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

## SCIENTIFIC REPORT FOR 1ST AND 2ND QUARTERS OF 2024

**IFR-Varna**

10/30/24

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This study is carried out by researchers from the Institute of Fish Resources – Varna, Agricultural Academy (AA), within Contract EAFA - 147 /10.03.2023 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 2024.

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 2024 and represents the dynamics of the biological parameters of Rapana venosa from the landed catch at six ports "Kavarna", "Rodopa 1", "Nessebar", "Balchik", "Varna", "Pomorie", based on the biometric measurements and analysis of 700 specimens of the target species.

## Scientific team


Leader - Assoc. Prof. Elitsa Petrova

Assoc. Prof. Vesselina Mihneva

Assoc. Prof. Stoyko Stoykov

Chief Ass. Prof Feriha Tserkova

Chief Ass. Prof. Philip Penchev

Stanimir Valchev

Rositsa Kuneva

Ass. Radinela Stefanova



*Petrova Mihneva V., Tserkova E., F., Stoykov S., Valchev S., Penchev Ph., 2024. BIOLOGICAL MONITORING (BIOLOGICAL SAMPLES COLLECTION) OF THE LANDED RAPANA CATCH BY THE BULGARIAN FISHING FLEET FOR 1st and 2nd QUARTERS OF 2024, Report under Contract with the Executive Agency for Fisheries and Aquaculture, National Fisheries Data Collection Program., p. 61*





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# 1. INTRODUCTION

The current report is representative for the first half of 2024 and is based on biometric measurements on 700 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 – "Kavarna", "Rodopa 1", "Nessebar", "Balchik", "Varna", "Pomorie".

## 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* – 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 700 specimens of Rapana venosa, 400 from beam trawl and 300 from scuba diving) was carried out by landings in ports, as the samples are collected from six ports - in the northern and southern marine waters, with regular fishing of Rapa whelk. The survey covers 7 days in the period Mar – June 2024, while the surveyed ports are - "Kavarna", "Rodopa 1", "Nessebar", "Balchik", "Varna", "Pomorie". 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 | Reg No Fishing vessel | Fishing method | Technical specifications |
|---|---|---|---|---|
| 31/03/2024 | Kavarna | KB5642 | beam trawl | 10.04 GT, 12.2 m, 69.88 kW |
| 02/04/2024 | Rodopa 1 | BH 7643 | beam trawl | 26.11 GT, 14.7 m, 147.1 kW |
| 06/04/2024 | Nessebar | HC592 | scuba diving | 3.13 GT, 9 m, 58.84 kW |
| 15/05/2024 | Nessebar | HC592 | scuba diving | 3.13 GT, 9 m, 58.84 kW |
| 16/05/2024 | Balchik | BH 8042 | beam trawl | 28.94 GT, 17.7 m, 110.33 kW |
| 05/06/2024 | Varna | BH 7979 | beam trawl | 19.74 GT, 15.97 m, 235 kW |
| 17/06/2024 | Pomorie | HC611 | scuba diving | 1.65 GT, 7.2 m, 22.07 kW |



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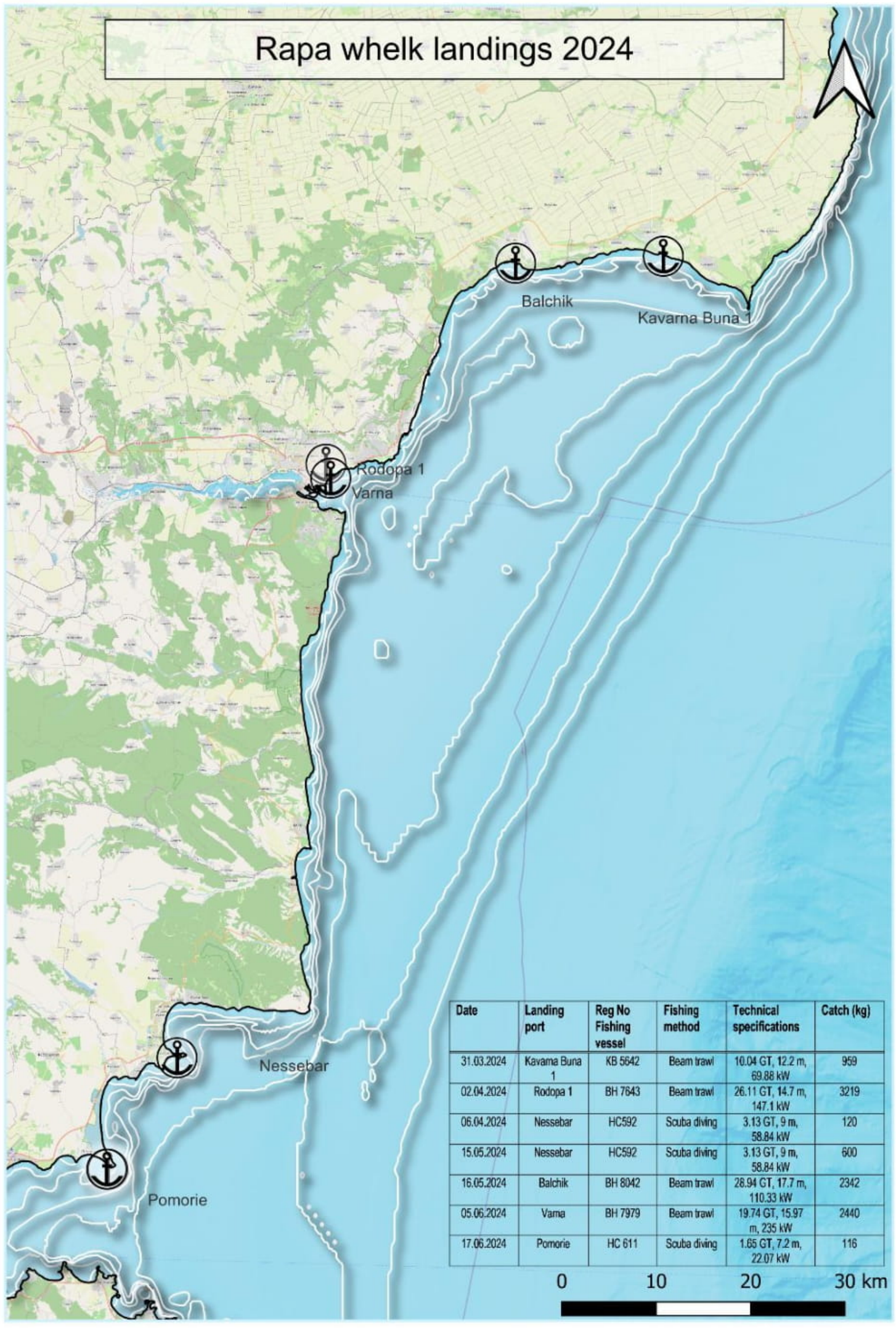


| Date | Landing port | Reg No Fishing vessel | Fishing method | Technical specifications | Catch (kg) |
|---|---|---|---|---|---|
| 31.03.2024 | Kavarna Buna 1 | KB 5642 | Beam trawl | 10.04 GT, 12.2 m, 69.88 kW | 959 |
| 02.04.2024 | Rodopa 1 | BH 7643 | Beam trawl | 26.11 GT, 14.7 m, 147.1 kW | 3219 |
| 06.04.2024 | Nessebar | HC592 | Scuba diving | 3.13 GT, 9 m, 58.84 kW | 120 |
| 15.05.2024 | Nessebar | HC592 | Scuba diving | 3.13 GT, 9 m, 58.84 kW | 600 |
| 16.05.2024 | Balchik | BH 8042 | Beam trawl | 28.94 GT, 17.7 m, 110.33 kW | 2342 |
| 05.06.2024 | Varna | BH 7979 | Beam trawl | 19.74 GT, 15.97 m, 235 kW | 2440 |
| 17.06.2024 | Pomorie | HC 611 | Scuba diving | 1.65 GT, 7.2 m, 22.07 kW | 116 |

**Figure 1 Landing ports for the first half of 2024**



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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.

In April, May and June 2024, samples were collected from landings from scuba diving - Nessebar and Pomorie. 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:

- "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%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), shell length (SL), shell width (Wd), aperture length (AL) was 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.

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 %



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The XLSTAT software product, together with the statistical libraries of PYTHON, 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 Kavarna, 31.03.2024

The sample consists of 100 individuals rapa whelk, weighing 2.282 kg, from a total landing of 959 kg rapa whelks at port Kavarna (from the fishing vessel).

The mean weight of the measured specimens reaches 22.82 g ± 7.99 SD , at a mean shell length of – 49.33 mm ± 5.31 SD, shell width – 36.84 mm ± 4.43 SD and aperture length 34.29 mm ± 4.23 SD. The mean body weight without shell (BW, g) is 8.54 g ± 2.78 SD forming 35.72 % ± 3.82 SD from the total weight, varying between 23.88 % and 45.85 % 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 Kavarna, 31.03.2024

| | TW g | SL mm | Wd mm | Al mm | BW g | BW % TW |
|---|---|---|---|---|---|---|
| Sample size | 100 | 100 | 100 | 100 | 50 | 50 |
| Mean | 22.82 | 49.33 | 36.84 | 34.29 | 8.54 | 35.72 |
| Standard deviation | 7.99 | 5.31 | 4.43 | 4.29 | 2.78 | 3.82 |
| Minimum | 9.92 | 40.00 | 27.00 | 25.00 | 4.56 | 23.88 |
| 50% (median) | 22.25 | 49.00 | 37.00 | 34.50 | 8.18 | 36.05 |
| Maximum | 59.53 | 67.00 | 49.00 | 47.00 | 20.11 | 45.85 |
| Sum | 2282.40 | 4933.00 | 3684.00 | 3429.00 | 426.89 | 1785.91 |
| Mode | 23.73 | 50.00 | 39.00 | 32.00 | 8.06 | 38.92 |
| Skewness | 1.37 | 0.50 | 0.32 | 0.33 | 1.63 | -0.49 |
| Sample variance | 0.35 | 0.11 | 0.12 | 0.12 | 0.33 | 0.11 |
| Kurtosis | 3.72 | 0.30 | -0.10 | 0.09 | 4.50 | 1.23 |
| Range | 49.61 | 27.00 | 22.00 | 22.00 | 15.55 | 21.97 |
| Confidence level 95% | 1.58 | 1.05 | 0.88 | 0.84 | 0.79 | 1.09 |

The mean ratio between the shell width (Wd, mm)/shell length (SL, mm) is 74.64 % ± 3.27 SD, while AL/SL (%) is 69.45 % ± 3.07 SD, and the ratio between AL/Wd (%) was calculated at – 93.06 % ± 1.73 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 Kavarna, 31.03.2024

| | Wd/SL % | Al/SL % | Al/Wd % |
|---|---|---|---|
| Sample size | 100 | 100 | 100 |
| Mean | 74.64 | 69.45 | 93.06 |
| Standard deviation | 3.27 | 3.07 | 1.73 |
| Minimum | 65.85 | 60.98 | 88.89 |
| 50% (median) | 74.25 | 69.31 | 93.41 |
| Maximum | 82.98 | 76.47 | 97.06 |
| Sum | 7464.11 | 6945.02 | 9305.98 |
| Mode | 75 | 66.67 | 92.31 |
| Skewness | 0.18 | -0.01 | -0.27 |
| Sample variance | 0.04 | 0.04 | 0.02 |
| Kurtosis | 0.33 | -0.09 | -0.68 |
| Range | 17.13 | 15.49 | 8.17 |
| Confidence level 95% | 0.65 | 0.61 | 0.34 |

The L-W ratios have been calculated, Figure 2. 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 Kavarna, 31.03.2024

| **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** | 0.00023 | 0.00147 | 0.00234 |
| **b** | 2.94 | 2.67 | 2.59 |
| **$R^2$** | 0.95 | 0.95 | 0.96 |



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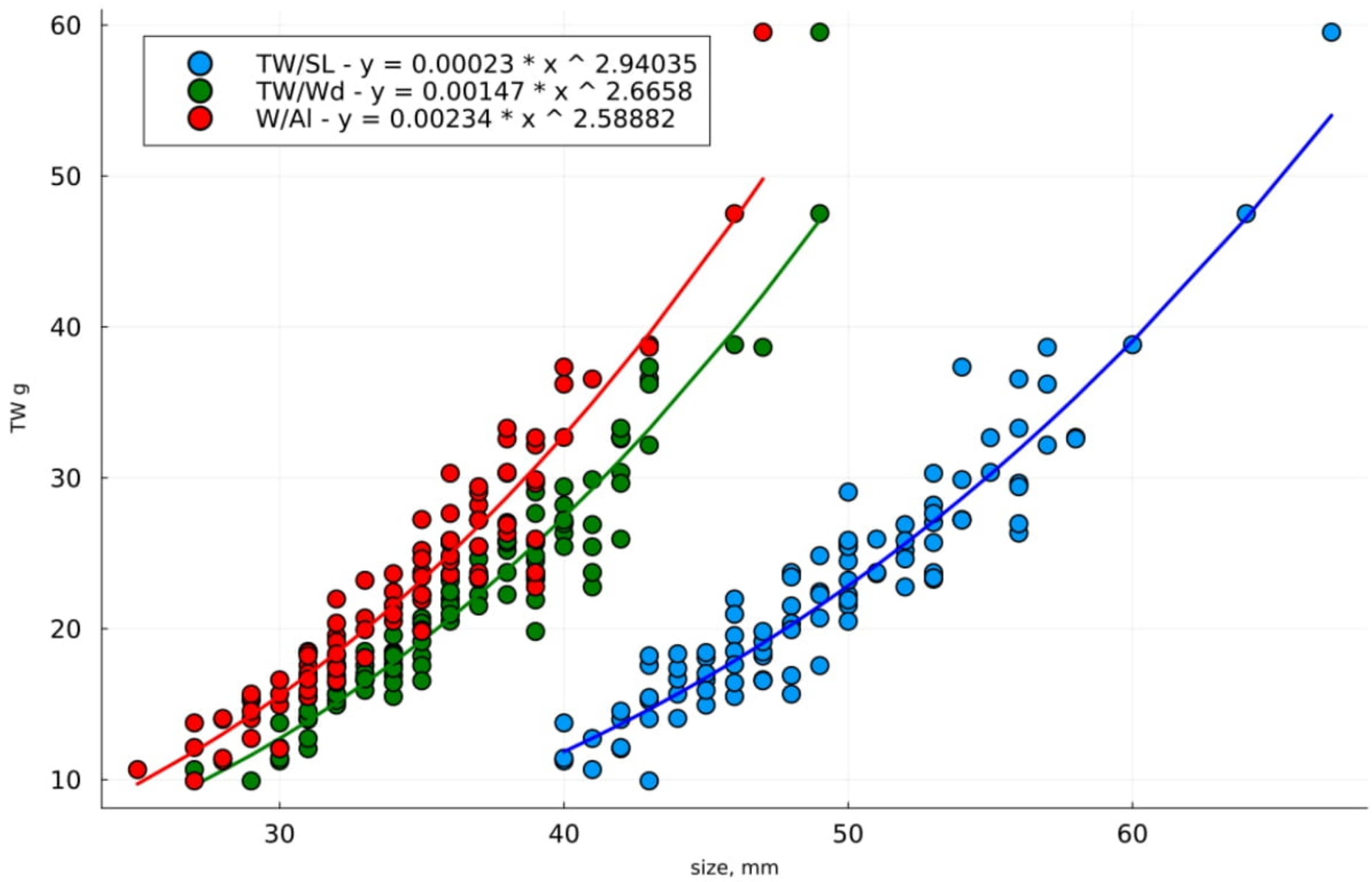


**Figure 2 L-W ratios for the sampled individuals, Port Kavarna, 31.03.2024 (1) ratio between total weight (TW, g) and shell length (SL, mm); (2) relationship between total weight (TW, g) and shell width (Wd, mm); (3) relationship between total weight (TW, g) and aperture length (AL, mm)**



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### 3.1.2. Port Rodopa 1, 02.04.2024

The sample consists of 100 individuals rapa whelk, weighing 2.634 kg, from a total landing of 3219 kg rapa whelks at port Rodopa 1 (from the fishing vessel).

