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 ORIGINAL PAPERS

Mesozooplankton Dynamics in The Romanian Black Sea Waters During 2020-2021

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Abstract. *The composition and space-time distribution of mesozooplankton community from the Romanian Black Sea waters during 2020-2021 was analysed. Sampling was carried out during two expeditions (October 2020, September 2021), resulting a number of 133 samples. A total of 21 taxa were identified, the maximum being recorded in 2020, with nine taxa among copepods. Variations were observed between the two cruises, the mesozooplankton community being best represented in October 2020, when the highest density and biomass values were observed. The fodder component of the mesozooplankton community was dominant both in 2020 and 2021, Noctiluca scintillans (the nonfodder component) being less represented, with lower density and biomass values. From the fodder component, Copepoda represented the bulk of the community, with the highest values in 2020, followed by Cladocera with a maximum development in 2021. Branchiostoma lanceolatum larvae were identified in 3 stations in 2020 and in one station in 2021 at different sampling depths.*

Keywords: taxa, abundance, biomass, *Branchiostoma lanceolatum*

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1. Introduction

The zooplankton community is represented by animal organisms found in the pelagic area, drifting in the water column, whose locomotion abilities are insufficient to withstand currents. These communities are very important in marine food webs, being the main consumers of phytoplankton and a feeding source for fish, thus controlling phytoplankton production and modelling processes within pelagic ecosystems [1].

Marine zooplankton comprises a large variety of organisms, divided into size classes, ranging from:

- microzooplankton (20-200µm)
- mesozooplankton (0.2-20mm)

- macrozooplankton (2-20cm)
- megazooplankton (20-200cm) [1].

This paper focuses on the mesozooplankton fraction, being an important part of zooplankton in pelagic trophic web, not only because of their sheer abundance and great diversity, but also for the vital functions within the ecosystem [1].

Due to the key role of zooplankton in the early stages of fish development, changes in species composition and abundance have significant implications for fish recruitment and dynamics. Therefore, understanding the abundance, species composition, and distribution of zooplankton is very valuable in supporting research on fish production and changes in ecosystems [2,3]. In the larval and juvenile stages, fish consume zooplankton as food, the synchronicity between the peak of mesozooplankton abundance and fish larvae being crucial in determining the recruitment and dynamics of fish populations [2].

The general aim of this study was to identify the qualitative and quantitative structure of the mesozooplankton community from the Romanian Black Sea waters in 2020-2021 and to point out the reoccurence of *Branchiostoma lanceolatum* larvae, which were first recorded in the Romanian Black Sea waters in 2018, according to Muresan et al., 2019 [4]. After fifty years since the first adult of *B. lanceolatum* was signalled, Muresan et al., 2019, identified pelagic larvae of the species in the national waters, within the surface and under thermocline layers [4].

2. Materials and method

The collection of mesozooplankton samples was performed by vertically towing the Juday net (a biconical net with non-filtering upper part and filtering lower part) in the water column, with a speed of 0.5-1 m /s, from stations located in the Romanian Black Sea area, in October 2020 and September 2021 (Fig. 1) from the following depth intervals:

- the upper mixed layer - from the upper boundary of the thermocline to the surface (surface homogeneous layer)
- thermocline - from lower thermocline boundary to the upper thermocline boundary
- from the bottom or from the top of oxycline (whichever is shallower) to the lower boundary of the thermocline [5]

