Status of the Rapa Whelk Agglomerations Along the Romanian Black Sea Coast *George Țiganov, Victor Niță, Cristian Sorin Danilov, Cătălin Păun, Dragoș Diaconu, Daniel Grigoraș, Magda Nenciu, Mădălina Galațchi*	"Cercetări Marine" Issue no. 53 Pages 70-82	2023
DOI: 10.55268/CM.2023.53.70		

STATUS OF THE RAPA WHELK AGGLOMERATIONS ALONG THE ROMANIAN BLACK SEA COAST

George Țiganov*, Victor Niță, Cristian Sorin Danilov, Cătălin Păun, Dragoș Diaconu, Daniel Grigoraș, Magda Nenciu, Mădălina Galațchi

National Institute for Marine Research and Development "Grigore Antipa", 300 Mamaia Blvd., 900581, Constanta, Romania
**Corresponding author: gtiganov@alpha.rmri.ro*

ABSTRACT

The Black Sea Rapa whelk (*Rapana venosa*, Valenciennes 1846) is, on one hand, a non-indigenous species harming Black Sea benthic ecosystem and on the other hand, since its ever-expanding stock found market in the Far East, one of the most profitable in the basin.
For this purpose, the Working Group on the Black Sea (WGBS) under General Fisheries Commission for Mediterranean and Black Sea (GFCM) agreed on the fact that, despite the invasive nature of the species, its stock in the Black Sea should be exploited within biologically safe limits. In order to cover the area of study in high percentage, a number of 51 stations were proposed for Romanian coast, that were distributed evenly. The duration of one haul was 30 minutes and the hauls were performed at a constant depth and rectilinear in a big percentage, but to avoid tangles and gear destruction, some deviations have been made. Age composition in 2020 was formed by 3 to 12 years generations, the percentages were recorded for 6- and 7-years classes. Regarding 2021 data, the age composition was composed by 3 to 11 years, with the numbers recorded for 5- and 6-years classes. Highest abundance and biomass values for rapa whelk in 2020 have been recorded in the north part of the Romanian coast in the sectors Zaton, Sahalin, Sf. Gheorghe and Mila 9. For 2021, data no significant changes were observed.
Keywords: Rapa whelk, biomass, abundance, age composition, strata

AIMS AND BACKGROUND

The Black Sea is a basin strongly affected by the invasion of non-native species that, in most cases, have managed to find a free ecological niche and even modify the qualitative structure of the pontic benthic biocenoses (Gomoiu & Skolka, 1998). One of these species is the gastropod *Rapana venosa*

(Valenciennes, 1846). It was first recorded outside its native distribution in 1946 in the Black Sea (Gomoiu & Skolka, 1996) and since has invaded estuarine and marine waters worldwide. Recent studies (Spotorno-Oliviera *et al.,* 2020) increase the known geographic distribution of identified populations to eight regions: Black Sea, Adriatic Sea and Aegean Sea, coast of Brittany, coast of Holland, Chesapeake Bay, La Plata River estuary in Argentina-Uruguay and southern coast of Brazil.

Although it is a species considered to have a major negative impact on mussel stocks (Zolotarev, 1996; Salomidi *et al*., 2012), rapana has a high commercial value, mainly due to its gastronomic qualities, its meat contains proteins, minerals and vitamins (Teacă *et al*., 2007), thus, it became an object of exploitation on an industrial scale for most riparian states.

Thus, the GFCM Working Group on the Black Sea (WGBS) agreed on the fact that, despite the invasive nature of the species, its stock in the Black Sea should be exploited within biologically safe limits. In order to ensure implementation of the decision, the GFCM, at its 42nd annual session, adopted Recommendation GFCM/42/2018/9 on a regional research programme for Rapa whelk fisheries in the Black Sea (geographical subarea 29). The aim of this recommendation is to improve scientific, technical and socio-economic knowledge of the fisheries exploiting Rapa whelk in the Black Sea. It is coordinated at regional level by the GFCM BlackSea4Fish Project.