The mean weight of the measured specimens reaches 26.34 g ± 21.31 SD, at a mean shell length of 50.39 mm ± 11.48 SD, shell width 37.55 mm ± 9.12 SD and aperture length 35.35 ± 8.78 SD. The mean body weight without shell (BW, g) is 13.27 g ± 10.62 SD forming 33.79 % ± 6.44 SD from the total weight, varying between 16.87% and 47.05 % 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 Rodopa 1, 02.04.2024

| | TW g | SL mm | Wd mm | Al mm | BW g | BW % TW |
|---|---|---|---|---|---|---|
| Sample size | 100 | 100 | 100 | 100 | 50 | 50 |
| Mean | 26.34 | 50.39 | 37.55 | 35.35 | 13.27 | 33.79 |
| Standard deviation | 21.31 | 11.48 | 9.12 | 8.78 | 10.62 | 6.44 |
| Minimum | 5.70 | 35.00 | 24.00 | 23.00 | 10.53 | 16.87 |
| 50% (median) | 18.12 | 47.00 | 35.00 | 33.00 | 16.90 | 32.82 |
| Maximum | 117.19 | 84.00 | 65.00 | 62.00 | 38.13 | 47.05 |
| Sum | 2634.17 | 5039.00 | 3755.00 | 3535.00 | 860.87 | 1693.66 |
| Mode | 14.63 | 47.00 | 34.00 | 27.00 | 15.29 | 11.29 |
| Skewness | 1.93 | 1.04 | 0.99 | 1.01 | 1.62 | 2.78 |
| Sample variance | 0.81 | 0.23 | 0.24 | 0.25 | 0.29 | 0.35 |
| Kurtosis | 3.43 | 0.29 | 0.17 | 0.19 | 4.62 | 12.09 |
| Range | 111.49 | 49.00 | 41.00 | 39.00 | 27.60 | 82.51 |
| Confidence level 95% | 4.23 | 2.28 | 1.81 | 1.74 | 1.40 | 3.34 |

The mean ratio between the shell width (Wd, mm)/shell length (SL, mm) is 74.37 % ± 3.91 SD, while AL/SL (%) is 69.95 % ± 3.96 SD, and the ratio between AL/Wd (%) was calculated at - 94.06 % ± 1.97 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 Rodopa 1, 02.04.2024

| | Wd/SL % | Al/SL % | Al/Wd % |
|---|---|---|---|
| Sample size | 100 | 100 | 100 |
| Mean | 74.37 | 69.95 | 94.06 |
| Standard deviation | 3.91 | 3.96 | 1.97 |
| Minimum | 66.67 | 62.22 | 88.24 |
| 50% (median) | 74.39 | 70 | 94.37 |
| Maximum | 95.12 | 92.68 | 97.44 |
| Sum | 7437.32 | 6995.09 | 9405.69 |
| Mode | 72.34 | 69.05 | 93.1 |
| Skewness | 1.29 | 1.72 | -0.47 |
| Sample variance | 0.05 | 0.06 | 0.02 |
| Kurtosis | 6.38 | 9.19 | -0.14 |
| Range | 28.46 | 30.46 | 9.2 |
| Confidence level 95% | 0.78 | 0.79 | 0.39 |

The L-W ratios are calculated, 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 Rodopa 1, 02.04.2024

| **Parameters** | $\mathbf{TW(g) = a.SL(mm)^b}$ | $\mathbf{TW(g) = a.Wd(mm)^b}$ | $\mathbf{W(g) = a.AL(mm)^b}$ |
|---|---|---|---|
| **a** | 0.00019 | 0.00096 | 0.00142 |
| **b** | 2.98 | 2.77 | 2.71 |
| **$R^2$** | 0.98 | 0.98 | 0.98 |



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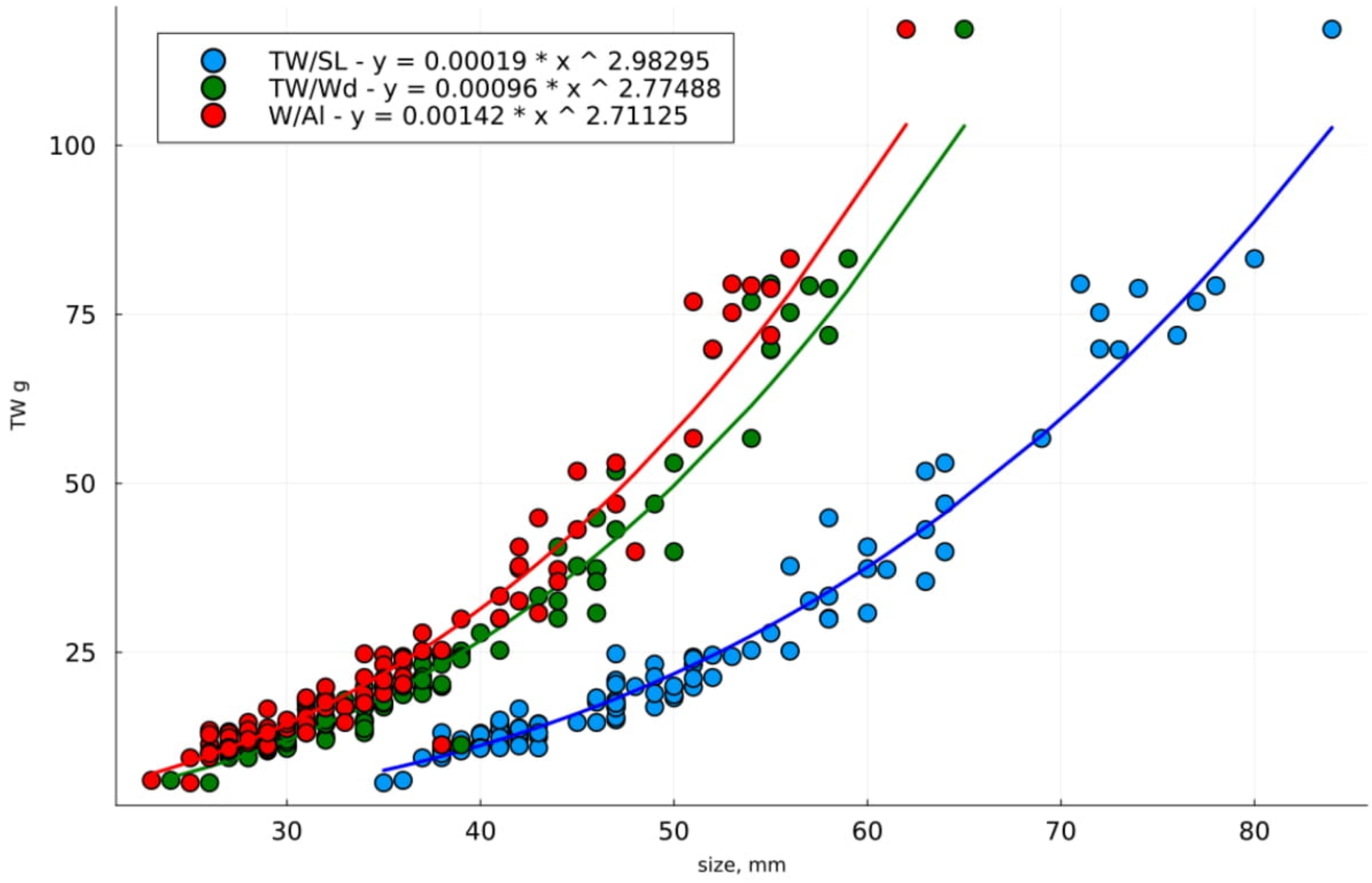


**Figure 3 L-W ratios for the sampled individuals, port Rodopa 1, 02.04.2024: (1) Total weight (TW, g) from the shell length (SL, mm); (2) Total weight (TW, g) from the shell width (Wd, mm); (3) total weight (TW, g) and aperture length (AL, mm)**



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### 3.1.3. Port Nessebar (scuba diving), 06.04.2024

The sample consists of 100 individuals rapa whelk (from scuba diving), with a weight of 4.601 kg, from a total landing of 120 kg rapa whelks at port Nessebar.

The mean weight of the measured specimens reaches 46.01 g ± 28.52 SD, at a mean shell length of 60.91 mm ± 13.03 SD, shell width – 45.80 mm ± 10.39 SD and aperture length 42.83 mm ± 10.1 SD. The mean body weight without shell (BW, g) is 17.39 g ± 10.2 SD forming 30.86 % ± 5.19 SD from the total weight, varying between 18.93 % и 39.04 % 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 Nessebar, 06.04.2024

| | TW g | SL mm | Wd mm | Al mm | BW g | BW % TW |
|---|---|---|---|---|---|---|
| Sample size | 100 | 100 | 100 | 100 | 50 | 50 |
| Mean | 46.01 | 60.91 | 45.80 | 42.83 | 17.39 | 30.86 |
| Standard deviation | 28.52 | 13.03 | 10.39 | 10.10 | 10.2 | 5.19 |
| Minimum | 7.52 | 35.00 | 25.00 | 23.00 | 4.71 | 18.93 |
| 50% (median) | 44.14 | 62.00 | 46.50 | 43.00 | 9.33 | 37.04 |
| Maximum | 148.39 | 94.00 | 71.00 | 68.00 | 40.70 | 39.04 |
| Sum | 4600.56 | 6091.00 | 4580.00 | 4283.00 | 578.53 | 1876.12 |
| Mode | 70.94 | 51.00 | 52.00 | 49.00 | 7.79 | 41.82 |
| Skewness | 1.08 | 0.14 | 0.01 | 0.09 | 2.33 | 0.90 |
| Sample variance | 0.62 | 0.21 | 0.23 | 0.24 | 0.57 | 0.09 |
| Kurtosis | 1.46 | -0.70 | -0.80 | -0.75 | 6.88 | 0.98 |
| Range | 140.87 | 59.00 | 46.00 | 45.00 | 35.99 | 16.90 |
| Confidence level 95% | 5.66 | 2.59 | 2.06 | 2.00 | 1.87 | 0.93 |

The mean ratio between the shell width (Wd, mm)/shell length (SL, mm) is 75.06 % ± 4.46 SD, while AL/SL (%) is 70.06 % ± 4.31 SD, and the ratio between AL/Wd (%) was calculated at - 93.36 % ± 2.25 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 Nessebar, 06.04.2024

| | Wd/SL % | Al/SL % | Al/Wd % |
|---|---|---|---|
| Sample size | 100 | 100 | 100 |
| Mean | 75.06 | 70.06 | 93.36 |
| Standard deviation | 4.46 | 4.31 | 2.25 |
| Minimum | 63.83 | 59.74 | 81.36 |
| 50% (median) | 74.58 | 70.32 | 93.68 |
| Maximum | 86.76 | 81.25 | 98.44 |
| Sum | 7505.75 | 7006.3 | 9336.16 |
| Mode | 75 | 66.67 | 92.31 |
| Skewness | 0.19 | 0.14 | -1.68 |
| Sample variance | 0.06 | 0.06 | 0.02 |
| Kurtosis | 0.13 | -0.26 | 7.03 |
| Range | 22.93 | 21.51 | 17.08 |
| Confidence level 95% | 0.88 | 0.85 | 0.45 |

The L-W ratios are calculated, **Figure** 4. 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 Nessebar, 06.04.2024

| **Parameters** | $TW(g) = a.SL(mm)^b$ | $TW(g) = a.Wd(mm)^b$ | $W(g) = a.AL(mm)^b$ |
|---|---|---|---|
| **a** | 0.00023 | 0.00123 | 0.00206 |
| **b** | 2.94 | 2.72 | 2.63 |
| **$R^2$** | 0.97 | 0.93 | 0.94 |



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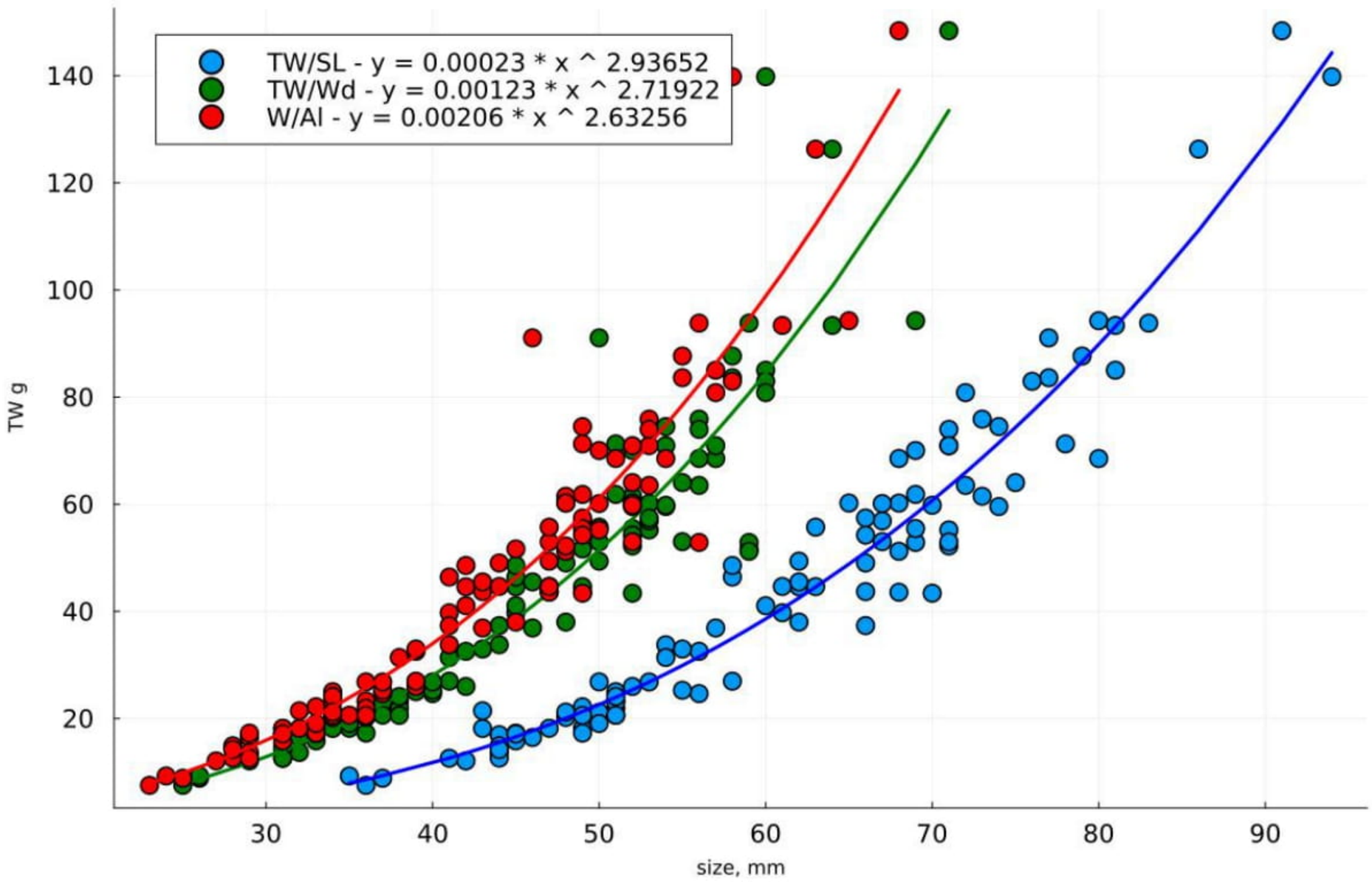


**Figure 4 L-W ratios for the sampled individuals, port Nessebar, 06.04.2024: (1) ratio between total weight (TW, g) and shell length (SL, mm); (2) relationship between total weight (TW, g) and shell width (Wd, mm); (3) relationship between total weight (TW, g) and aperture length (AL, mm)**



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### 3.1.4. Port Nessebar (scuba diving), 15.05.2024

The sample consists of 100 individuals rapa whelk (from scuba diving), weighing 6.149 kg, from a total landing of 600 kg rapa whelks at port Nessebar.

The mean weight of the measured specimens reaches 61.49 g ± 20.00 SD, at a mean shell length of – 68.73 mm ± 6.59 SD, shell width - 53.39 mm ± 5.81 SD and aperture length 50.67 mm ± 5.64 SD. The mean body weight without shell (BW, g) is 21.63 g ± 7.57 SD forming 35.29 % ± 4.49 SD from the total weight, varying between 21.11 % и 44.77 % from the total weight (Table 11).

**Table 11**

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 Nessebar, 15.05.2024

| | TW g | SL mm | Wd mm | Al mm | BW g | BW % TW |
|---|---|---|---|---|---|---|
| Sample size | 100 | 100 | 100 | 100 | 50 | 50 |
| Mean | 61.49 | 68.73 | 53.39 | 50.67 | 21.63 | 35.29 |
| Standard deviation | 20.00 | 6.59 | 5.81 | 5.64 | 7.57 | 4.49 |
| Minimum | 22.77 | 54.00 | 38.00 | 36.00 | 10.55 | 21.11 |
| 50% (median) | 58.88 | 69.00 | 53.00 | 50.50 | 20.94 | 35.16 |
| Maximum | 145.69 | 87.00 | 69.00 | 66.00 | 47.61 | 44.77 |
| Sum | 6149.21 | 6873.00 | 5339.00 | 5067.00 | 1081.73 | 1764.35 |
| Mode | 59.99 | 70.00 | 53.00 | 52.00 | 21.01 | 32.68 |
| Skewness | 1.22 | 0.47 | 0.25 | 0.34 | 1.17 | -0.20 |
| Sample variance | 0.33 | 0.10 | 0.11 | 0.11 | 0.35 | 0.13 |
| Kurtosis | 2.60 | 0.52 | 0.27 | 0.34 | 1.95 | 0.96 |
| Range | 122.92 | 33.00 | 31.00 | 30.00 | 37.06 | 23.66 |
| Confidence level 95% | 3.97 | 1.31 | 1.15 | 1.12 | 2.15 | 1.28 |

The mean ratio between the shell width (Wd, mm)/shell length (SL, mm) is 77.63 % ± 3.05 SD, while AL/SL (%) is 73.66 % ± 2.93 SD, and the ratio between AL/Wd (%) was calculated at - 94.89 % ± 1.46 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 Nessebar, 15.05.2024

| | Wd/SL % | Al/SL % | Al/Wd % |
|---|---|---|---|
| Sample size | 100 | 100 | 100 |
| Mean | 77.63 | 73.66 | 94.89 |
| Standard deviation | 3.05 | 2.93 | 1.46 |
| Minimum | 69.44 | 66.67 | 91.38 |
| 50% (median) | 77.48 | 73.53 | 94.87 |
| Maximum | 85.71 | 80.6 | 98.11 |
| Sum | 7763.25 | 7366.15 | 9489.45 |
| Mode | 75 | 74.29 | 94.55 |
| Skewness | 0.1 | 0.06 | -0.36 |
| Sample variance | 0.04 | 0.04 | 0.02 |
| Kurtosis | -0.06 | -0.04 | -0.25 |
| Range | 16.27 | 13.93 | 6.73 |
| Confidence level 95% | 0.61 | 0.58 | 0.29 |
| Sample size | 100 | 100 | 100 |
| Mean | 77.63 | 73.66 | 94.89 |

The L-W ratios are calculated (Figure 5). 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 if the L-W ratio and values of $R^2$ for the sample from port Nessebar, 15.05.2024

| **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** | 0.00012 | 0.0013 | 0.00152 |
| **b** | 3.10 | 2.73 | 2.96 |
| **$R^2$** | 0.94 | 0.95 | 0.95 |