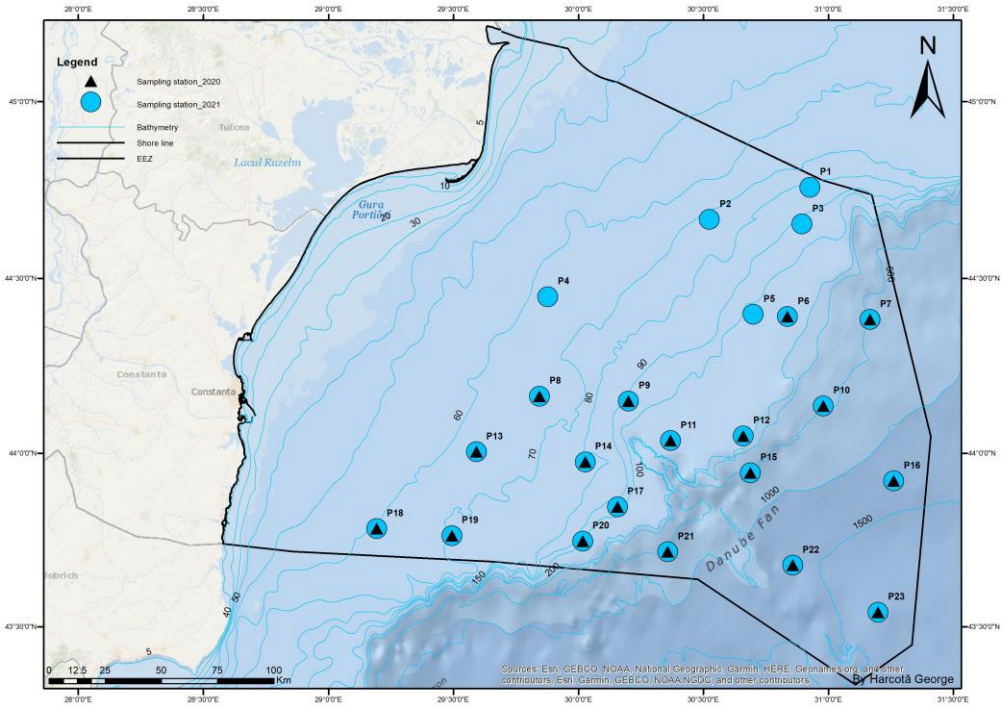

Fig. 1. Network of mesozooplankton sampling stations, 2020-2021

Quantitative and qualitative mesozooplankton's samples processing was performed under Olympus SZX10 stereomicroscope. All plankters were counted in the Bogorov chamber (subsamples of 2 ml), until each of the three dominant taxonomic groups reached 100 individuals. For the estimation of large animals'numbers, the whole sample was examined in a Petri dish. The number of individuals and mean individual weights were used for estimating the density as ind/m^{-3}, respectively the biomass as mg/m^{-3} wet weight [5].

PRIMER software was used for statistical analyses, using the non-metric multidimensional scaling (NMDS) [6] to examine the relationships between the mesozooplankton community and the sampling stations. Shade plots which represent multivariate analysis that show clear community structures, characterising responses of individual (or groups) species across the sample, were also obtained by using the PRIMER software [6].

3. Results and discussion

The qualitative structure of the mesozooplankton community in 2020 and 2021 did not show high variations, the only difference being recorded for Copepoda represented by 9 species in 2020 and 8 species in 2021, the other

mesozooplankton groups being represented by the same number of taxa: 1 species for the non-fodder component (*Noctiluca scintillans*), 5 species for Cladocera, 4 taxa for the meroplanktonic component and 3 species for Other groups category. Copepods usually comprise 55–95% of total zooplankton abundance in marine pelagic systems [7]. Because of their high abundance, copepods are a major trophic link between phytoplankton and upper-level consumers, possessing a key role in biogeochemical cycles [8].