Based on this, the study will provide fisheries independent (survey) data for Rapa whelk in Romanian waters, which will contribute to accomplishment of one of the tasks in the Rapa whelk Research Program tailored during the 7th session of Working Group on the Black Sea (WGBS) and adopted by the GFCM at its 42nd session (Recommendation GFCM/42/2018/9 on a regional research programme for Rapa whelk fisheries in the Black Sea (geographical subarea 29)). The objective is to allow the GFCM Sub-regional Group on Stock Assessment for the Black Sea (SGSABS) to assess the status of the stock of Rapa whelk in the Black Sea and will contribute to the preparation of a management plan targeting sustainable exploitation of the Rapa whelk stock in the Black Sea. In particular, the information will contribute to FAO Strategic Development Goal 14 - Conserve and sustainably use the oceans, seas and marine resources for sustainable development and Strategic Objective 2 - Make agriculture, forestry and fisheries more productive and sustainable (UN, 2022).

EXPERIMENTAL

The methodology used in the survey was according to Rapa Whelk Survey protocol provided by GFCM through BlackSea4Fish, project standardized in the demonstration survey organized in Trabzon, Turkey.

In the implementation of the survey, a Turkish design beam trawl described in Kaykaç *et al.*, 2014 has been used with a mesh size of 72 mm. The gear was towed by research vessel Steaua de mare 1 with 570 hp engine power and connected to the winch with a warp of 12 mm. The warp length during hauls was 4 times the depth. Trawling speed was fixed for every haul at 2,0 knots.

In order to cover a high percentage of the study area, a number of 51 stations were proposed for Romanian area, evenly distributed (Fig. 1 and 2). The duration of the haul was 30 minutes.

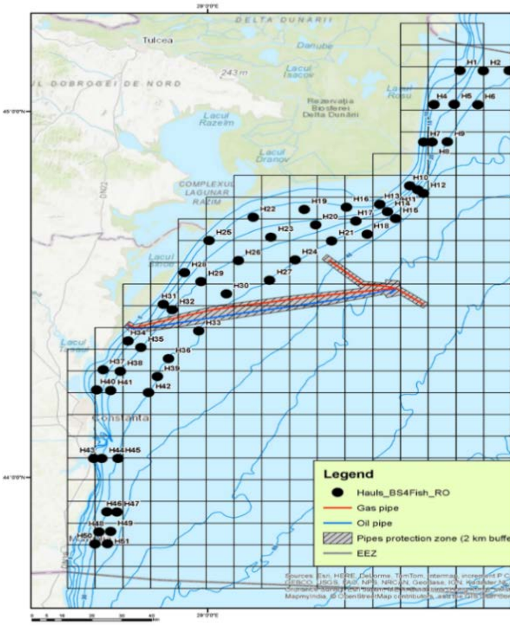


Fig. 1. Map of Rapa whelk research survey sampling stations in the Romanian Black Sea coast, NIMRD

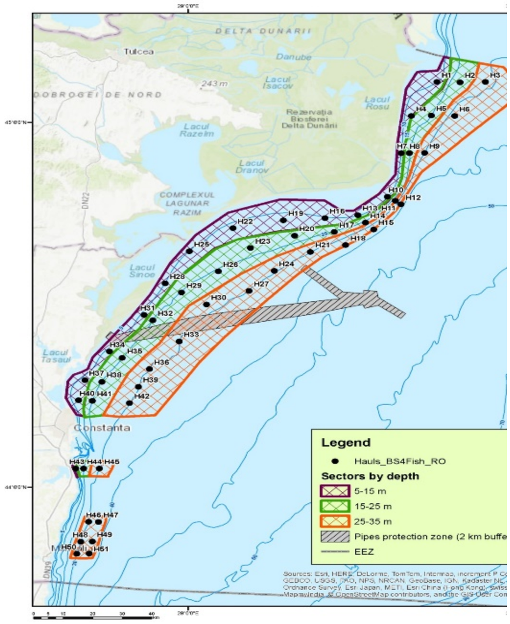


Fig. 2. Researched area for each depth strata in the Romanian Black Sea coast, NIMRD

Hauls were performed at a constant depth and rectilinear in a big percentage, but to avoid tangles and gear destruction, some deviations have been made. Depth strata was adopted as in Table 1.