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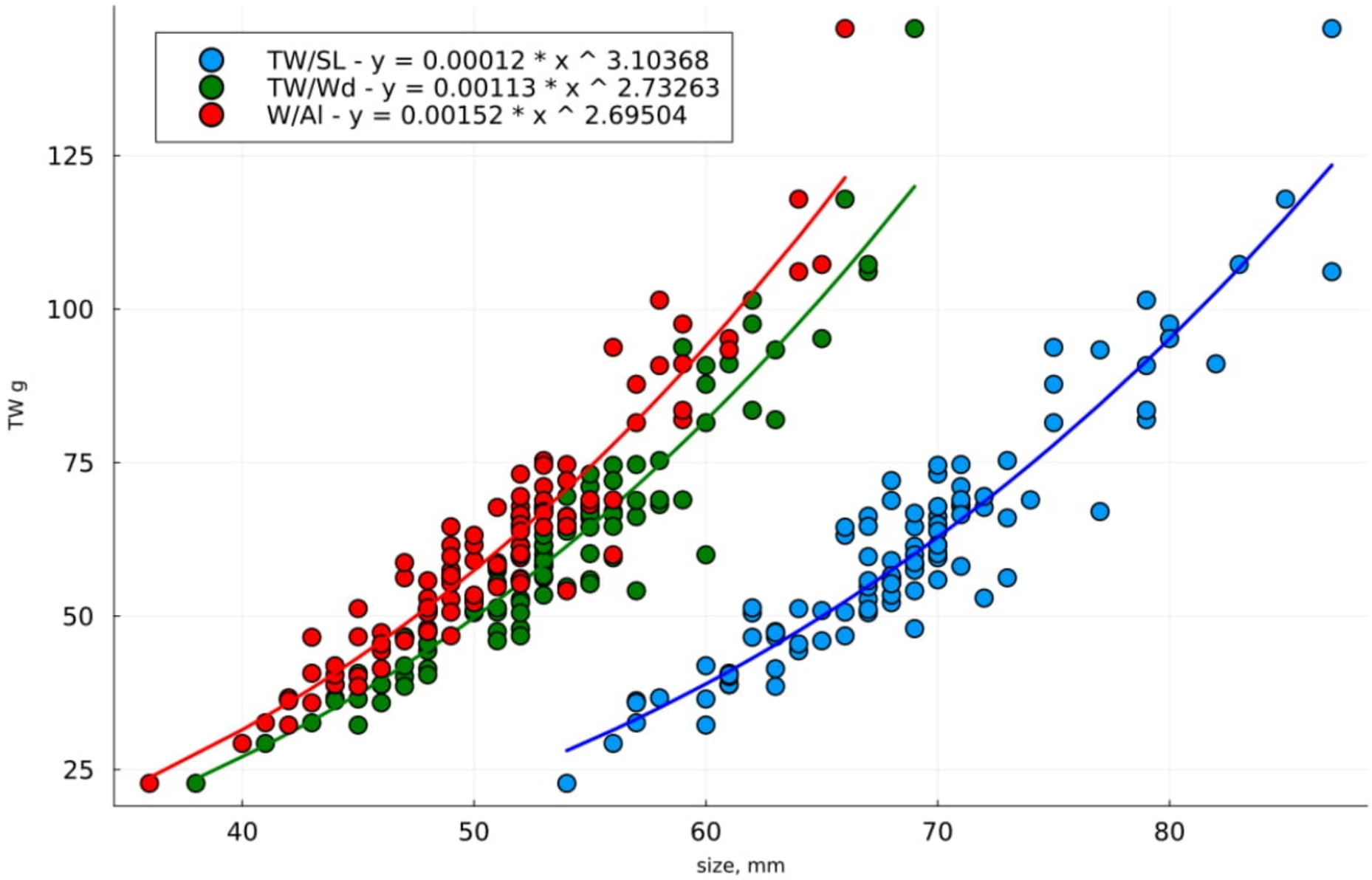


**Figure 5 L-W ratios for the sampled individuals, port Nessebar, 15.05.2024: (1) ratio between total weight (TW, g) and shell length (SL, mm); (2) relationship between total weight (TW, g) and shell width (Wd, mm); (3) relationship between total weight (TW, g) and aperture length (AL, mm)**



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## 3.1.5. PORT BALCHIK, 16.05.2024

The sample consists of 100 individuals rapa whelk, weighing 3.64 kg, from a total landing of 2342 kg rapa whelks at port Balchik (from the fishing vessel).

The mean weight of the measured specimens reaches 36.4 g ± 22.44 SD, at a mean shell length of 56.95 mm ± 10.22 SD, shell width - 44.17 mm ± 8.68 SD and aperture length 41.72 ± 8.36 SD. The mean body weight without shell (BW, g) is 11.57 g ± 6.56 SD forming 37.52 % ± 3.29 SD from the total weight, varying between 30.99 % и 47.89 % 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 Balchik, 16.05.2024

| | TW g | SL mm | Wd mm | Al mm | BW | BW % TW |
|---|---|---|---|---|---|---|
| Sample size | 100 | 100 | 100 | 100 | 50 | 50 |
| Mean | 36.40 | 56.95 | 44.17 | 41.72 | 11.57 | 37.52 |
| Standard deviation | 22.40 | 10.22 | 8.68 | 8.36 | 6.56 | 3.29 |
| Minimum | 12.81 | 43.00 | 30.00 | 29.00 | 4.71 | 30.99 |
| 50% (median) | 28.41 | 54.00 | 42.00 | 39.00 | 9.33 | 37.04 |
| Maximum | 127.59 | 89.00 | 76.00 | 74.00 | 40.70 | 47.89 |
| Sum | 3639.97 | 5695.00 | 4417.00 | 4172.00 | 869.69 | 1542.77 |
| Mode | 49.64 | 52.00 | 41.00 | 38.00 | 16.18 | 36.61 |
| Skewness | 1.94 | 1.21 | 1.20 | 1.23 | 1.00 | -0.42 |
| Sample variance | 0.62 | 0.18 | 0.20 | 0.20 | 0.59 | 0.17 |
| Kurtosis | 3.71 | 0.99 | 1.65 | 1.83 | 1.24 | -0.70 |
| Range | 114.78 | 46.00 | 46.00 | 45.00 | 46.98 | 20.11 |
| Confidence level 95% | 4.44 | 2.03 | 1.72 | 1.66 | 2.90 | 1.47 |

The mean ratio between the shell width (Wd, mm)/shell length (SL, mm) is 77.44 % ± 4.15 SD, while AL/SL (%) is 73.1 % ± 3.93 SD, and the ratio between AL/Wd (%) was calculated at - 94.41 % ± 1.67 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, %) of the individuals from the sample from Balchik, 16.05.2024

| | Wd/SL % | Al/SL % | Al/Wd % |
|---|---|---|---|
| Sample size | 100 | 100 | 100 |
| Mean | 77.44 | 73.1 | 94.41 |
| Standard deviation | 4.15 | 3.93 | 1.67 |
| Minimum | 66.67 | 63.64 | 90.7 |
| 50% (median) | 77.66 | 73.05 | 94.49 |
| Maximum | 89.47 | 84.21 | 98.18 |
| Sum | 7744.31 | 7310.25 | 9441 |
| Mode | 77.78 | 75 | 92.68 |
| Skewness | -0.35 | -0.05 | 0.02 |
| Sample variance | 0.05 | 0.05 | 0.02 |
| Kurtosis | 0.69 | 0.2 | -0.38 |
| Range | 22.81 | 20.57 | 7.48 |
| Confidence level 95% | 0.82 | 0.78 | 0.33 |

The L-W ratios are calculated (Figure 6). 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 Balchik, 16.05.2024

| **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** | 0.00026 | 0.0014 | 0.00195 |
| **b** | 2.91 | 2.65 | 2.61 |
| **$R^2$** | 0.98 | 0.97 | 0.97 |



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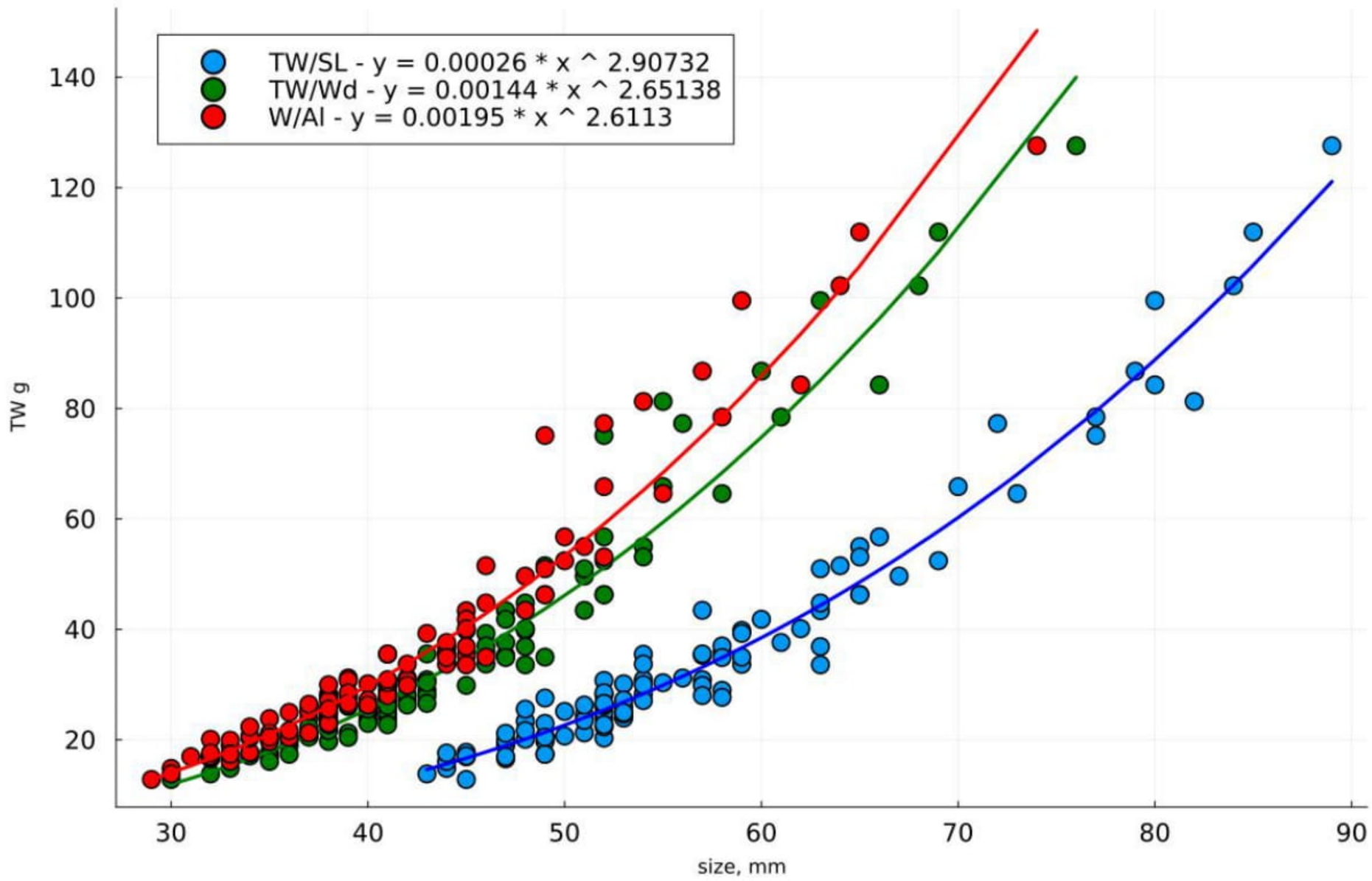


**Figure 6 L-W ratios for the sampled individuals, port Balchik, 16.05.2024: (1) ratio between total weight (TW, g) and shell length (SL, mm); (2) relationship between total weight (TW, g) and shell width (Wd, mm); (3) relationship between total weight (TW, g) and aperture length (AL, mm)**



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## 3.1.6. PORT VARNA, 05.06.2024

The sample consists of 100 individuals rapa whelk, weighing 4.646 kg, from a total landing of 2440 kg rapa whelks at port Varna (from the fishing vessel).

The mean weight of the measured specimens reaches 46.46 g ± 21.32 SD, at a mean shell length of 63.57 mm ± 8.05 SD, shell width - 46.7 mm ± 6.15 SD and aperture length 44.38 ± 5.92 SD. The mean body weight without shell (BW, g) is 13.69 g ± 5.28 SD forming 32.57 % ± 3.64 SD from the total weight, varying between 26.44 % и 40.71 % 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 Varna, 05.06.2024

| | TW g | SL mm | Wd mm | Al mm | BW g | BW % TW |
|---|---|---|---|---|---|---|
| Sample size | 100 | 100 | 100 | 100 | 50 | 50 |
| Mean | 46.46 | 63.57 | 46.70 | 44.38 | 13.69 | 32.57 |
| Standard deviation | 21.32 | 8.05 | 6.15 | 5.92 | 5.28 | 3.64 |
| Minimum | 21.19 | 49.00 | 36.00 | 34.00 | 6.85 | 26.44 |
| 50% (median) | 41.12 | 62.50 | 46.00 | 44.00 | 12.80 | 32.24 |
| Maximum | 144.17 | 91.00 | 71.00 | 68.00 | 34.55 | 40.71 |
| Sum | 4646.14 | 6357.00 | 4670.00 | 4438.00 | 684.67 | 1628.43 |
| Mode | 48.07 | 62.00 | 46.00 | 44.00 | 22.26 | 33.19 |
| Skewness | 2.64 | 0.97 | 1.13 | 1.15 | 1.44 | 0.43 |
| Sample variance | 0.46 | 0.13 | 0.13 | 0.13 | 0.39 | 0.11 |
| Kurtosis | 8.64 | 1.77 | 2.76 | 2.86 | 3.18 | -0.48 |
| Range | 122.98 | 42.00 | 35.00 | 34.00 | 27.70 | 14.27 |
| Confidence level 95% | 4.23 | 1.60 | 1.22 | 1.17 | 1.50 | 1.03 |

The mean value of the ratio width (Wd, mm)/length (SL, mm) of the shell is 73.5 % ± 3.27 SD, while AL/SL (%) is 69.83 % ± 3.08 SD, and the ratio between AL/Wd (%) results 95.03 % ± 1.67 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, %) of the individuals from the sample from port Varna, 05.06.2024



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| | Wd/SL % | Al/SL % | Al/Wd % |
|---|---|---|---|
| Sample size | 100 | 100 | 100 |
| Mean | 73.5 | 69.83 | 95.03 |
| Standard deviation | 3.27 | 3.08 | 1.67 |
| Minimum | 65.91 | 62.5 | 90.48 |
| 50% (median) | 73.13 | 69.53 | 95.35 |
| Maximum | 82.35 | 79.03 | 98.08 |
| Sum | 7349.55 | 6982.97 | 9502.84 |
| Mode | 71.21 | 66.67 | 95.65 |
| Skewness | 0.25 | 0.24 | -0.24 |
| Sample variance | 0.04 | 0.04 | 0.02 |
| Kurtosis | -0.23 | 0 | -0.15 |
| Range | 16.44 | 16.53 | 7.6 |
| Confidence level 95% | 0.65 | 0.61 | 0.33 |

The L-W ratios are calculated (Figure 7). The parameters *a, b* of the derived L-W ratio and the value of the coefficient of determination $R^2$ 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 Varna, 05.06.2024

| **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** | 0.00038 | 0,00131 | 0,00164 |
| **b** | 2,81 | 2,71 | 2,69 |
| **$R^2$** | 0.96 | 0.94 | 0.94 |



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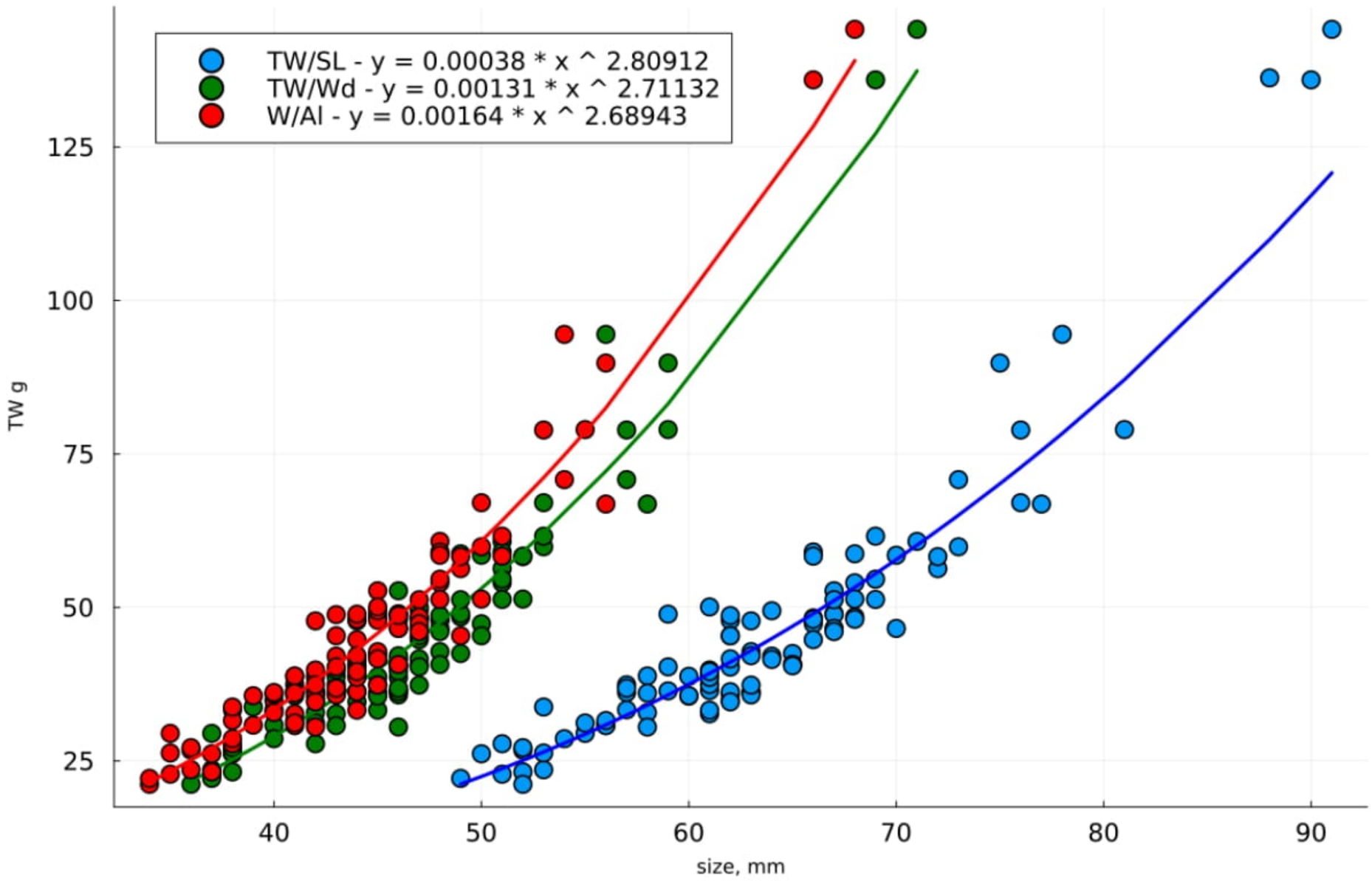


**Figure 7 L-W ratios for the sampled individuals, port Varna, 05.06.2024: (1) ratio between total weight (TW, g) and shell length (SL, mm); (2) relationship between total weight (TW, g) and shell width (Wd, mm); (3) relationship between total weight (TW, g) and aperture length (AL, mm)**



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### 3.1.7. PORT POMORIE (SCUBA DIVING), 17.06.2024

The sample consists of 100 individuals (from scuba diving) with a total weight of 5.467 kg, from a total landing of 116 kg rapa whelks at port Pomorie.