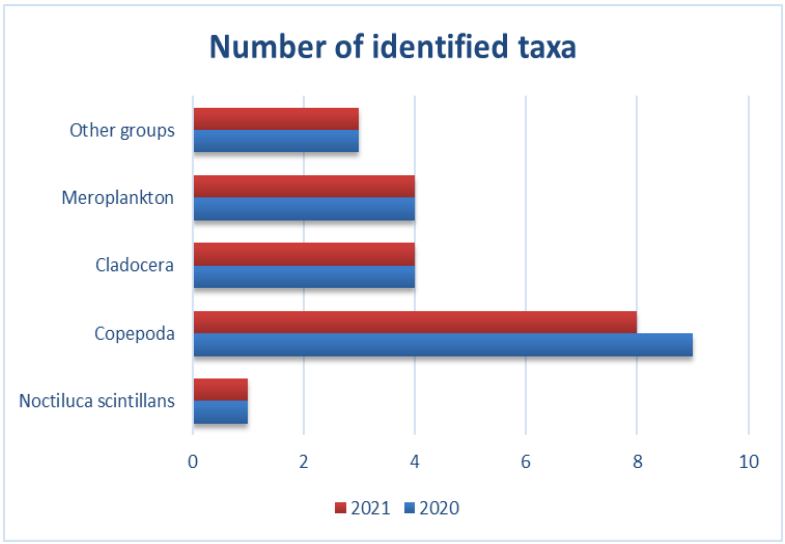

Fig. 2. Qualitative structure of mesozooplankton in 2020-2021

Regarding the quantitative structure, in 2020 the mesozooplankton community recorded the highest density values. Copepoda represented the bulk of the community, with species *Acartia clausi*, *Pseudocalanus elongatus* and *Oithona similis* being best represented. The maximum density values have been recorded in station P19 (Fig. 3). From Cladocera's group, *Penilia avirostris* and *Evadna spinifera* were better represented in terms of density. The meroplanktonic elements did not record high density values and from the Other groups category, the chaetognath *Parasagitta setosa* recorded the highest density values, with maximum development in station P18. *Noctiluca scintillans* was best represented in station P19, but overall, with lower density values in comparison to copepods, cladocerans, meroplankton and other groups (Fig. 3).

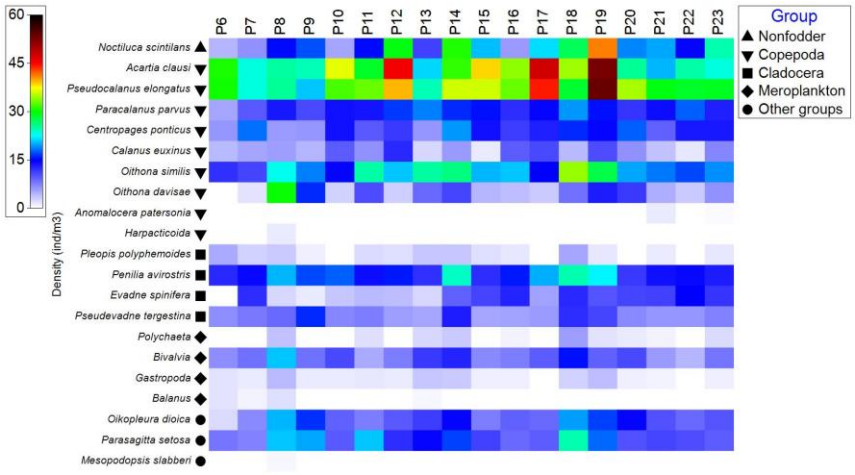

Fig. 3. Matrix of mesozooplankton taxa in 2020

In 2021 high density values were observed for copepods, best represented being *Acartia clausi*, *Pseudocalanus elongatus and Oithona similis.* The cladoceran *Penilia avirostris* reached the highest mean density values, with the maximum at station P19 (Fig. 4). The meroplanktonic elements were better represented by Bivalvia, which reached high density values in stations P21, P2 and P4 (Fig. 4). Other groups (*Oikopleura dioica* and *Parasagitta setosa*) were also well represented quantitatively (Fig. 4) and *Noctiluca scintillans*, representative of the non-fodder component, recorded lower density values in comparison with the other mesozooplanktonic groups.

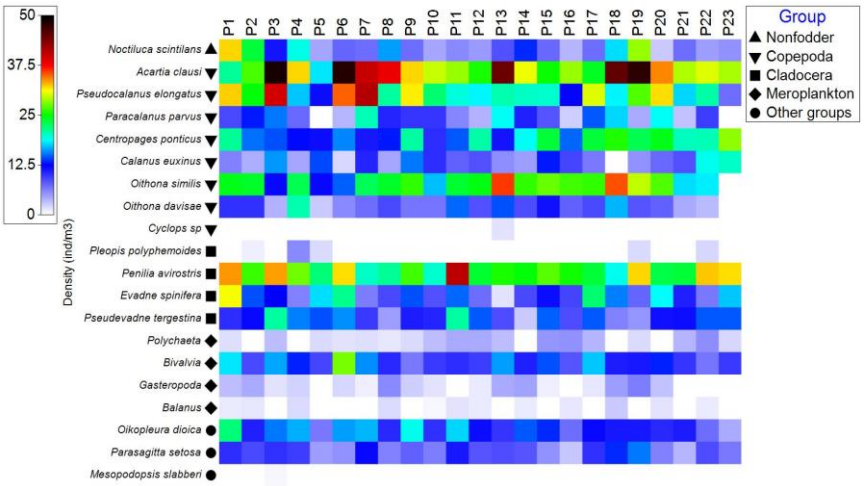

Fig. 4. Matrix of mesozooplankton taxa in 2021

In 2020, the mesozooplankton's fodder component was dominant both in terms of density and biomass, with the non-fodder category recording lower densities and biomass values (Fig. 5). Based on the densities and biomass values for the total mesozooplankton (non-fodder and fodder) clusters of 60% and 80% similarities were observed (Fig. 5).