Table 1. Depth strata and covered area

Depth strata	**Area (sqkm)**
5 - 15 m	1418.01
15 - 25 m	1662.40
25 - 35 m	2437.31
Total	**5517.72**

After the haul operation ended, the catch was sorted by species, debris and marine litter. All the catch were weighted; for fish, the total length and weight were measured; for other species such as mussels with large catch, only the total weight was recorded.

For Rapa whelk the total catch was weighted and a subsample of approx. 10 kilograms was taken for measuring, in case of less than 10 kilograms catch, the whole catch was measured and weighed. For age reading and cleaning of epibionts a number of 20 individuals from each length class were selected or the whole number, if the length class was comprised by less than 20 individuals. All cleaned specimens selected for age reading have been weighed individually. The size of individuals was measured to nearest 0.5 cm length class below and the individuals in each length class were put in different containers. For the primary analysis we used Microsoft Excel and the file example provided in the demonstrative survey organized in Trabzon.

Maps were made in ArcGIS and for quality check R routine RoMEBS and the script Biondex for abundance, biomass, map display, the templates TA, TB and TC were completed according to the specifications.

To determine Rapa whelk agglomerations BioIndex routine has been used, developed in R language, with the purpose of estimating different biological indicators related to a given target species. In particular it allows to estimate the time series of the mean abundance and biomass indices, the inverse of the CV of the abundance indices, the mean individual weight, and the sex ratio at GSA level. Using the time series of the indices previously estimated, the routine performs the analysis of trends using two different tests: Spearman's rho test and the Interception Union Test. The estimation of the indices is also performed with the resolution of the 30 second GFCM statistical grid. Bubble plots of the abundance of recruits and spawners by hauls are also generated.

State-indicators have been calculated by the routine as follows:

1. Number of positive hauls to the species. It is assumed that the size of the spreading area of a stock is mainly dependent on its abundance. A trend analysis can provide insight into the evolution of the occupied area in the medium term. This indicator can be also affected by environmental changes. It is computed as: *Positive hauls * Total hauls* ^{1}**100*

2. Mean biomass index (kg/km²). This index measures the total biomass of a species per unit area. Changes (decrease) in these indices can be caused by an excessive fishing pressure.

The index is calculated as (Souplet, 1996):

$$I = \sum_{i=1}^{N} W_i \bar{x}_i \qquad (1)$$

where I is the index, W_i is the weight of the stratum i, and x_i is given by:

$$\overline{x}_i = \frac{\sum_{j=1}^{n_i} x_{i,j}}{\sum_{j=1}^{n_i} A_{i,j}} \qquad (2)$$

where $x_{i,j}$ is the weight of the individuals in the haul j of the stratum i and $A_{i,j}$ is the area trawled in the haul j of the stratum i; n_i is the number of hauls in the stratum i. within stratum variance is calculated as:

$$S_{x_i}{}^2 = \frac{1}{n_i - 1} \sum_{j=1}^{n_i} A_{i,j} \left(\frac{x_{i,j}}{A_{i,j}} - \overline{x}_i \right)^2 \qquad (3)$$

and the variance in the survey area as:

$$\operatorname{var}(I) = \sum_{i=1}^{N} \frac{W_i^2 S_{x_i}{}^2}{\sum_{j=1}^{n_i} A_{i,j}} (1 - f_i) \qquad (4)$$

where f_i is the ratio between the area trawled in the stratum i and the stratum area (finite population correction factor, generally negligible).

3. Mean abundance index (number/km^2). Abundance indices, like the biomass ones, can change (decrease) for the effect of an excessive fishing pressure, however more than the biomass ones, are likely to be substantially affected by large recruitment pulses in the stock, particularly if numbers of adults are low. For the analysis of time series of such index the ln transformation of the variable ln(x)+1 is usually applied.

For computation the same formulas were used as for mean biomass index.

4. Inverse of mean abundance Coefficient of Variation (CV). The reciprocal of the coefficient of variation could be seen as a descriptor of the stability of the variable under investigation (higher is the metrics, more stable is the variable).

It is the square root of the variance, as obtained for the biomass index, divided by the mean abundance index.