The mean weight of the measured specimens reaches 54.67 g ± 17.22 SD at a mean shell length of – 68.35 mm ± 6.48 SD, shell width – 51.19 mm ± 5.19 SD and aperture length 48.39 mm ± 5.01 SD. The mean body weight without shell (BW, g) is 17.22 g ± 4.94 SD, which is 32.54 % ± 8.02 SD from the total weight, varying between 11.29 % and 57.23 % from the total weight (Table 20 ).

**Table 20**

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 Pomorie, 17.06.2024

| | TW g | SL mm | Wd mm | Al mm | BW g | BW % TW |
|---|---|---|---|---|---|---|
| Sample size | 100 | 100 | 100 | 100 | 50 | 50 |
| Mean | 54.67 | 68.35 | 51.19 | 48.39 | 17.22 | 8.02 |
| Standard deviation | 17.22 | 6.48 | 5.19 | 5.01 | 4.94 | 11.29 |
| Minimum | 24.29 | 54 | 40 | 38 | 10.53 | 32.59 |
| 50% (median) | 52.78 | 68.5 | 51 | 48 | 16.9 | 57.23 |
| Maximum | 140.65 | 95 | 69 | 65 | 38.13 | 32.54 |
| Sum | 5466.64 | 6835 | 5119 | 4839 | 663.4 | 1689.66 |
| Mode | 46.35 | 65 | 50 | 51 | 39.12 | 33.38 |
| Skewness | 2.13 | 1.16 | 0.89 | 0.86 | 0.91 | -0.21 |
| Sample variance | 0.31 | 0.09 | 0.1 | 0.1 | 0.8 | 0.19 |
| Kurtosis | 7.95 | 3.4 | 1.85 | 1.61 | -0.51 | 0.3 |
| Range | 116.36 | 41 | 29 | 27 | 36.4 | 30.19 |
| Confidence level 95% | 3.42 | 1.29 | 1.03 | 0.99 | 3.02 | 1.83 |

The mean ratio between the shell width (Wd, mm)/shell length (SL, mm) is 74.91 % ± 3.08 SD, while AL/SL (%) is 70.8 % ± 2.98 SD, and the ratio between AL/Wd (%) results in - 94.52 % ± 1.49 SD (Table 21).



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**Table 21**

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 Pomorie, 17.06.2024.

| | Wd/SL % | Al/SL % | Al/Wd % |
|---|---|---|---|
| Sample size | 100 | 100 | 100 |
| Mean | 74.91 | 70.8 | 94.52 |
| Standard deviation | 3.08 | 2.98 | 1.49 |
| Minimum | 66.67 | 61.9 | 91.3 |
| 50% (median) | 74.67 | 70.83 | 94.34 |
| Maximum | 81.16 | 77.14 | 98.15 |
| Sum | 7490.74 | 7079.78 | 9452.14 |
| Mode | 74.29 | 73.85 | 94 |
| Skewness | -0.24 | -0.18 | 0.02 |
| Sample variance | 0.04 | 0.04 | 0.02 |
| Kurtosis | -0.2 | -0.19 | -0.56 |
| Range | 14.49 | 15.24 | 6.84 |
| Confidence level 95% | 0.61 | 0.59 | 0.3 |

The L-W ratios are calculated (Figure 8). The parameters a, b of the linear-weight relationships and the values of the correlation coefficient $R^2$ are presented in Table 22.

**Table 22**

Parameters a,b of the L-W ratios and values of $R^2$ for the sample from port Pomorie, 17.06.2024.

| **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** | 0.0017 | 0.00629 | 0.00931 |
| **b** | 2.45 | 2.30 | 2.23 |
| **$R^2$** | 0.84 | 0.84 | 0.83 |



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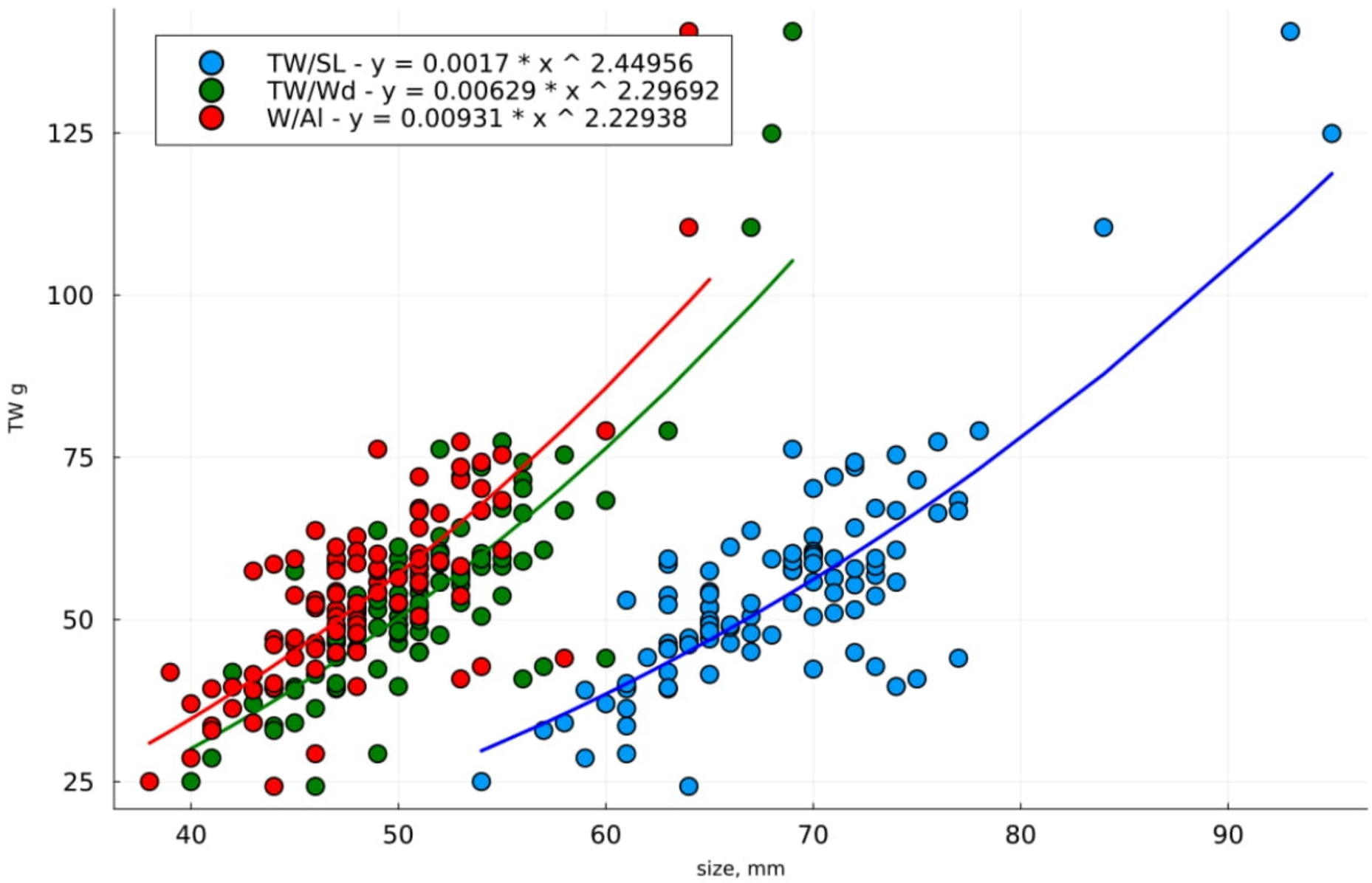


**Figure 8 L-W ratios for the sampled individuals, port Pomorie, 17.06.2024: (1) ratio between total weight (TW, g) and shell length (SL, mm); (2) relationship between total weight (TW, g) and shell width (Wd, mm); (3) relationship between total weight (TW, g) and aperture length (AL, mm).**



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### 3.1.8. Summarized Results for the First Half of 2024

The landings for the period March – June 2024 vary between 116 and 2440 kg/day for all observed ports. The biggest landing from beam trawl fishing was registered at port Varna in June 2024. (Table 23)

**Table 23**

Summarized data about the landings by days and ports from different fishing vessels and fishing methods for the first half of 2024

| Date | Landing port | Fishing vessel | Fishing method | Catch (kg) | Sample weight (per 100 ind) (kg) |
|---|---|---|---|---|---|
| 3/31/2024 | Kavarna | KB5642 | beam trawl | 959 | 2.28 |
| 4/2/2024 | Rodopa 1 | BH 7643 | beam trawl | 321 | 2.63 |
| 4/6/2024 | Nessebar | HC592 | Scuba diving | 120 | 4.60 |
| 5/15/2024 | Nessebar | HC592 | Scuba diving | 600 | 6.16 |
| 5/16/2024 | Balchik | BH 8042 | beam trawl | 234 | 3.64 |
| 6/5/2024 | Varna | BH 7979 | beam trawl | 2440 | 4.64 |
| 6/17/2024 | Pomorie | HC611 | Scuba diving | 116 | 5.47 |

The mean size (SL, mm) of the specimens, caught by beam trawl, for the first half of 2024 is 55.06 mm ± 10.70 SD. In general, the size varies by ports and is dependent on the fishing method. In the beam trawl samples the variations are between 49 – 60 mm, while the mean size of individuals from scuba diving is in the range 61 – 69 mm (Table 24.1)



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**Table 24**

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 2024. (The samples, collected by scuba diving, are shown in grey.)

**Size (SL, mm)**

| Port | Sample size | Mean SL, mm | Standard deviation | Minimum SL, mm | Maximum SL, mm |
|---|---|---|---|---|---|
| Kavarna | 100 | 49.33 | 5.31 | 40.00 | 67.00 |
| Rodopa 1 | 100 | 50.39 | 11.48 | 35.00 | 84.00 |
| Nessebar | 100 | 60.91 | 13.03 | 35.00 | 94.00 |
| Nessebar | 100 | 68.73 | 6.59 | 54.00 | 87.00 |
| Balchik | 100 | 56.95 | 10.22 | 43.00 | 89.00 |
| Varna | 100 | 63.57 | 8.05 | 49.00 | 91.00 |
| Pomorie | 100 | 68.35 | 6.48 | 54.00 | 95.00 |

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

| Port | Sample size | Mean TW, g | Standard deviation | Minimum TW, g | Maximum TW, g |
|---|---|---|---|---|---|
| Kavarna | 100 | 22.82 | 7.99 | 9.92 | 59.53 |
| Rodopa 1 | 100 | 26.34 | 21.31 | 5.70 | 117.19 |
| Nessebar | 100 | 46.01 | 28.52 | 7.52 | 148.39 |
| Nessebar | 100 | 61.49 | 20.00 | 22.77 | 145.69 |
| Balchik | 100 | 36.40 | 22.40 | 12.81 | 127.59 |
| Varna | 100 | 46.46 | 21.32 | 21.19 | 144.17 |
| Pomorie | 100 | 54.67 | 17.22 | 24.29 | 140.65 |

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

| Port | Sample size | Mean BW, g | Standard deviation | Minimum BW, g | Maximum BW, g |
|---|---|---|---|---|---|
| Kavarna | 50 | 24.13 | 8.13 | 12.05 | 59.53 |
| Rodopa 1 | 50 | 36.46 | 25.60 | 11.17 | 117.19 |
| Nessebar | 50 | 54.54 | 27.41 | 16.97 | 139.81 |
| Nessebar | 50 | 61.64 | 21.81 | 29.27 | 145.69 |
| Balchik | 50 | 30.52 | 16.12 | 12.81 | 99.54 |
| Varna | 50 | 41.66 | 13.53 | 21.19 | 89.81 |
| Pomorie | 50 | 55.13 | 19.48 | 29.31 | 140.65 |

The weight and size classes distributions from beam trawl fishing and by ports are presented on Figure 9.



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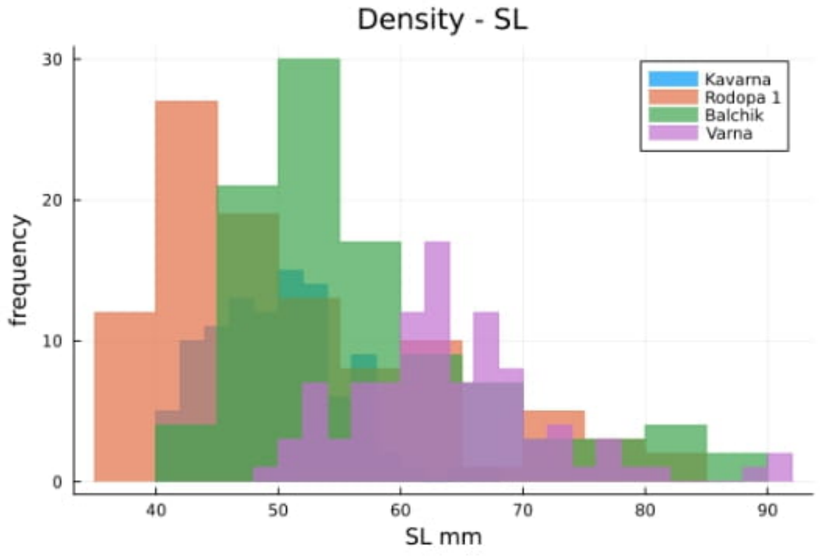
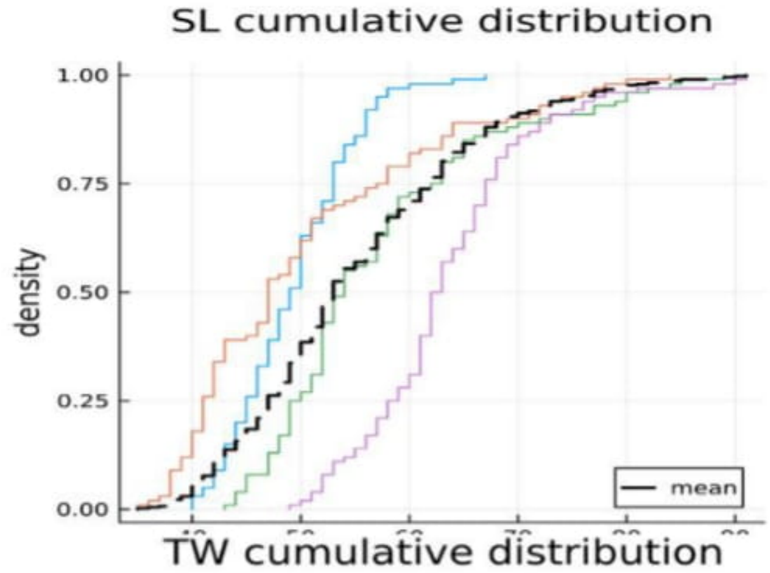
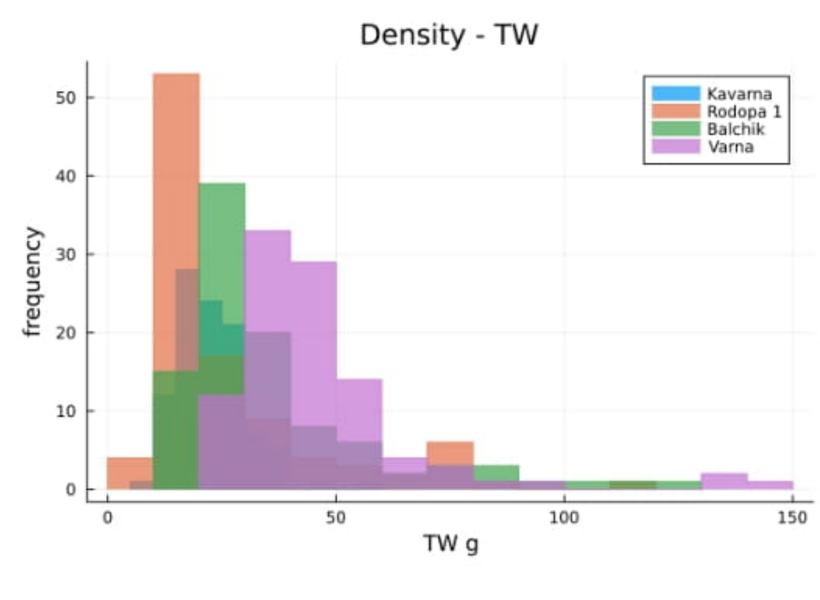
According to the size structure, most individuals fall into the size class - 40 - 60 SL mm, while in terms of weight composition (TW, g), the predominant weight class is < 60 g (93% of the total number of measured specimens).

1 SL mm




2 TW g



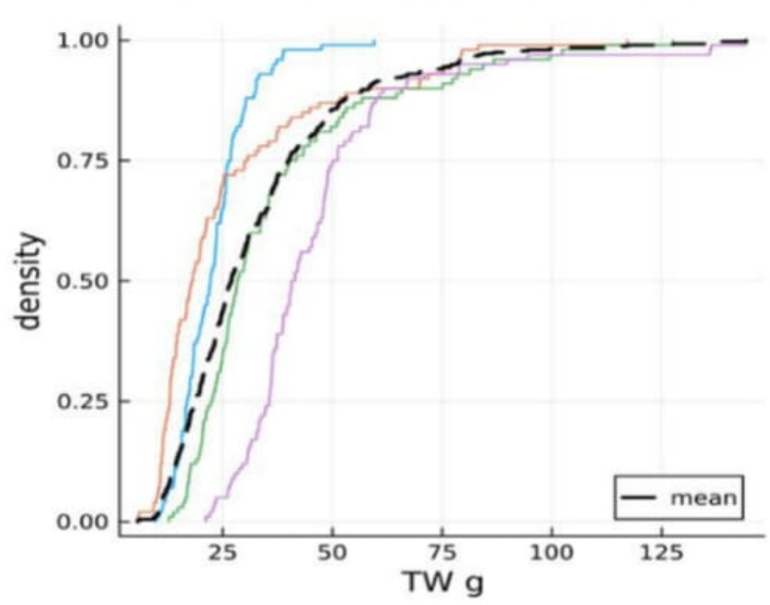




**Figure 9** Distribution of the shell length (SL, mm, 1) and total weight (TW, g, 2) by classes and cumulative distribution by classes for the samples from beam trawl for the first half of 2024

Detailed data about the percentage distribution of the size and weight classes for the observed individuals in the first half of 2024 is presented on Figure 10 and Figure 11 .

The dominant size classes in the beam trawl samples are 40 - 50 mm SL and 50 – 60 mm SL (66 %), while for the scuba diving method - 60 - 70 mm SL (44 %) and 70 – 80 mm SL (31%) (Figure 10). As for the weight structure, the dominant weight class for the beam trawl samples is < 50 g TW (84 % from the measured individuals), while the scuba diving method results in the weight class > 50 g TW (59 % from the measured individuals) (Figure 11).



