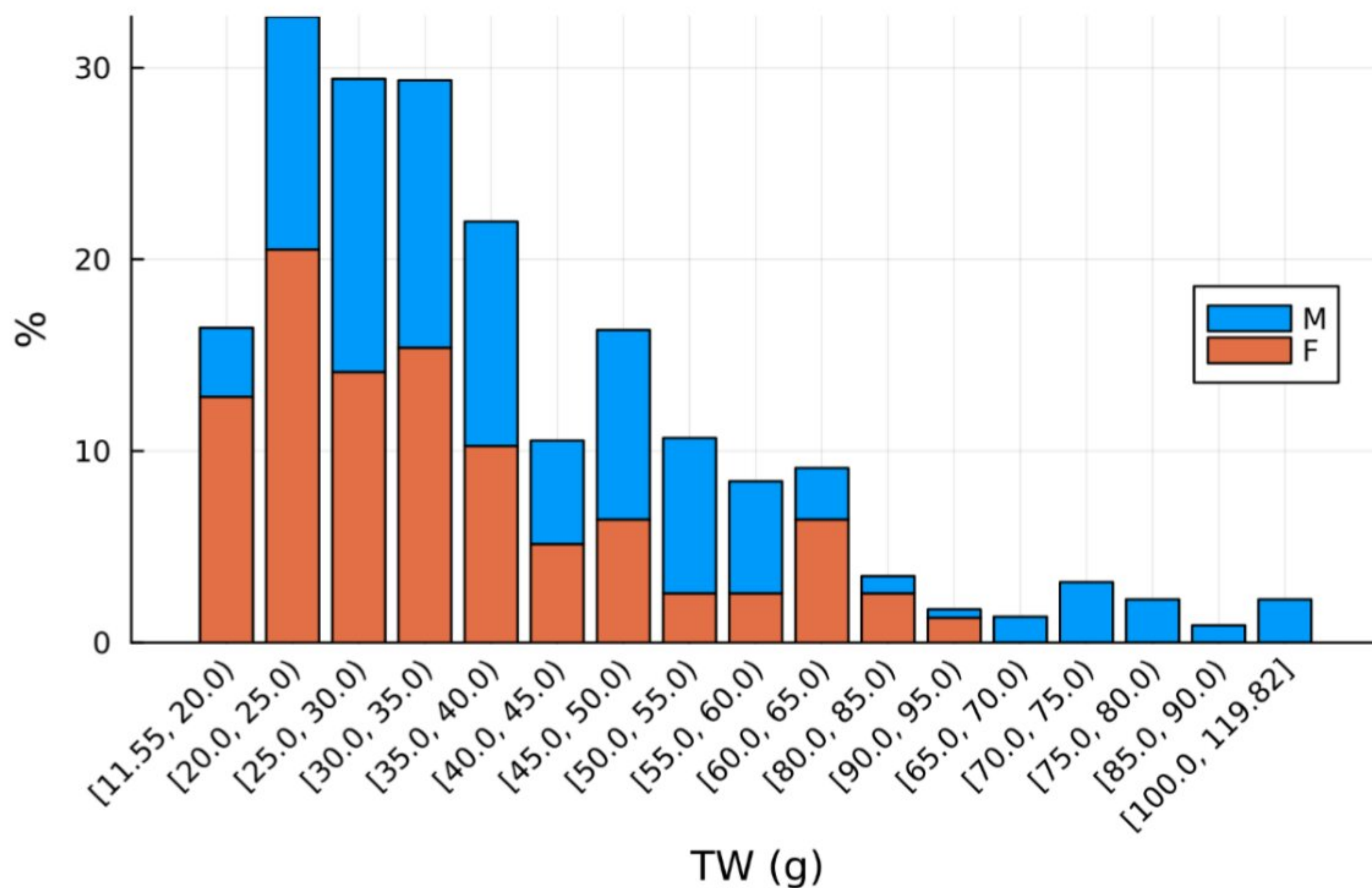


Figure 23 Percentage distribution by weight class (TW, g) of males (M) and females (F) for the first half of 2025

Based on summarized data from all beam trawl catches in the first half of 2025, it can be concluded that the growth for males is negative allometric with a coefficient $b < 3$. The same trend is observed for the females - negative allometric as well with a coefficient $b < 3$. (The parameters of the equation ration L-W for both sexes are presented in **Figure 24 Total weight (TW, g) from the shell length (SL, mm) for all individuals based on the summarized data for the beam trawl fishing for the first half of 2025 (M - males, F - females) Figure 24 and in Table 36.**