5. Mean individual weight (MIW). Mean Individual Weight (MIW) is generally considered an indicator that synthesizes the structure of the population (Piet and Jennings, 2005) and its changes in time are likely linked to changes in fishing pressure, though it can be also influenced by the recruitment peaks. This influence is expected to be less pronounced if older individuals in

the population are well represented. Mean weight is particularly useful for those species caught in the trawl surveys for which no data on individual size is collected.
It is computed as the ratio between overall biomass by haul i and overall number of individuals by haul i: Bi//Ni.

6. Sex-ratio. Sex ratio provides information on the distribution of female and male individuals present in a population. It represents the proportion of females in a population and indicates the level of sex dominance (Adebiyi, 2013). Generally, this is a peculiar trait of the population. The sex-ratio, as the proportion of the females on the overall number of individuals, can be considered correlated with the stock productivity and renewal (eq. 5 and 6).

It is computed as:

$$Sr = \frac{\sum_{i=1}^{n} FE_i}{\sum_{i=1}^{n} (FE_i + MA_i)} \qquad (5)$$

where FE are females, MA males, i is the haul and n the total number of hauls.
Variance is estimated as:

$$Var(Sr) = \sqrt{\frac{Sr * (1 - Sr)}{\sum_{i=1}^{n} (FE_i + MA_i)}} \qquad (6)$$

7. Index of recruits (number/km^2). Recruits are often measured as the individuals belonging to the first component of the length frequency distributions, or as the individuals of the first age class, according to the recruitment mode, population structure and species. Thresholds to split the recruits from the whole population index can be also obtained from different areas or from literature.
For the indices calculation see mean biomass.
8. Index of spawners (number/km^2). As individuals in spawning phase are not always intercepted by surveys, spawners can be approximated using the indices of adult individuals, i.e. those larger than the size at first maturity.
For the indices calculation see mean biomass.
9. Length at the 95° percentile (L0.95). The different percentiles of a length frequency distribution (LFD) are expected to respond differently to fishing, recruitment pulses, and loss of spawning stock. A large percentile of the population length distribution (L0.95) is an index of the numbers of adult, older

fish. It is assumed to be negatively (decrease) affected by an excessive fishing pressure.

It is computed from the standardised LFD that is:

$$Fq_{j,l} = \frac{fq_{j,l}}{A_j} \quad , \forall \text{ j}, \forall \text{ l}, \tag{7}$$

where $fq_{j,l}$ is the number of individuals in the length class l from the haul j standardised to the km^2, and A_j is the surface trawled in the haul j.

The length at the 95° percentile (L0.95) is computed as:

$$L_{q,i} = l_{q,i} \left| \frac{\sum_{l=1}^{l_q} y_{l,i}}{y_i} = q \right. \tag{8}$$

Where *l* is the length class corresponding to the 95° percentile (q = 0.95) for the species *i*, and $y_{l,i}$ is the value of the catch for the length class *l*.

The variance of the length at the 95° percentile is computed as:

$$Var[L_{q,i}] = \frac{q(1-q)}{y_i \left(y_{l_{q,i}}/y_i\right)^2} \tag{9}$$

Data compilation has been realized in 3 csv files (TA, TB, TC) based on Medits Manual (in which are included information regarding: trawling (number of hauls, date, time, depth, warp length, trawl characteristics, etc.), catch (species, total catch in grams, number of individuals, maturity, sex, etc.) and also salinity and temperature parameters.

Data quality checks of the csv files have been performed by RoME routine, a script that detects errors based on a sequence of functions (https://www.coispa.it/cms/archivio/download/BioIndex_Technicaldocument.pdf).