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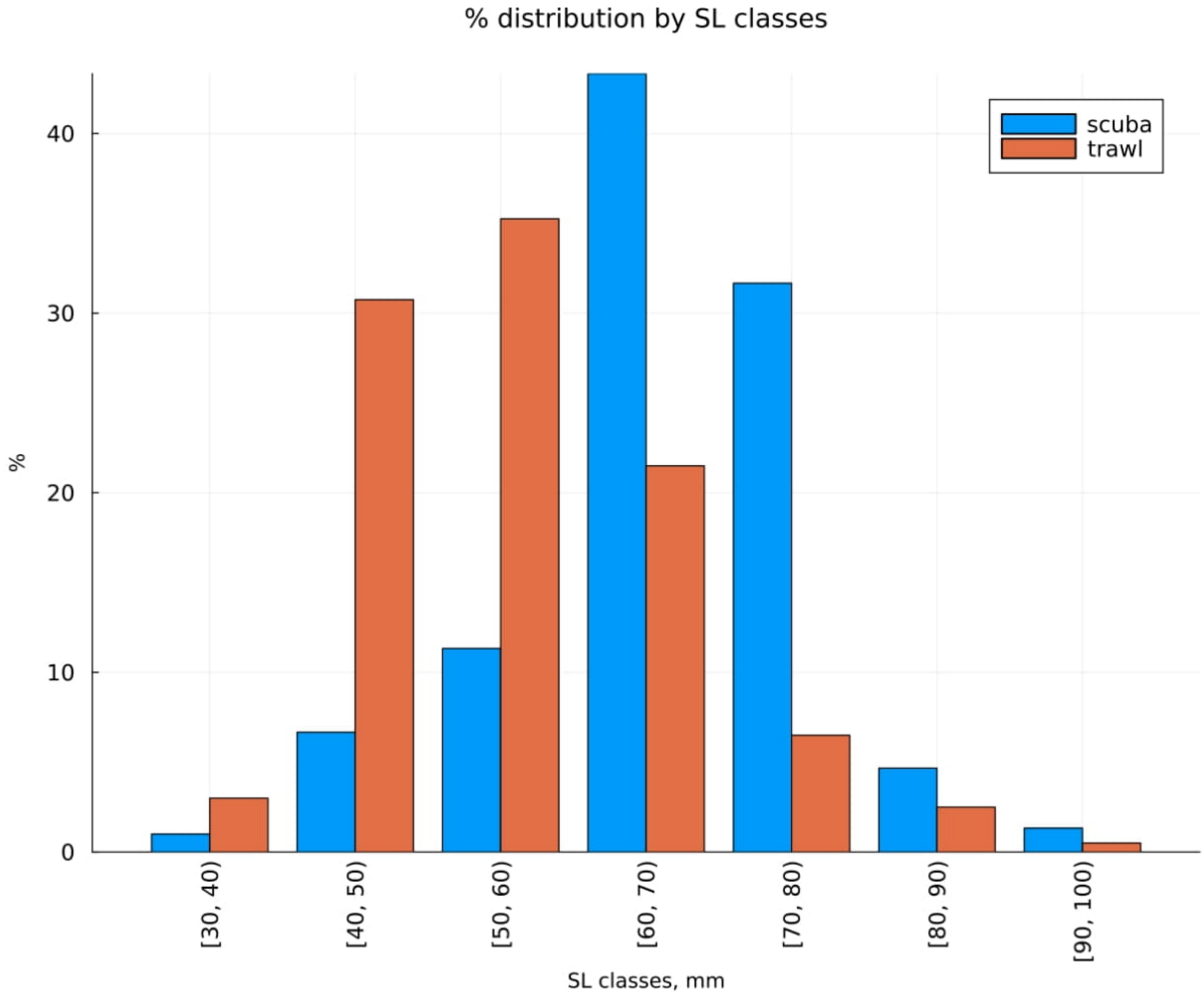


**Figure 10 Distribution in % by size class (SL, mm), based on the summarized data from both fishing (Beam trawl and Scuba diving) for the first half of 2024.**



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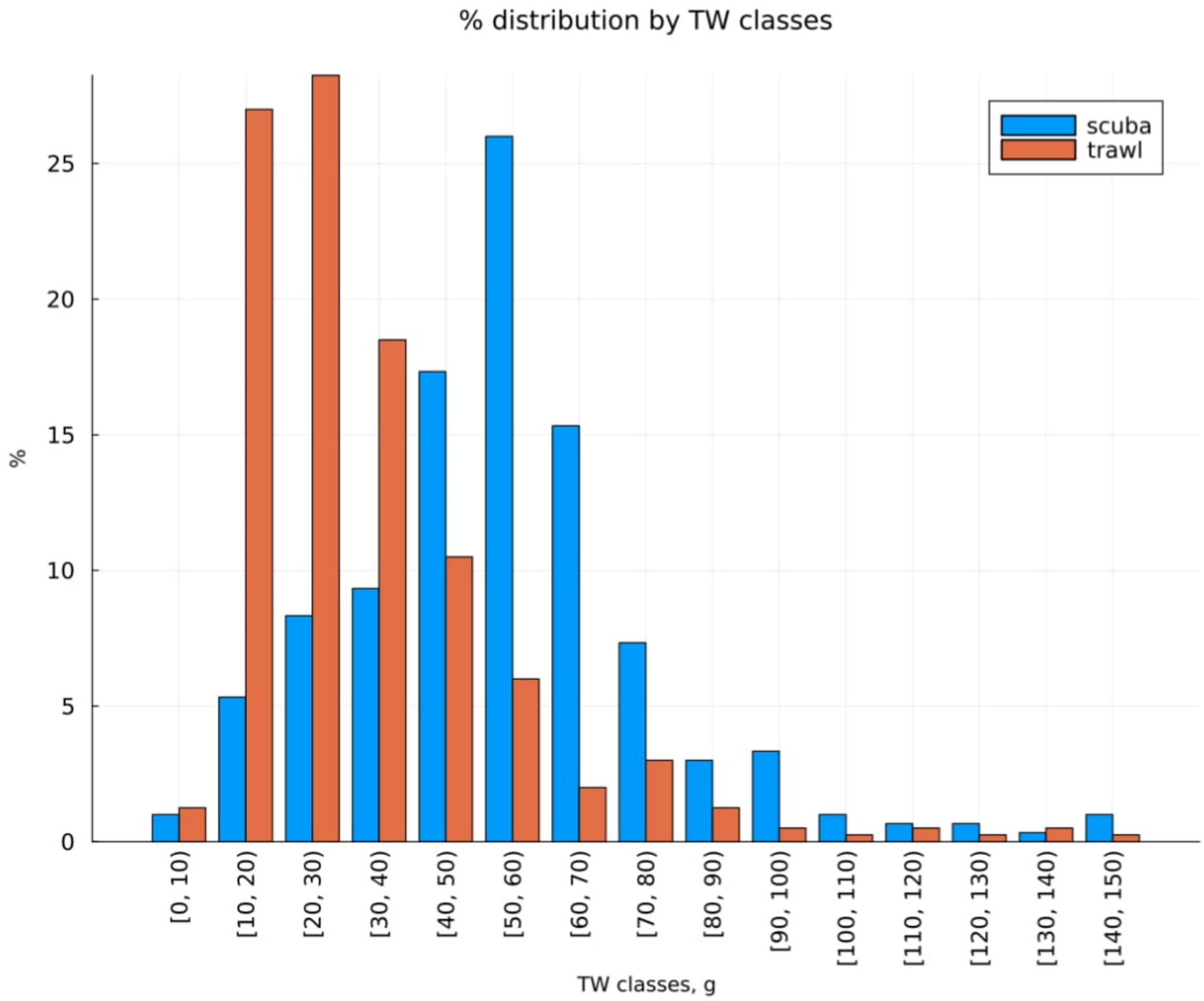


**Figure 11 Distribution in % by weight class (TW, g) based on the summarized data from both fishing methods (beam trawl and scuba diving) for the first half of 2024**



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The comparison analysis of the parameters a and b of the L-W ratio: $TW(g) = a.SL(mm)^b$ shows there is mostly allometric growth of R. venosa in all samples with a coefficient b ≠ 3 (Figure 12).
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 was registered in the sample from Pomorie, 17.06.2024 - b = 2.44.

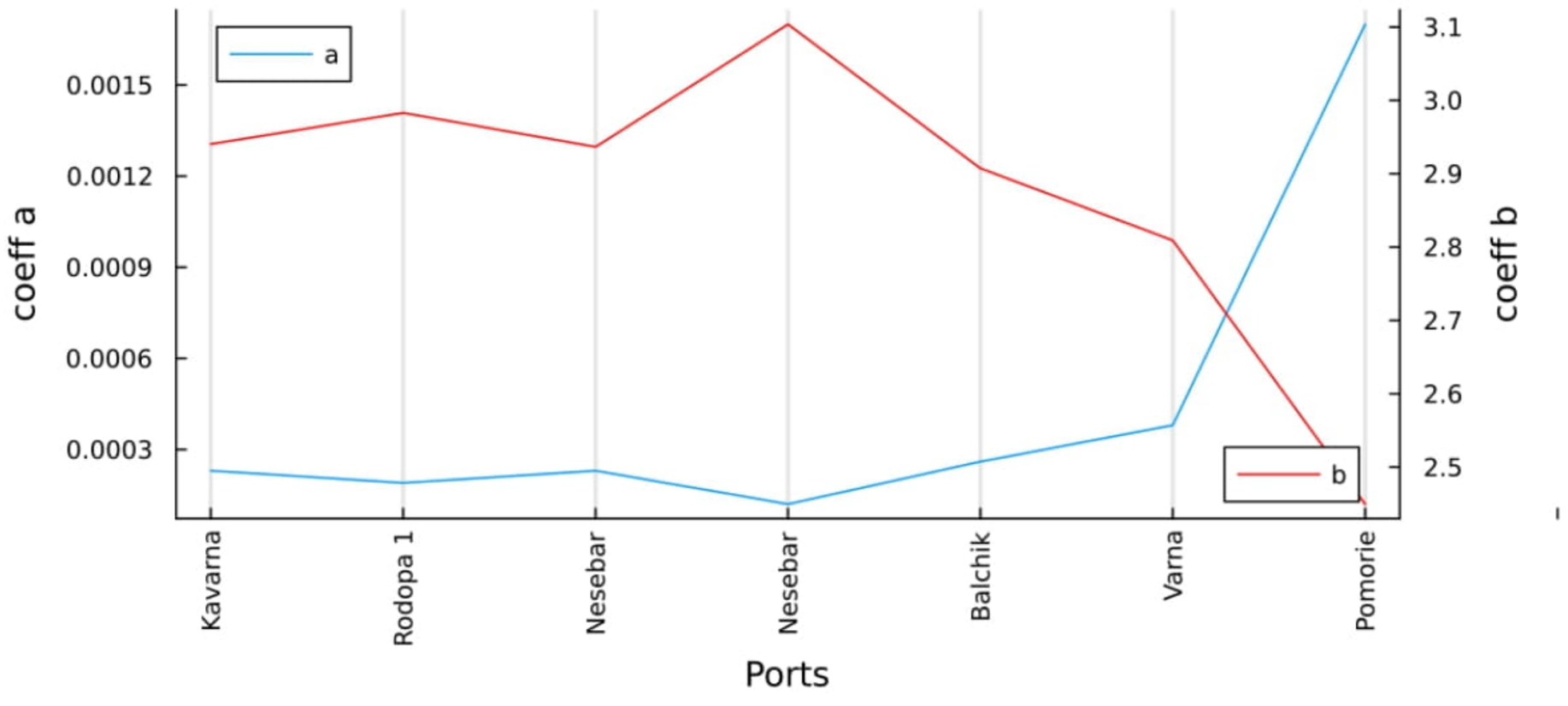


**Figure 12 Parameters *a, b* of the L-W ratios for the equation $TW(g) = a.SL(mm)^b$ for all landing ports for the first half of 2024.**

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 2024 are presented on Figure 13.



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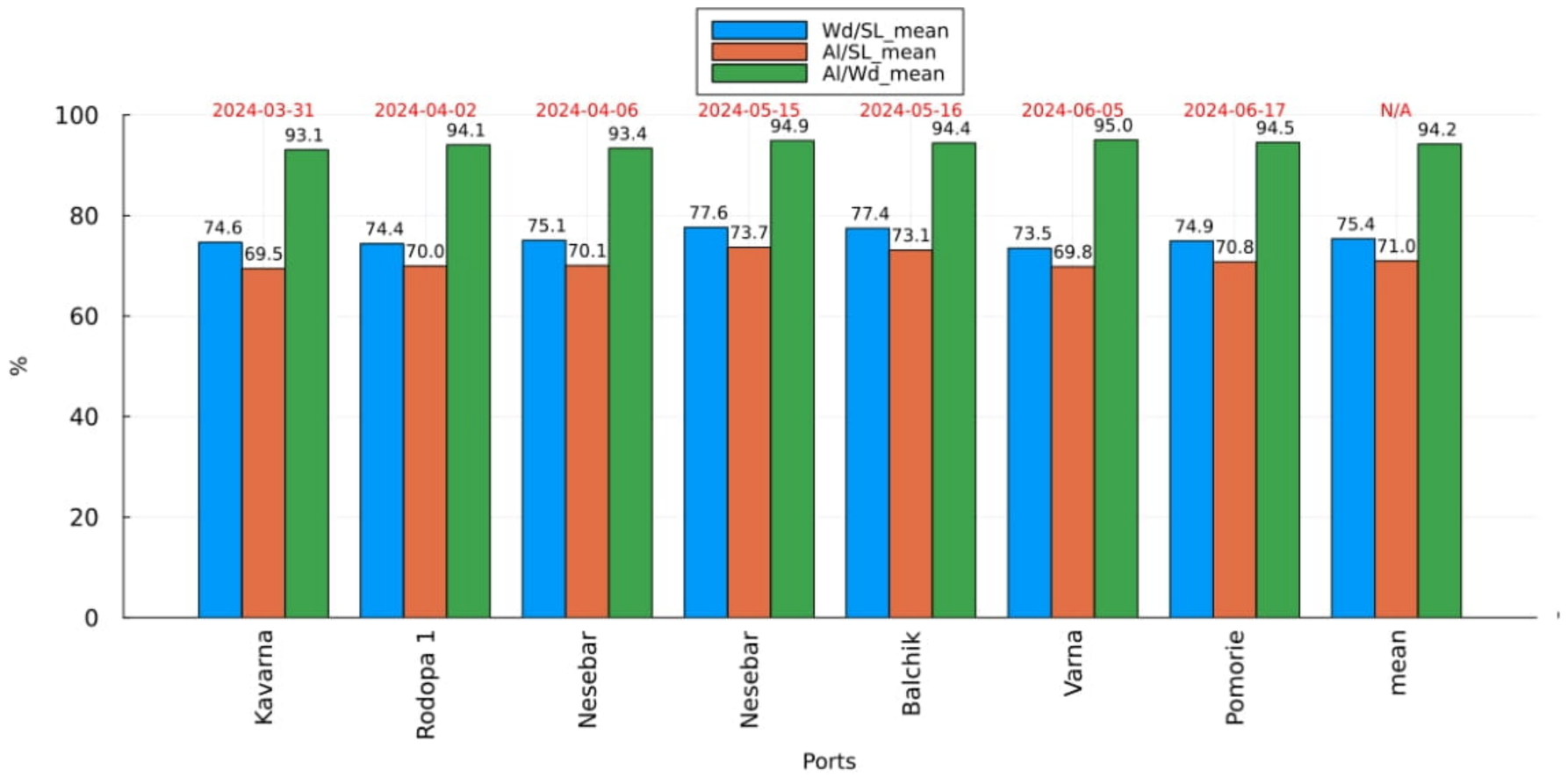


**Figure 13 The mean ratios of the width/length of the shells (Wd/SL, %) of R. venosa, aperture length/ shell length (AL/SL, %) and aperture length/total shell width (AL/Wd, %) by ports for the first half of 2024.**

The mean ratio Wd/SL reaches 75.4 % in the first half of 2024, with very little variations between the different samples. The ratio AL/SL is 71 %, on average, varying between 69 % and 73 %. The mean value of the ratio AL/Wd (%) for the first half of 2024 is 94.2 %.



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## 3.2. SEX STRUCTURE

### 3.2.1. Port Kavarna (scuba diving), 31.03.2024

The sex ratio in the sample is 34 % ♂ : 66 % ♀ or 1 : 1.94.

The mean size of the females' shell length in the sample is 49.88 mm ± 5.22 SD, while for the males the mean size is with 3 % bigger - 51.18 mm ± 5.16 SD. In regard to the parameter total weight (TW, g), the mean weight of the male individuals is 24.96 g ± 7.42 SD, while for the females it is slightly lower ↓ 5 % (Table 25).

**Table 25**

Summarized statistics of the biological parameters - shell length (SL, mm) and total weight (TW, g) by sex in the sample from port Kavarna, 31.03.2024

| | SL mm | | TW g | |
|---|---|---|---|---|
| Sex | M | F | M | F |
| Number | 17 | 33 | 17 | 33 |
| Mean | 51.18 | 49.88 | 24.96 | 23.71 |
| Standard deviation | 5.16 | 5.22 | 7.42 | 8.55 |
| Minimum | 43.00 | 41.00 | 14.94 | 12.05 |
| 50% (median) | 53.00 | 50.00 | 23.57 | 23.38 |
| Maximum | 60.00 | 67.00 | 38.82 | 59.53 |
| Sum | 870.00 | 1646.00 | 424.27 | 782.33 |
| Mode | 53.00 | 50.00 | 38.82 | 59.53 |
| Skewness | 0.10 | 0.10 | 0.30 | 0.36 |
| Sample variance | 0.01 | 0.87 | 0.29 | 2.22 |
| Kurtosis | -1.20 | 1.97 | -0.95 | 7.50 |
| Range | 17.00 | 26.00 | 23.88 | 47.48 |
| Confidence level 95% | 2.65 | 1.85 | 3.81 | 3.03 |

Looking at the parameters shell width (Wd, mm) and aperture length (aperture length, AL, mm), the percentage differences are similarly disproportionate, 3 % in favor of the male individuals (Table 26).