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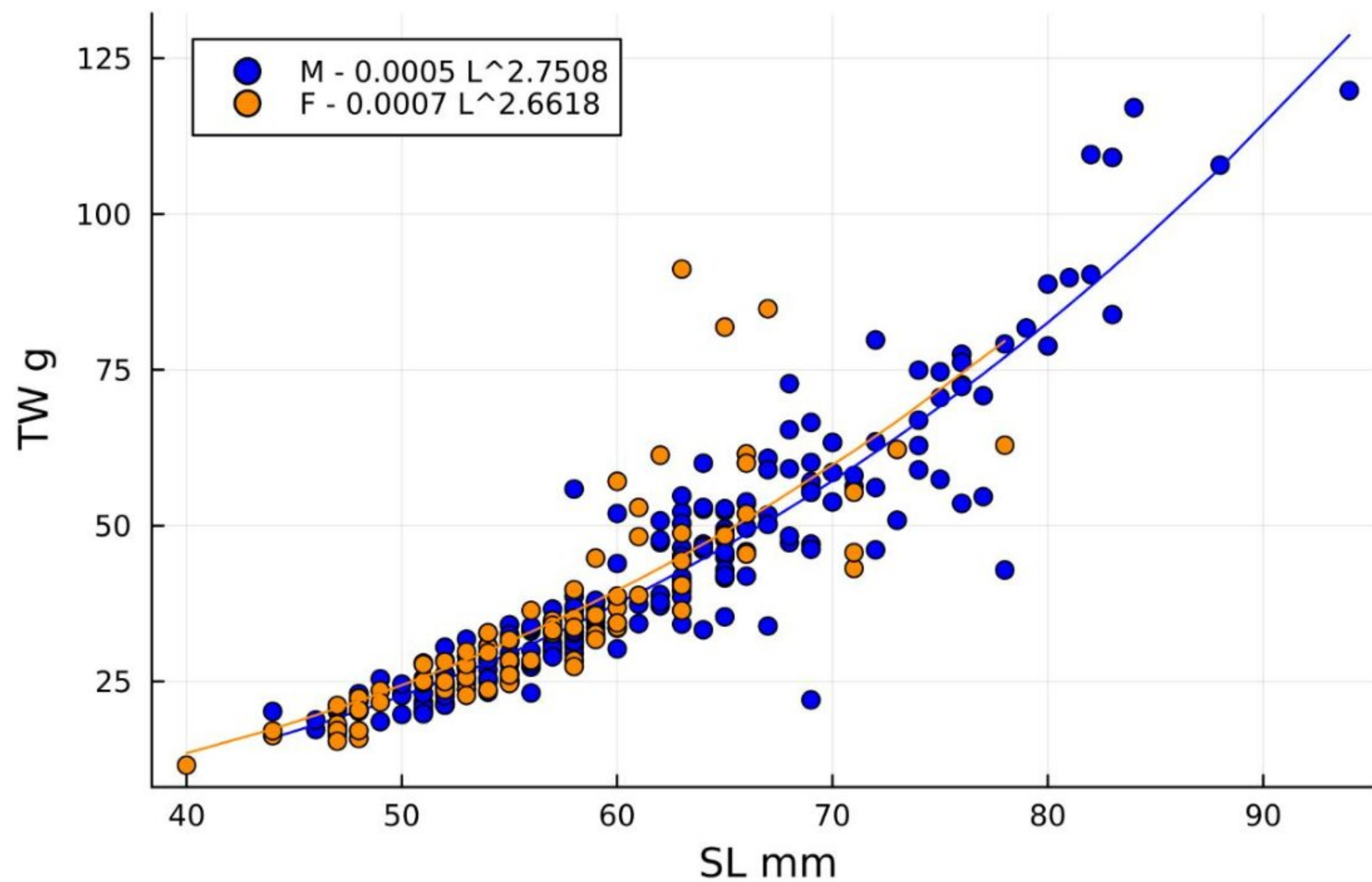


Figure 24 Total weight (TW, g) from the shell length (SL, mm) for all individuals based on the summarized data for the beam trawl fishing for the first half of 2025 (M - males, F - females)

Table 36

Parameters a , b of the L-W ratios and values of R^2 by sex based on the summarized data from the beam trawl samples for the first half of 2025

Parameters	♀	♂
$TW(g) = a \cdot SL(mm)^b$		
a	0.0007	0.0005
b	2.67	2.75
R²	0.84	0.92



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4. CONCLUSIONS

- During the first half of 2025, biological samples were collected and analyzed from a total of 600 specimens of *R. venosa*, caught by beam trawl from landings at four ports – Rodopa 1, Kavarna, Balchik and Ada Bahcha. The present study is indicative for the population dynamics of the rapa whelk and provides information on the size, weight, and sex structure, as well as on the main length-weight relationships of the species during the active fishing season.
- The mean size (SL) of all observed individuals is $61.2 \text{ mm} \pm 10.4 \text{ SD}$, as it varies between 39 and 94 mm. The total weight (TW) reaches $45.43 \text{ g} \pm 23.56 \text{ SD}$, while the body weight (BW) is $17.10 \text{ g} \pm 9.97 \text{ SD}$, or 37.05% of the total weight. Clear differences are observed between the sexes – the male individuals have an average length of 63.2 mm and a mean weight of 49.2 g, while female specimens have an average length of 57.4 mm and a mean weight of 41.1 g. This indicates that males are about 9% longer and over 15% heavier than females.
- The predominant size class in the beam trawl catches is - 50 - 60 mm SL (42% from the observed individuals), while specimens over 70 mm are limitedly represented (<15%). Most of the individuals are in the weight class 20–40 g, as the specimens over 80 g are rarely present. (< 10%). These results indicate that the catches during the first half of 2025 consisted mainly of small and medium-sized groups, while larger individuals were less represented.
- The analysis of the length-weight relationships (**LWR**) showed negative allometric growth in all of the observed samples. The coefficient b ranged from 2.33 to 2.75, depending on the area and time of sampling, confirming that in larger individuals, the increase in length outpaces the weight. The obtained values of the parameters a and b are comparable to those from previous years, indicating stability in the population's growth despite the observed local variations.
- The sex ratio in the samples shows a predominance of male individuals (74% ♂ : 26% ♀). This trend is consistent in all observed ports and aligns with the results from previous years. The distribution by size and weight classes confirms that males are, on average, larger and heavier than females, with the differences being statistically significant.
- For the first half of 2025, the mean value of the gonadosomatic index (GSI) is 15.47% BW. The highest GSI was observed in the samples from March and April (up to 17–18% BW), which indicates an active reproductive phase of the population during this period. The observed values are consistent with the seasonal reproductive dynamics of the species.



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5. REFERENCES

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