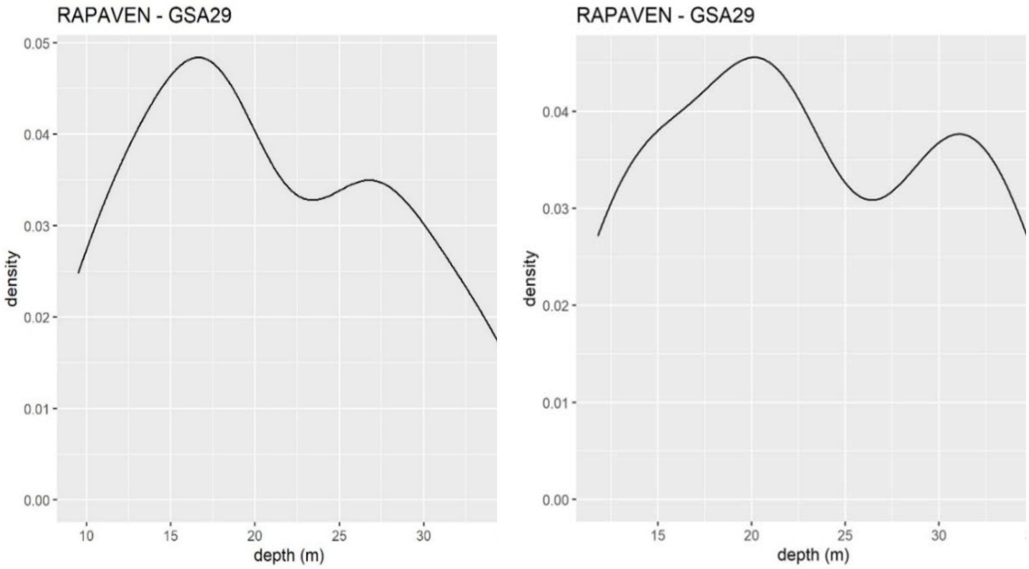
BioIndex and RoME for Black Sea, were presented for the first time in Burgas (May 27-30, 2019) during the "*Data preparation meeting of benchmark session for Black Sea turbot*" organized by GFCM through BlackSea4Fish project (https://gfcmsitestorage.blob.core.windows.net/website/2.BlackSea4Fish/Rapana_Survey_Protocol_May%202021.pdf).

RESULTS AND DISCUSSION

Highest density of Rapa whelk specimens have been recorded in depth range 15-20 m for the year 2020, respectively 17 – 22 m for the year 2021 (Fig.3).

Abundance index of recruits for 2020 have been recorded values between 170.94 to 95164.60 no./km^2, the highest value was shown in Zaton-

Sahalin and Mangalia areas in strata's 10-15 m and 15-25 m, the mean value for the entire studied area was 20642.88 no./km^2.



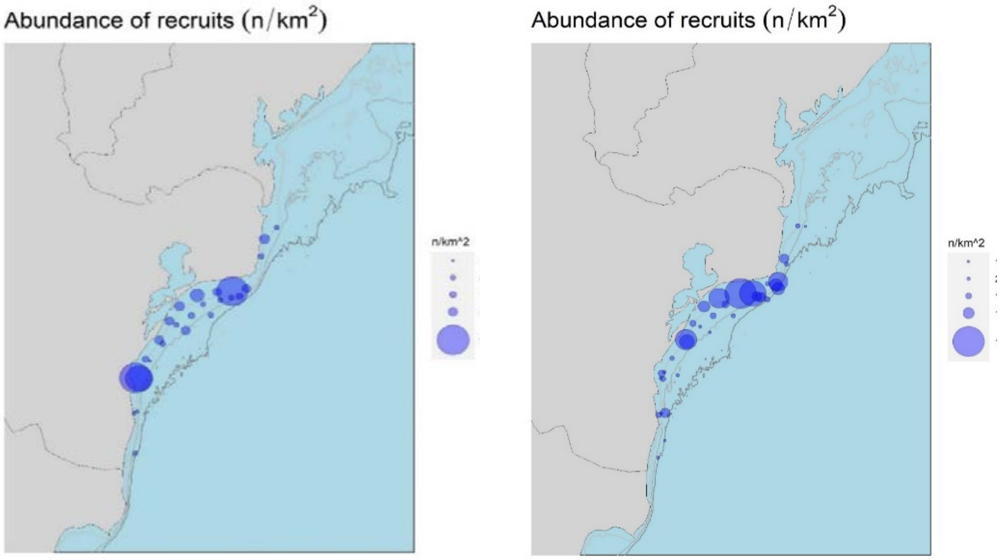
a) b)

Fig. 3. Density of Rapa whelk in accordance with the water depth (m), in 2020 (a) and 2021 (b)

For 2021 the recorded values oscillated between 139.41 to 110748.76 no./km^2, with the peaks in Zaton, Sahalin, Perisor and Eforie areas in strata 10-15m and a mean value for the entire area of 24610.68 no./km^2 (Fig. 4, a-b).