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**Table 26**

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, 31.03.2024

| | Wd mm | | Al mm | |
|---|---|---|---|---|
| Sex | M | F | M | F |
| Number | 17 | 33 | 17 | 33 |
| Mean | 38.53 | 37.21 | 35.76 | 34.79 |
| Standard deviation | 4.17 | 4.07 | 4.04 | 3.89 |
| Minimum | 32.00 | 31.00 | 29.00 | 28.00 |
| 50% (median) | 39.00 | 38.00 | 37.00 | 35.00 |
| Maximum | 46.00 | 49.00 | 43.00 | 47.00 |
| Sum | 655.00 | 1228.00 | 608.00 | 1148.00 |
| Mode | 43.00 | 39.00 | 37.00 | 36.00 |
| Skewness | 0.11 | 0.11 | 0.11 | 0.11 |
| Sample variance | -0.09 | 0.48 | -0.08 | 0.67 |
| Kurtosis | -1.04 | 0.46 | -0.97 | 1.23 |
| Range | 14.00 | 18.00 | 14.00 | 19.00 |
| Confidence level 95% | 2.14 | 1.44 | 2.08 | 1.38 |



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## 3.2.2. Port Rodopa 1, 02.04.2024

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

The mean shell length of the female individuals is 50.85 mm ± 10.22 SD, while for the males the mean shell length is considerably longer - 58.03 ± 12.90 SD (Table 27).

**Table 27**

Summarized statistics of the biological parameters - shell length (SL, mm) and total weight. (TW, g) by sex in the sample from port Port Rodopa 1, 02.04.2024

| | SL mm | | TW g | |
|---|---|---|---|---|
| Sex | M | F | M | F |
| Number | 37 | 13 | 37 | 13 |
| Mean | 58.03 | 50.85 | 38.99 | 29.27 |
| Standard deviation | 12.90 | 10.22 | 26.91 | 20.70 |
| Minimum | 40.00 | 38.00 | 11.17 | 11.32 |
| 50% (median) | 57.00 | 49.00 | 29.93 | 17.96 |
| Maximum | 84.00 | 71.00 | 117.19 | 79.51 |
| Sum | 2147.00 | 661.00 | 1442.63 | 380.57 |
| Mode | 42.00 | 49.00 | 117.19 | 79.51 |
| Skewness | 0.22 | 0.20 | 0.69 | 0.71 |
| Sample variance | 0.31 | 0.51 | 1.01 | 1.18 |
| Kurtosis | -1.03 | -0.80 | 0.17 | 0.52 |
| Range | 44.00 | 33.00 | 106.02 | 68.19 |
| Confidence level 95% | 4.30 | 6.18 | 8.97 | 12.51 |

For the parameters shell width (Wd, mm) and aperture length (aperture length, AL, mm), the percentage differences between the male and female individuals are 10-11% in favor of the male individuals (Table 28).



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**Table 28**

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, 02.04.2024

| | Wd mm | | Al mm | |
|---|---|---|---|---|
| Sex | M | F | M | F |
| Number | 37 | 13 | 37 | 13 |
| Mean | 43.30 | 39.00 | 40.73 | 36.77 |
| Standard deviation | 10.31 | 8.42 | 10.04 | 8.23 |
| Minimum | 28.00 | 28.00 | 26.00 | 27.00 |
| 50% (median) | 41.00 | 38.00 | 39.00 | 36.00 |
| Maximum | 65.00 | 55.00 | 62.00 | 53.00 |
| Sum | 1602.00 | 507.00 | 1507.00 | 478.00 |
| Mode | 46.00 | 55.00 | 29.00 | 42.00 |
| Skewness | 0.24 | 0.22 | 0.25 | 0.22 |
| Sample variance | 0.26 | 0.42 | 0.27 | 0.45 |
| Kurtosis | -1.05 | -0.92 | -1.06 | -0.83 |
| Range | 37.00 | 27.00 | 36.00 | 26.00 |
| Confidence level 95% | 3.44 | 5.09 | 3.35 | 4.97 |



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## 3.2.3. Port Nessebar (scuba diving), 06.04.2024

The sex ratio in the sample is 80 % ♂ to 20 % ♀ or 1 : 0.25.

The mean shell length of the female individuals is 54.60 mm ± 9.07 SD. The mean shell length of the males is considerably bigger - 67.62 mm ± 10.90 SD (Table 29). It has to be noted that the number of female individuals in the representative sample is small. (10).

**Table 29**

Summarized statistics of the biological parameters - shell length (SL, mm) and total weight. (TW, g) by sex in the sample from port Nessebar, 06.04.2024

| | SL mm | | TW g | |
|---|---|---|---|---|
| Sex | M | F | M | F |
| Number | 40 | 10 | 40 | 10 |
| Mean | 67.62 | 54.60 | 60.77 | 29.62 |
| Standard deviation | 10.90 | 9.07 | 26.42 | 14.25 |
| Minimum | 43.00 | 44.00 | 18.15 | 16.97 |
| 50% (median) | 68.00 | 50.50 | 58.78 | 23.94 |
| Maximum | 94.00 | 69.00 | 139.81 | 55.46 |
| Sum | 2705.00 | 546.00 | 2430.67 | 296.16 |
| Mode | 68.00 | 50.00 | 139.81 | 55.46 |
| Skewness | 0.16 | 0.17 | 0.43 | 0.48 |
| Sample variance | -0.07 | 0.70 | 0.79 | 1.00 |
| Kurtosis | -0.08 | -1.17 | 1.07 | -0.56 |
| Range | 51.00 | 25.00 | 121.66 | 38.49 |
| Confidence level 95% | 3.49 | 6.49 | 8.45 | 10.19 |

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 27 % and 25 % in favor of the male individuals. (Table 30).



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**Table 30**

Summarized statistics of the biological parameters - shell width (Wd, mm) and aperture length (aperture length, AL, mm) by sex in the sample from port Nessebar, 06.04.2024

| | Wd mm | | Al mm | |
|---|---|---|---|---|
| Sex | M | F | M | F |
| Number | 40 | 10 | 40 | 10 |
| Mean | 51.42 | 40.90 | 47.90 | 38.30 |
| Standard deviation | 7.97 | 7.56 | 8.08 | 7.24 |
| Minimum | 34.00 | 31.00 | 31.00 | 29.00 |
| 50% (median) | 52.00 | 38.50 | 48.50 | 36.00 |
| Maximum | 69.00 | 55.00 | 65.00 | 52.00 |
| Sum | 2057.00 | 409.00 | 1916.00 | 383.00 |
| Mode | 60.00 | 36.00 | 49.00 | 36.00 |
| Skewness | 0.16 | 0.18 | 0.17 | 0.19 |
| Sample variance | -0.33 | 0.77 | -0.20 | 0.83 |
| Kurtosis | -0.20 | -0.50 | -0.25 | -0.42 |
| Range | 35.00 | 24.00 | 34.00 | 23.00 |
| Confidence level 95% | 2.55 | 5.41 | 2.58 | 5.18 |



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## 3.2.4. PORT NESSEBAR (SCUBA DIVING), 15.05.2024

The sex ratio in the sample is 50 % ♂ to 50 % ♀ or 1 : 1.

The mean shell length of the female individuals is 66.56 mm ± 5.81 SD, while it was observed that the length of the males is with 7 % longer – 71.36 mm ± 7.31 SD (Table 31).

**Table 31**

Summarized statistics of the biological parameters - shell length (SL, mm) and total weight. (TW, g) by sex in the sample from port Nessebar, 15.05.2024

| | SL mm | | TW g | |
|---|---|---|---|---|
| Sex | M | F | M | F |
| Number | 25 | 25 | 25 | 25 |
| Mean | 71.36 | 66.56 | 67.63 | 55.64 |
| Standard deviation | 7.31 | 5.81 | 23.88 | 18.05 |
| Minimum | 56.00 | 57.00 | 29.27 | 32.26 |
| 50% (median) | 70.00 | 67.00 | 59.99 | 51.11 |
| Maximum | 87.00 | 85.00 | 145.69 | 117.91 |
| Sum | 1784.00 | 1664.00 | 1690.75 | 1391.02 |
| Mode | 69.00 | 61.00 | 59.99 | 117.91 |
| Skewness | 0.10 | 0.09 | 0.35 | 0.32 |
| Sample variance | 0.55 | 1.08 | 1.53 | 1.59 |
| Kurtosis | 0.25 | 2.13 | 2.82 | 3.66 |
| Range | 31.00 | 28.00 | 116.42 | 85.65 |
| Confidence level 95% | 3.02 | 2.40 | 9.86 | 7.45 |

For the parameters shell width (Wd, mm) and aperture length (aperture length, AL, mm), the percentage differences between male and female individuals are in favor of males – 9.5 % (Table 32 ).



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**Table 32**

Summarized statistics of the biological parameters - shell width (Wd, mm) and aperture length (aperture length, AL, mm) by sex in the sample from port Nessebar, 15.05.2024

| | Wd mm | | Al mm | |
|---|---|---|---|---|
| Sex | M | F | M | F |
| Number | 25 | 25 | 25 | 25 |
| Mean | 54.88 | 51.20 | 52.28 | 48.68 |
| Standard deviation | 6.41 | 4.95 | 6.13 | 4.73 |
| Minimum | 41.00 | 43.00 | 40.00 | 41.00 |
| 50% (median) | 53.00 | 51.00 | 52.00 | 48.00 |
| Maximum | 69.00 | 66.00 | 66.00 | 64.00 |
| Sum | 1372.00 | 1280.00 | 1307.00 | 1217.00 |
| Mode | 53.00 | 51.00 | 52.00 | 48.00 |
| Skewness | 0.12 | 0.10 | 0.12 | 0.10 |
| Sample variance | 0.31 | 0.86 | 0.35 | 1.09 |
| Kurtosis | 0.04 | 1.43 | -0.04 | 2.56 |
| Range | 28.00 | 23.00 | 26.00 | 23.00 |
| Confidence level 95% | 2.64 | 2.04 | 2.53 | 1.95 |



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## 3.2.5. PORT BALCHIK, 16.05.2024

The sex ratio in the sample is 60 % ♂: 40 % ♀ or 1: 0.67.

The mean shell length of the female individuals is 53.60 mm ± 9.02 SD, while it was observed that the length of the males is similar – 54.15 mm ± 6.93 SD (Table 33).

In regard to the parameter total weight (TW, g), the mean weight of the male individuals is 30.47 g ± 12.32 SD, while for the females is 30.60 ± 20.93 (Table 33).

**Table 33**

Summarized statistics of the biological parameters - shell length (SL, mm) and total weight. (TW, g) by sex in the sample from port Balchik, 16.05.2024

| | SL mm | | TW g | |
|---|---|---|---|---|
| Sex | M | F | M | F |
| Number | 30 | 20 | 30 | 20 |
| Mean | 54.13 | 53.60 | 30.47 | 30.60 |
| Standard deviation | 6.93 | 9.02 | 12.32 | 20.93 |
| Minimum | 44.00 | 47.00 | 12.81 | 16.95 |
| 50% (median) | 53.00 | 51.00 | 27.16 | 24.02 |
| Maximum | 67.00 | 80.00 | 56.75 | 99.54 |
| Sum | 1624.00 | 1072.00 | 914.22 | 611.93 |
| Mode | 59.00 | 49.00 | 49.64 | 99.54 |
| Skewness | 0.13 | 0.17 | 0.40 | 0.68 |
| Sample variance | 0.17 | 2.20 | 0.50 | 2.50 |
| Kurtosis | -1.03 | 3.65 | -0.76 | 5.08 |
| Range | 23.00 | 33.00 | 43.94 | 82.59 |
| Confidence level 95% | 2.59 | 4.22 | 4.60 | 9.79 |

For the parameters shell width (Wd, mm) and aperture length (aperture length, AL, mm), the percentage differences between male and female individuals are insignificantly small (Table 34).



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**Table 34**

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, 16.05.2024

| | Wd mm | | Al mm | |
|---|---|---|---|---|
| Sex | M | F | M | F |
| Number | 30 | 20 | 30 | 20 |
| Mean | 41.90 | 41.25 | 39.63 | 39.00 |
| Standard deviation | 6.34 | 8.07 | 6.21 | 7.53 |
| Minimum | 30.00 | 32.00 | 29.00 | 31.00 |
| 50% (median) | 41.00 | 39.50 | 38.00 | 37.00 |
| Maximum | 54.00 | 63.00 | 51.00 | 59.00 |
| Sum | 1257.00 | 825.00 | 1189.00 | 780.00 |
| Mode | 46.00 | 42.00 | 38.00 | 35.00 |
| Skewness | 0.15 | 0.20 | 0.16 | 0.19 |
| Sample variance | 0.08 | 1.66 | 0.08 | 1.71 |
| Kurtosis | -0.94 | 2.12 | -1.10 | 2.19 |
| Range | 24.00 | 31.00 | 22.00 | 28.00 |
| Confidence level 95% | 2.37 | 3.78 | 2.32 | 3.53 |



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## 3.2.6. PORT VARNA, 05.06.2024

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 56.00 mm ± 5.22 SD, while for the males the mean size is with 14 % bigger (Table 35). In regard to the total weight (TW, g), the mean weight of the male individuals is 45.35 g ± 13.32 SD, while for the females is 32.16 ± 8.79 SD (Table 35).

**Table 35**

Summarized statistics of the biological parameters - shell length (SL, mm) and total weight (TW, g) by sex in the sample port Varna, 05.06.2024

| | SL mm | | TW g | |
|---|---|---|---|---|
| Sex | M | F | M | F |
| Number | 36 | 14 | 36 | 14 |
| Mean | 64.11 | 56.00 | 45.35 | 32.16 |
| Standard deviation | 5.54 | 5.22 | 13.32 | 8.79 |
| Minimum | 51.00 | 49.00 | 22.84 | 21.19 |
| 50% (median) | 64.00 | 55.00 | 45.98 | 31.83 |
| Maximum | 76.00 | 64.00 | 89.81 | 48.91 |
| Sum | 2308.00 | 784.00 | 1632.76 | 450.31 |
| Mode | 66.00 | 52.00 | 48.07 | 42.07 |
| Skewness | 0.09 | 0.09 | 0.29 | 0.27 |
| Sample variance | -0.06 | 0.14 | 1.11 | 0.31 |
| Kurtosis | -0.04 | -1.57 | 1.88 | -1.13 |
| Range | 25.00 | 15.00 | 66.97 | 27.72 |
| Confidence level 95% | 1.87 | 3.01 | 4.51 | 5.08 |

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 13 % in favor of the male individuals (Table 36).



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**Table 36**

Summarized statistics of the biological parameters - shell width (Wd, mm) and aperture length (aperture length, AL, mm) by sex in the sample from port Nesebar, 05.06.2024

| | Wd mm | | Al mm | |
|---|---|---|---|---|
| Sex | M | F | M | F |
| Number | 36.00 | 14.00 | 36.00 | 14.00 |
| Mean | 46.58 | 41.00 | 44.11 | 38.93 |
| Standard deviation | 4.69 | 3.55 | 4.41 | 3.43 |
| Minimum | 37.00 | 36.00 | 35.00 | 34.00 |
| 50% (median) | 47.00 | 42.00 | 44.00 | 39.00 |
| Maximum | 59.00 | 46.00 | 56.00 | 44.00 |
| Sum | 1677.00 | 574.00 | 1588.00 | 545.00 |
| Mode | 45.00 | 43.00 | 45.00 | 41.00 |
| Skewness | 0.10 | 0.09 | 0.10 | 0.09 |
| Sample variance | 0.28 | 0.01 | 0.34 | 0.09 |
| Kurtosis | 0.67 | -1.47 | 0.79 | -1.21 |
| Range | 22.00 | 10.00 | 21.00 | 10.00 |
| Confidence level 95% | 1.59 | 2.05 | 1.49 | 1.98 |



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## 3.2.7. PORT POMORIE (SCUBA DIVING), 17.06.2024

The sex ratio in the sample is 68 % ♂ : 32 % ♀ or 1 : 0.47.

The mean size of the females' shell length (SL, mm) in the sample 65.31 mm ± 4.21 SD, 7% smaller than the male individuals. (Table 37). The mean weight of the males is 57.39 g ± 22.34 SD, while the mean weight of the females is 14% lower. ↓ (Table 37).

**Table 37**

Summarized statistics of the biological parameters - shell length (SL, mm) and total weight. (TW, g) by sex in the sample from port Pomorie, 17.06.2024

| | SL mm | | TW g | |
|---|---|---|---|---|
| Sex | M | F | M | F |
| Number | 34 | 16 | 3 | 16 |
| Mean | 69.97 | 65.31 | 57.39 | 50.33 |
| Standard deviation | 7.82 | 4.21 | 22.34 | 10.25 |
| Minimum | 61.00 | 60.00 | 29.31 | 36.29 |
| 50% (median) | 69.50 | 65.00 | 52.77 | 49.53 |
| Maximum | 95.00 | 75.00 | 140.65 | 72.01 |
| Sum | 2379.00 | 1045.00 | 1951.31 | 805.21 |
| Mode | 63.00 | 65.00 | 46.35 | 40.85 |
| Skewness | 0.11 | 0.06 | 0.39 | 0.20 |
| Sample variance | 1.58 | 0.75 | 2.31 | 0.38 |
| Kurtosis | 2.99 | -0.16 | 5.87 | -0.64 |
| Range | 34.00 | 15.00 | 111.34 | 35.72 |
| Confidence level 95% | 2.73 | 2.24 | 7.79 | 5.46 |

As for the parameters shell width (Wd, mm) and aperture length (aperture length, AL, mm), the percentage differences between the male and female individuals are respectively 6% and 5% in favor of the males (Table 38).



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**Table 38**

Summarized statistics of the biological parameters - shell width (Wd, mm) and aperture length (aperture length, AL, mm) by sex in the sample from port Pomorie, 17.06.2024

| | Wd mm | | Al mm | |
|---|---|---|---|---|
| Sex | M | F | M | F |
| Number | 34 | 16 | 34 | 16 |
| Mean | 51.74 | 48.88 | 48.82 | 46.06 |
| Standard deviation | 5.89 | 3.67 | 5.71 | 3.66 |
| Minimum | 42.00 | 43.00 | 39.00 | 40.00 |
| 50% (median) | 50.50 | 49.00 | 48.00 | 46.00 |
| Maximum | 69.00 | 56.00 | 65.00 | 53.00 |
| Sum | 1759.00 | 782.00 | 1660.00 | 737.00 |
| Mode | 47.00 | 53.00 | 48.00 | 48.00 |
| Skewness | 0.11 | 0.08 | 0.12 | 0.08 |
| Sample variance | 1.26 | 0.16 | 1.09 | 0.07 |
| Kurtosis | 1.85 | -0.86 | 1.39 | -0.80 |
| Range | 27.00 | 13.00 | 26.00 | 13.00 |
| Confidence level 95% | 2.05 | 1.95 | 1.99 | 1.95 |



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### 3.2.8. GONADOSOMATIC INDEX (GSI)

The summarized statistics of the dynamics of the gonadosomatic index (GSI) for the first half of 2024 is presented in Table 39. The mean ratio of the index is 15.46 % BW.