The plots obtained for abundance in assessment (Fig. 5) shows values for 2020 between 4856.6 to 83322.40 no./km2, the highest value was shown in Sf. Gheorghe and Sahalin areas in strata's 10-15 m and 15-25 m, the mean value was 35767.81 no./km2, for 2021 the recorded values oscillated between 5995 to 58332.80 no./km2, with the biggest values in Sf. Gheorghe, Sahalin and Zaton areas in strata 10-15 m and a mean value for the entire area of 30574.66 no./km2 (Fig. 5, a-b). The distribution of Rapa whelk remained for the 2 years in almost the same areas, this behavior is influenced mainly by food availability and climatic condition.

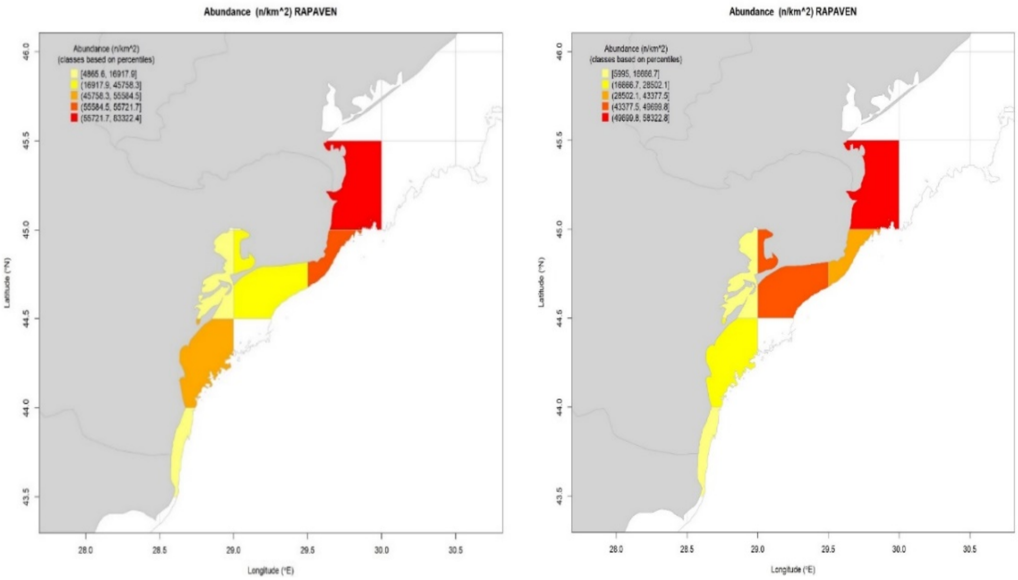
The eq. 1,2,3, and 4 establish the value of biomass indices for Rapa whelk, the period 2020-2021. The biomass indices obtained showed for 2020 values of 355.65 – 5592.54 kg/km2, with a mean value of 2278.83 kg/km2, as for 2021 the values have a decreasing trend and oscillated between 562066 – 4378.93, with a mean value of 1858.678. The sectors with the highest biomasses are for the 2 years Sf. Gheorghe, Sahalin, Zaton and Mangalia in strata 10-15 m, respectively 15-25 m (Fig. 6, a-b).



a) b)

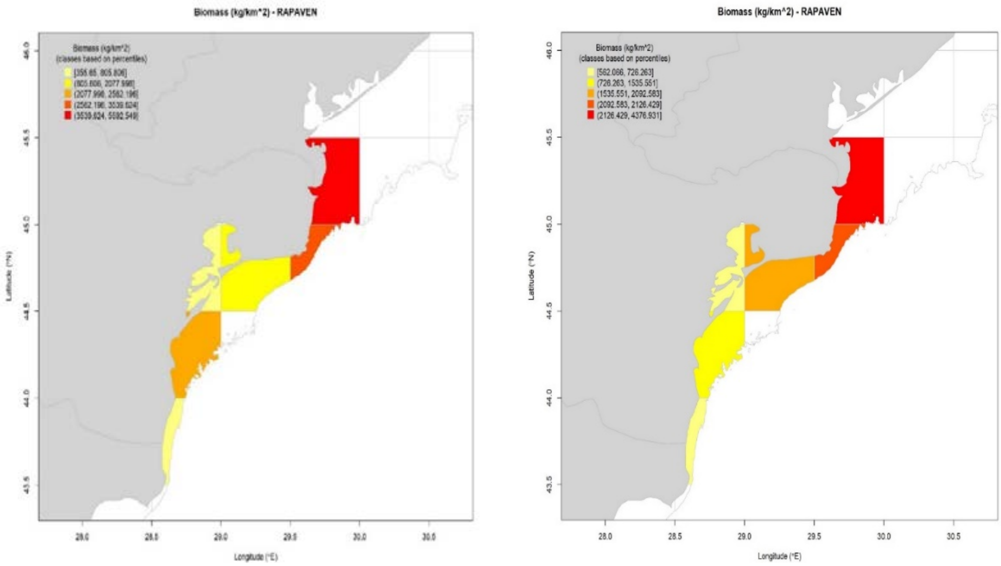
Fig. 4. Abundance of recruits in 2020 (a) and 2021 (b) for Rapa whelk, at the Romanian coast

The eq. 7,8 and 9 refers to the value of length frequency for the 2 studied years, that kept the same pattern, with the largest number of specimens situated between 50-75mm (Fig.7, a-b).



a) b)

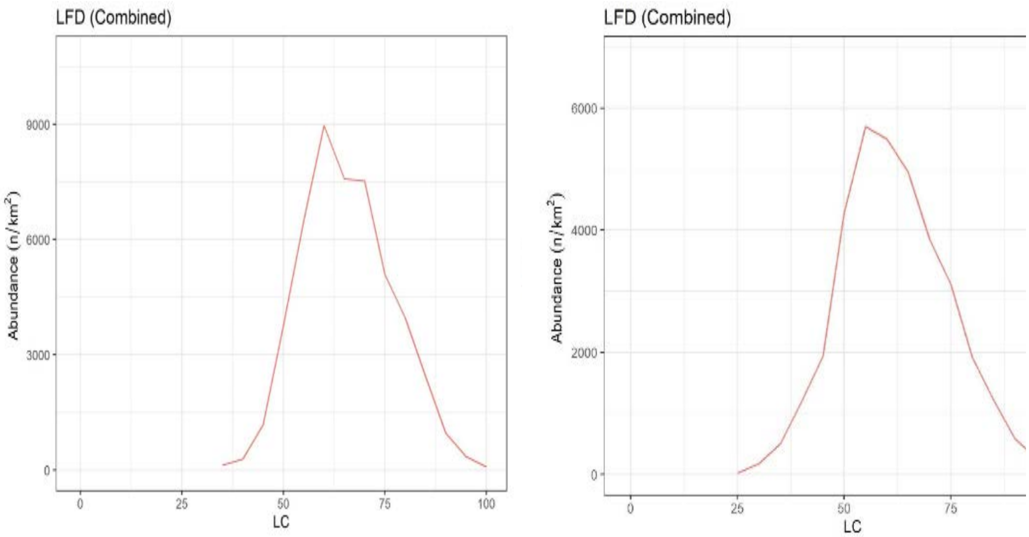
Fig. 5. Abundance of Rapa whelk in 2020 (a) and 2021 (b), at the Romanian coast



a) b)

Fig. 6. Biomass distribution of Rapa whelk in 2020 (a) and 2021 (b), at the Romanian coast

The biomass indices obtained by the 3 stratums in 2020 and 2021 are shown in Table 2. It also presented the total biomass value of 14285.79 tons in 2020, respectively 10910.50 tons in 2021.



a) b)

Fig. 7. Lenght frequency distribution of Rapa whelk in 2020 (a) and 2021 (b), at the Romanian coast

Table 2. Biomass and abundance indices of Rapa whelk population from the Romanian coast in 2020 and 2021

	Indices	Stratum 1	Stratum 2	Stratum 3	Total biomass (tons)
2020	Biomass (kg/km^2)	4754.91	2949.09	1083.47	14285.79
	Abundance (N/km^2)	101239	53553	15447	
2021	Biomass (kg/km^2)	3429.26	2271.65	931.93	10910.50
	Abundance (N/km^2)	75023	40198	14671	

Based on these results the stock of Rapa whelk in Romanian waters has a declining trend due to overfishing and, most probably because the lack of food, this aspect is also visible in the commercial catches of rapa whelk (Fig. 8).