**Table 39**

Summarized statistics of GSI (% BW) by ports for the first half of 2024. (data from scuba diving is in grey)

| | Port | number | mean | std. | min | median | max |
|---|---|---|---|---|---|---|---|
| **1** | Kavarna | 50 | 16.03 | 3.07 | 9.09 | 15.59 | 23.81 |
| **2** | Rodopa 1 | 50 | 18.36 | 5.87 | 1.68 | 17.33 | 34.47 |
| **3** | Nessebar | 50 | 13.80 | 2.98 | 9.98 | 12.59 | 23.41 |
| **4** | Nessebar | 50 | 16.33 | 3.45 | 11.13 | 15.79 | 27.05 |
| **5** | Balchik | 50 | 14.81 | 2.45 | 10.29 | 14.42 | 21.34 |
| **6** | Varna | 50 | 14.77 | 3.77 | 6.00 | 14.31 | 26.33 |
| **7** | Pomorie | 50 | 14.15 | 3.01 | 9.19 | 13.73 | 20.53 |



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### 3.2.9. SUMMARIZED RESULTS ABOUT SEX STRUCTURE

The sex ratio for all observed ports is 63 % ♂: 37 % ♀ (Figure 14). No imposex forms were identified in the first half of 2024.

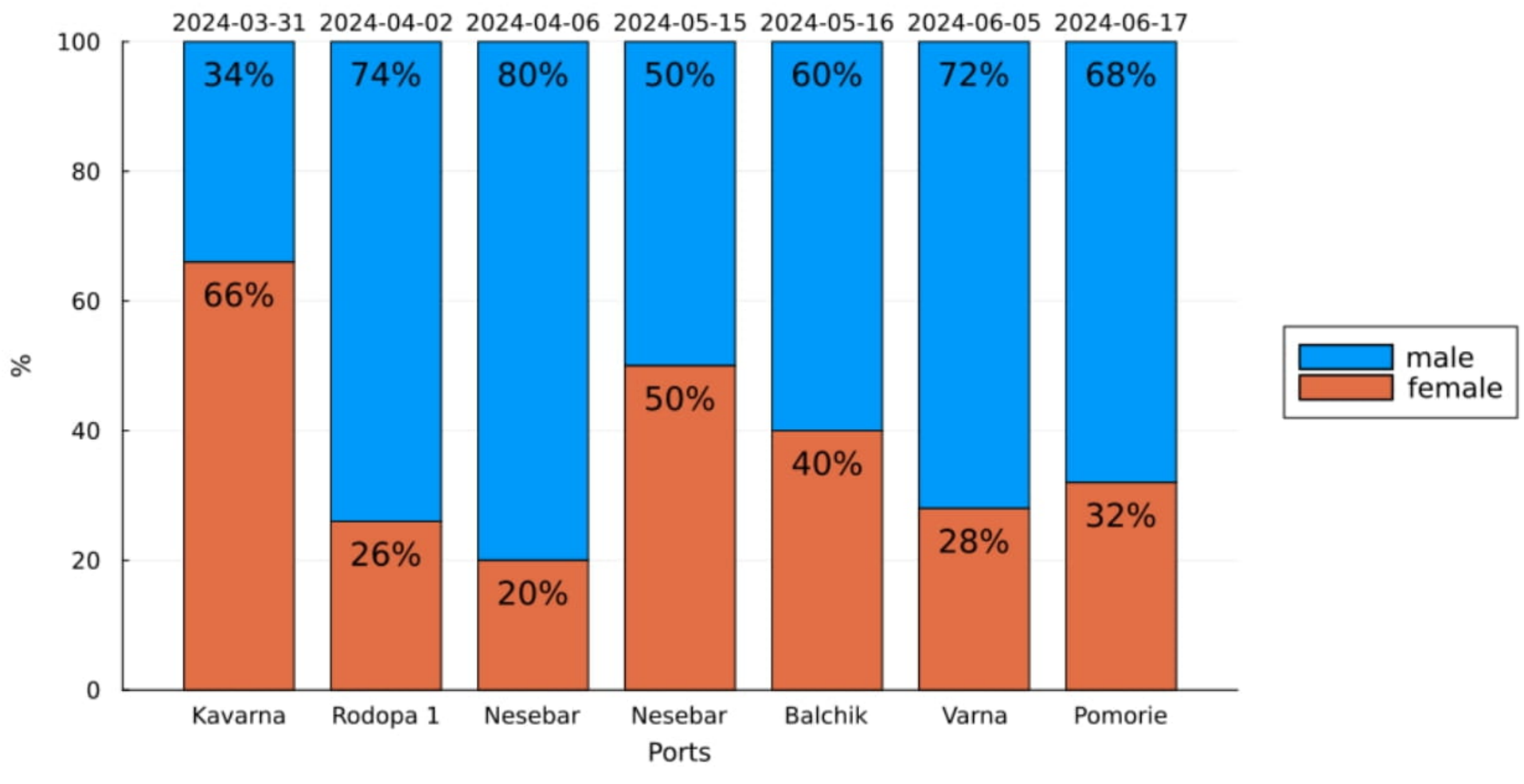


**Figure 14 Summarized data about the sex structure of R. venosa by ports for the first half of 2024**

The mean shell length (SL, mm) of the male individuals, caught by beam trawl, is 56.75 mm ± 7.75 SD, with the longest mean size of 64.00 mm – in the sample from June at port Varna (05.06.2024, Table 40, Figure 15.1). The mean length of the female individuals reached 52.75 mm ± 7.25 SD for the period, with a percentage difference of 8 % ↓ compared to the mean length of the male specimens. Accordingly, the mean weight of the males for the period is 34.75 g ± 14.75 SD, and for females – 29.00 g ± 15.00 SD, with a percentage difference of 19.6 % between the two sexes (Table 40, Figure 15.2).



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**Table 40**

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 2024. (data from scuba diving is in grey).

| | Port | sex | mean | std | min | max |
|---|---|---|---|---|---|---|
| **1. Size (SL, mm)** | Kavarna | M | 51.00 | 5.00 | 43.00 | 60.00 |
| | | F | 50.00 | 5.00 | 41.00 | 67.00 |
| | Rodopa 1 | M | 58.00 | 13.00 | 40.00 | 84.00 |
| | | F | 51.00 | 10.00 | 38.00 | 71.00 |
| | Nessebar scuba diving | M | 68.00 | 11.00 | 43.00 | 94.00 |
| | | F | 55.00 | 9.00 | 44.00 | 69.00 |
| | Nessebar scuba diving | M | 71.00 | 7.00 | 56.00 | 87.00 |
| | | F | 67.00 | 6.00 | 57.00 | 85.00 |
| | Balchik | M | 54.00 | 7.00 | 44.00 | 67.00 |
| | | F | 54.00 | 9.00 | 47.00 | 80.00 |
| | Varna | M | 64.00 | 6.00 | 51.00 | 76.00 |
| | | F | 56.00 | 5.00 | 49.00 | 64.00 |
| | Pomorie scuba diving | M | 70.00 | 8.00 | 61.00 | 95.00 |
| | | F | 65.00 | 4.00 | 60.00 | 75.00 |
| | **Port** | **sex** | **Mean** | **std** | **min** | **max** |
| **2. Total weight (TW, g)** | Kavarna | M | 25.00 | 7.00 | 15.00 | 39.00 |
| | | F | 24.00 | 9.00 | 12.00 | 60.00 |
| | Rodopa 1 | M | 39.00 | 27.00 | 11.00 | 117.00 |
| | | F | 29.00 | 21.00 | 11.00 | 80.00 |
| | Nessebar scuba diving | M | 61.00 | 26.00 | 18.00 | 140.00 |
| | | F | 30.00 | 14.00 | 17.00 | 55.00 |
| | Nessebar scuba diving | M | 68.00 | 24.00 | 29.00 | 146.00 |
| | | F | 56.00 | 18.00 | 32.00 | 118.00 |
| | Balchik | M | 30.00 | 12.00 | 13.00 | 57.00 |
| | | F | 31.00 | 21.00 | 17.00 | 100 |
| | Varna | M | 45.00 | 13.00 | 23.00 | 90.00 |
| | | F | 32.00 | 9.00 | 21.00 | 49.00 |
| | Pomorie scuba diving | M | 57.00 | 22.00 | 29.00 | 141.00 |
| | | F | 50.00 | 10.00 | 36.00 | 72.00 |



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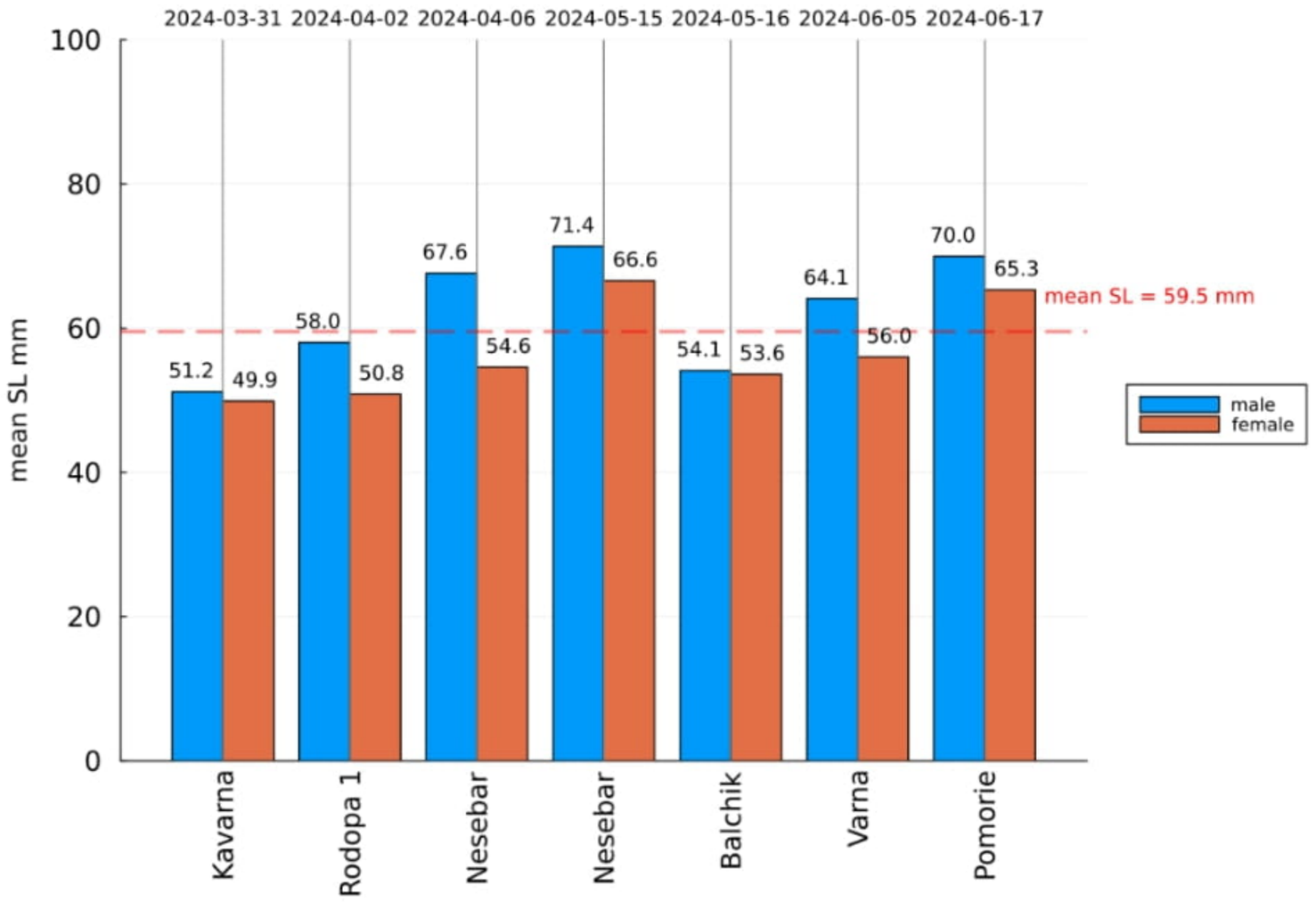
1.




2.

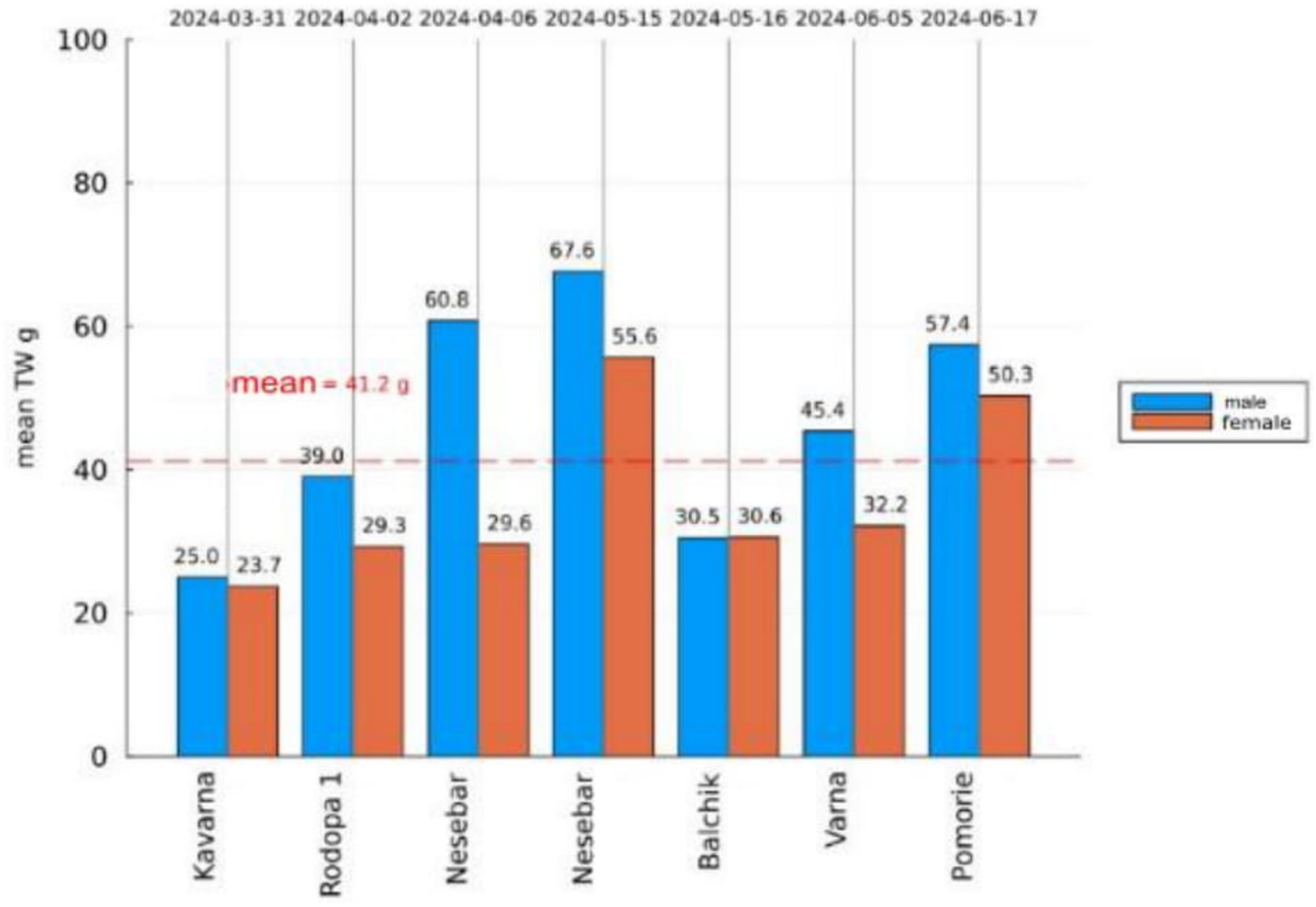



**Figure 15 Summarized data for the (1) mean size (SL, mm) of R. venosa by sex and (2) mean weight (TW, g) by sex for the first half of 2024**



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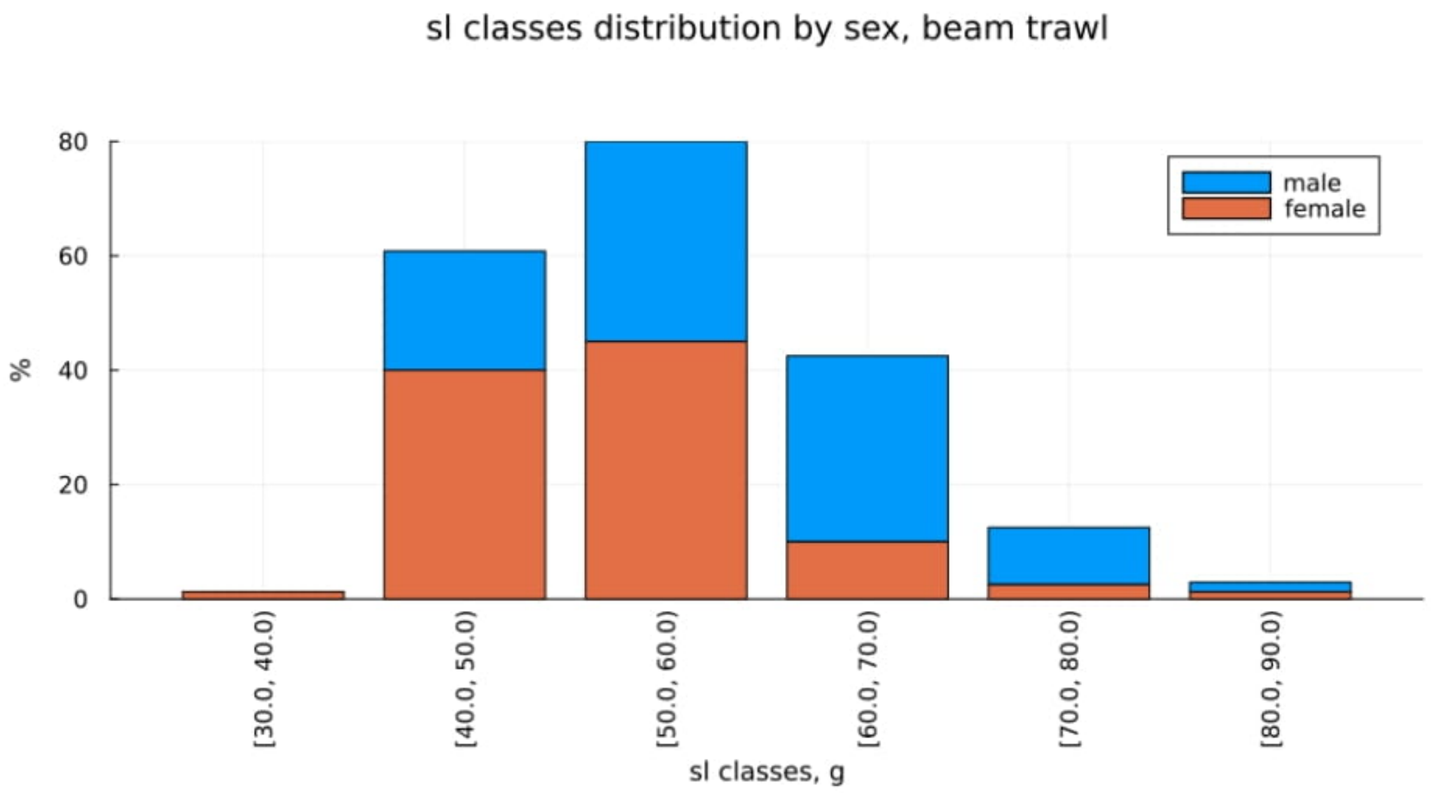
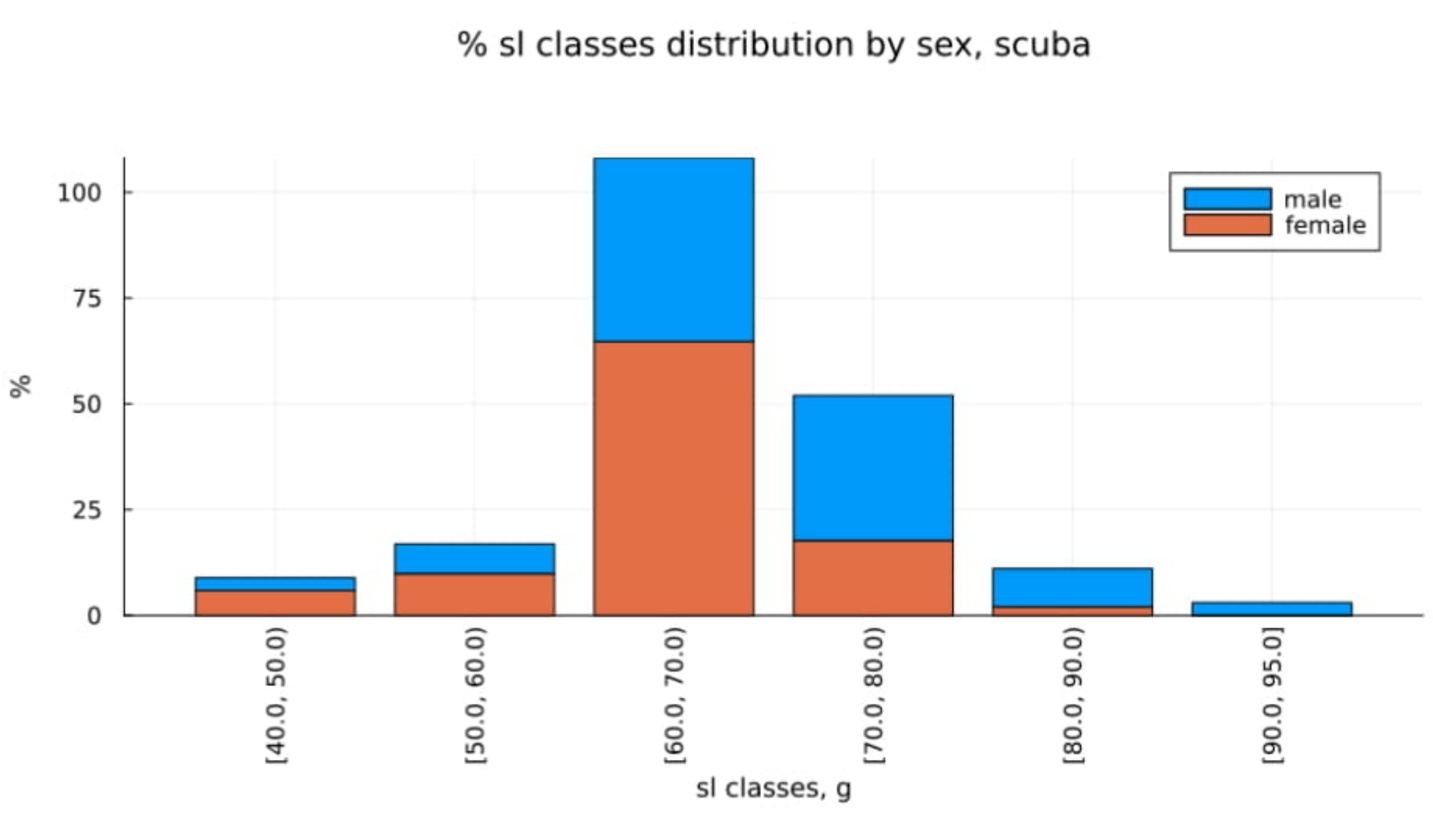
The analysis of the size class dynamics by sex shows that in beam trawl catches, the size class - 50 - 60 mm is the dominant one or 36 % from all the male individuals. The female individuals that fall into this size class are 42 % from the observed individuals (Figure 16.1). The bigger size classes > 80 mm in the beam trawl catches form only 2% of the male individuals and are not observed in the females. In the scuba diving method (Figure 16.2), the predominant size classes are 60 – 70 mm and 70 – 80 mm, which are present in about 30 % of the males and 60 % of the females.




1.




2.

**Figure 16 Percentage distribution by size class (SL, mm) of males (M) and females (F) for the first half of 2024: (1) beam trawl and (2) scuba diving**



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The most common weight class in the samples from beam trawl is 20 – 40 g, which was observed in 38% of the males and 54% of the females. (Figure 17). Respectively, in the samples from scuba diving, the most common weight class is 50-60 g for both the male and female individuals. (30 % of them)

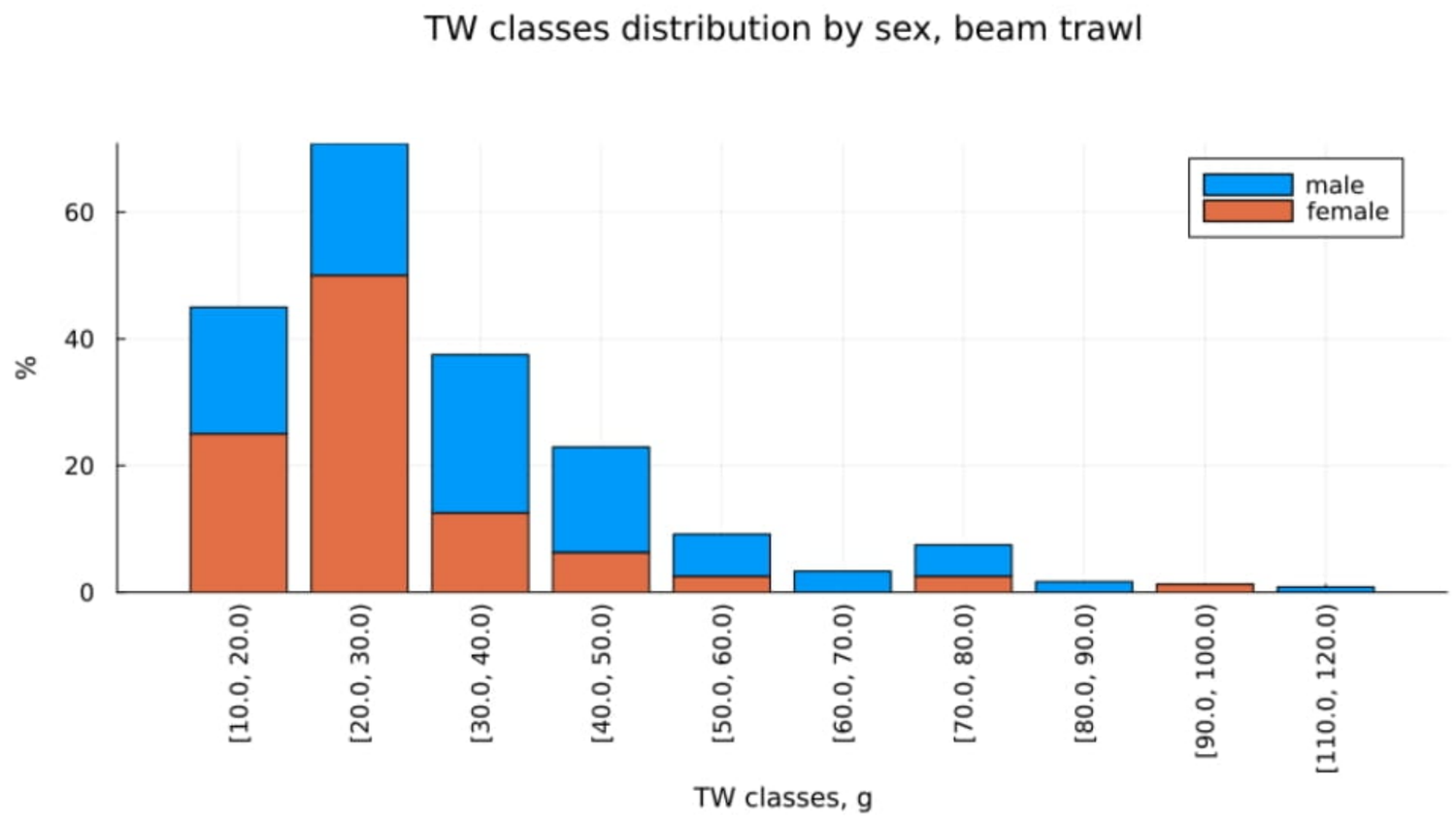


**Figure 17 Percentage distribution by weight class (TW, g) of males (M) and females (F) for the first half of 2024: (1) beam trawl and (2) scuba diving**

Based on summarized data from all beam trawl catches in the first half of 2024, it can be concluded that the growth for males is negative allometric with a coefficient b < 3, as for the females is negative allometric as well with a coefficient b < 3. (The parameters of the equation ration L-W for both sexes are presented on Figure 18 and in Table 41 ).

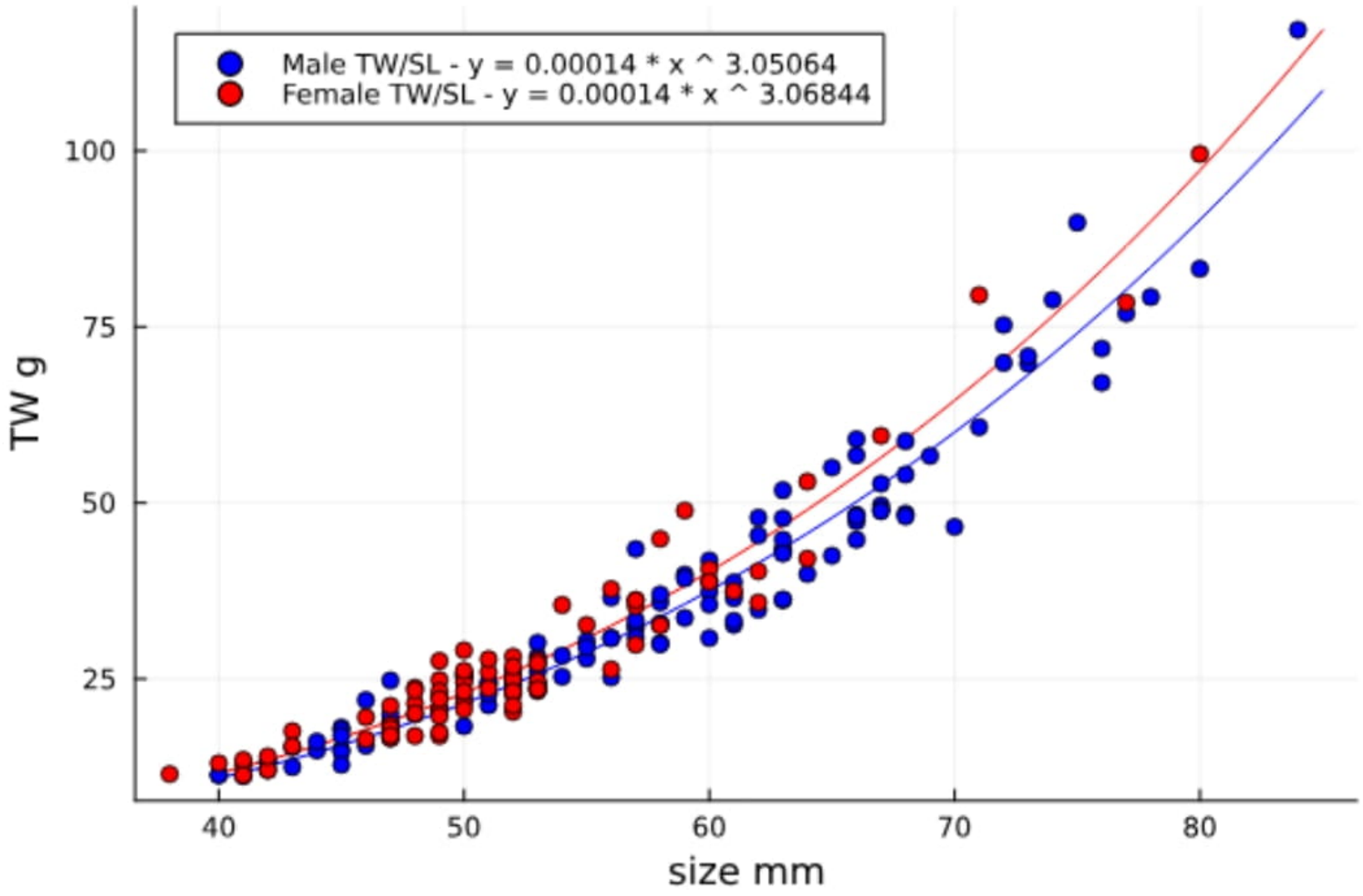


**Figure 18 Total weight (TW, g) from the shell length (SL, mm) for all individuals based on the summarized data for the beam trawl fishing for the first half of 2024 (M - males, F - females)**

**Table 41**

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 2024

| **Parameters** $TW(g) = a.SL(mm)^b$ | ♀ | ♂ |
|---|---|---|
| **a** | 0.00014 | 0.00014 |
| **b** | 3.07 | 3.05 |
| **$R^2$** | 0.94 | 0.95 |



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## CONCLUSIONS

- The analyzes in this report are based on biometric measurements of 700 individuals R. venosa, including 400 specimens, collected from beam trawl catches and 300 specimens from scuba diving catches. The landings' samples were collected at 6 ports – "Kavarna", "Rodopa 1", "Nessebar", "Balchik", "Varna", "Pomorie". For beam trawling, the total daily landings at the observed ports varied between 959 - 3219 kg/day, with the most significant catch landed at port Rodopa 1 on 04.02.2024. The landings from scuba diving for the observed period vary between 116 - 959 kg/day with the highest observed at port Nessebar (04.06.2024).
- For the first half of 2024, in the beam trawl catches, the mean size (SL, mm) of the specimens from the landing ports is 59.75 mm ± 11.68 SD. The variations of the mean sizes by ports mainly depend on the fishing method – for the beam trawl fishing they are between 49.33 – 63.57 mm, while for the scuba diving 64.82 – 68.35 mm. Concerning the weight structure, the beam trawl catches result in a mean weight (TW, g) of 33.00 g ± 22.24 SD, while the scuba diving method resulted in a mean weight of 54.05 g ± 23.24 SD. The mean body weight (BW, g) for the beam trawl catches is 11.76 g ± 7.16 SD, forming 34.90 % of the total weight of all the individuals for the whole observed period. The mean body weight of the individuals caught by scuba diving is 18.75 g ± 8.08 SD or 33.33 % from the body weight.
- The predominant size class in the beam trawl catches is - 50 - 60 mm SL (35 % from the observed individuals), while in the scuba diving catches is 60-70 mm SL (42 %). Most of the individuals from the beam trawl catches are in the weight class < 50 g TW (90 % from all the rapa whelks), while in the landing from scuba diving, the weight class > 50 g TW (50 % from the observed individuals).
- In the first half of 2024, in the beam trawl catches, the average shell width to shell length ratio Wd/SL was 74.99%, with minimal variation between the samples. The average share of the ratio between the length of the aperture and the length of the shell AL/SL (%) is 70.58 % and varies within 69 % - 73 %. The average AL/Wd ratio (%) was 94.13%, with variations from 93% to 95%. In the scuba diving catches, the average ratios are respectively – 74.98 % Wd/SL, 70.58 % AL/SL and 94.13 % AL/Wd.
- The comparison analysis of the parameters *a* and *b* of the L-W ratio: $W(g) = a \times L(mm)^b$ shows an allometric growth of *R. venosa* at a coefficient $b \neq 3$. The coefficient b has its lowest value $b = 2.45$ for the sample from port Pomorie (17.06.2024). When $b < 3$ is an indicator for negative allometric growth, or the growth in length outpaces the growth in weight.
- The sex ratio for the first half of 2024 is 62 ♂: 38 % ♀. The mean value of the gonadosomatic index is 15.46 % BW. The highest GSI was observed in the sample from Rodopa 1 in April 2024 (02.04.2024) – 18.36 % BW ± 5.87 SD.
- The mean length of the male specimens from the beam trawl catches 57.90 mm ± 9.81 SD, with the largest mean size - 64.11 mm - in the June sample from the port Varna (05.06.2024).



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The mean length of female specimens is 52.03 mm ± 7.51 SD for the period, with a percentage difference of 11.30 % ↓ compared to the male individuals.
The average weight of the male individuals was 36.78 g ± 19.21 SD, and of the females – 27.81 g ± 15.02 SD, with a percentage decrease of 32 %. In the case of the scuba diving method, the average shell length of males increases to 69.37 mm ± 9.13 SD, with an average weight of 61.34 g ± 24.51 SD, and the average shell length of females is 63.82 mm ± 7.60 SD, with an average weight of 48.87 g ± 17.95 SD.
In the beam trawl catches, the size class - 51 - 60 mm is dominant, with a share of 36 % of the total measured male specimens and 43% female individuals from the observed individuals.
In the catches by selective scuba diving method, size classes - 61 - 70 mm and 70 - 80 mm dominate, which form about 60% of the measured individuals - both males and females. Concerning the weight structure in the beam trawl catches, the dominant class is 20 - 30 g for both the male and female individuals, as 20 % of the observed males belong to this class and respectively 46.5 % for the females. In the scuba diving catches, the size class 50-60 g dominate, which form about 30% of the measured individuals - both males and females. Weight classes above > 100 g are representing 10 % of the male individuals.



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