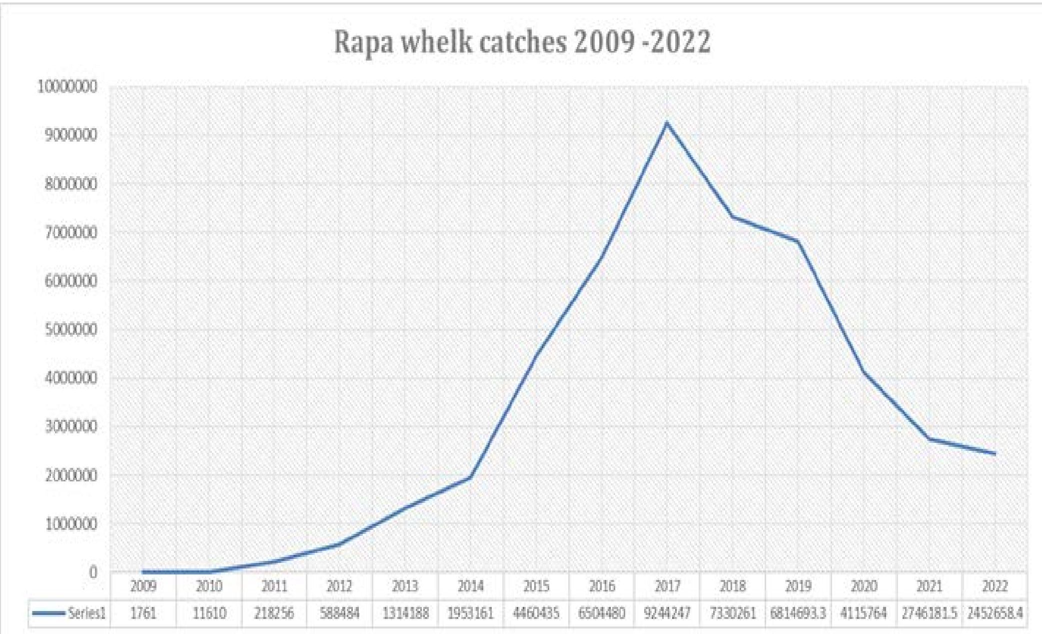


Fig. 8. Rapa whelk catches in commercial fishing in Romanian coast in the period 2009-2022

CONCLUSIONS

Total number of Rapa whelk sampled in 2020 was 15842 and for 2021 was 11950, as for measured individuals were 5430 in 2020 and 5436 in 2021. For age reading the number was 3922 in 2020, respectively 4033 in 2021.

Length frequency distribution in 2020 was between 3.5 – 10.0 cm, with a peak of 6.0 cm length class, for 2021 oscillated between 2.5 -10.0 cm, most frequently encountered age class was 5.5 cm.

Highest abundance and biomass values for rapa whelk in 2020 have been recorded in the north part of the Romanian coast in sectors Zaton, Sahalin, Sf. Gheorghe, for 2021 the same trend is observed.

Total biomass values of rapa whelk are 14285.79 tons in 2020, respectively 10910.50 tons in 2021, indicating a decreasing slope for the stock present in the study area.

In order to have a sustainable harvest for this invasive species that become a resource for the Black Sea fishery, measures regarding fishing season and gear mesh sizes should be applied.

More research studies for the biology and ecology will provide a clear view and will improve knowledge regarding migration patterns, food preference and life cycle.

Acknowledgement. This research work is part from the project MTF/ INT/943/MUL – Baby 31 "Select activities of the strategies towards the sustainability of fisheries and sustainable aquaculture development implemented in the Mediterranean and the Black Sea"- "Rapa Whelk research surveys in the coastal waters of Romania" with the support of Food and Agriculture Organization of the United Nations (FAO).

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