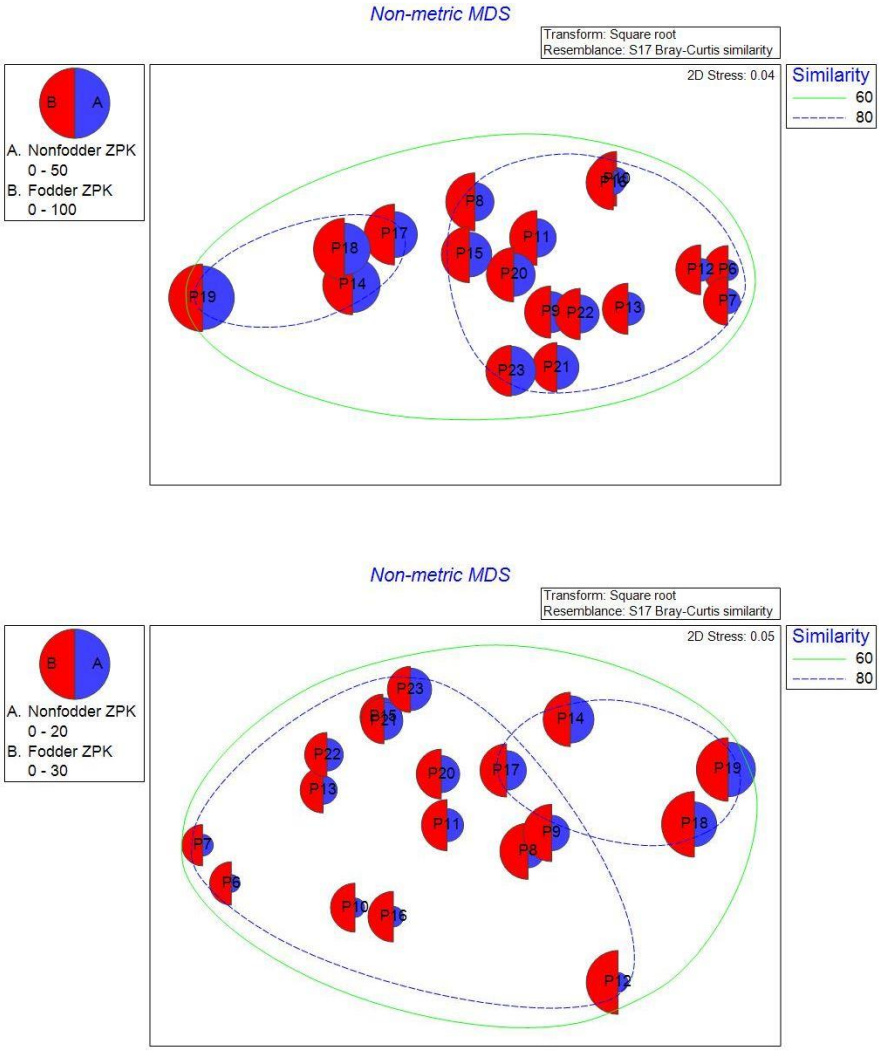

Fig. 5. NMDS analysis of total mesozooplankton density (up) and biomass (down) in 2020

The fodder component was mainly represented by copepods, with the highest density value (85 ind/m^3) and the highest biomass (16 mg/m^3) in station P19. Cladocera was the second-best represented group, with the highest values in station P18 (22 ind/m^3, 4.75 mg/m^3). The meroplanktonic groups and the Other groups category did not record high densities and biomasses, the bulk of the

community being mainly represented by copepods and Cladocera, clusters of 60% and 80% similarities being formed based mainly on the quantitative structure of these two mesozooplanktonic components (Fig. 6).

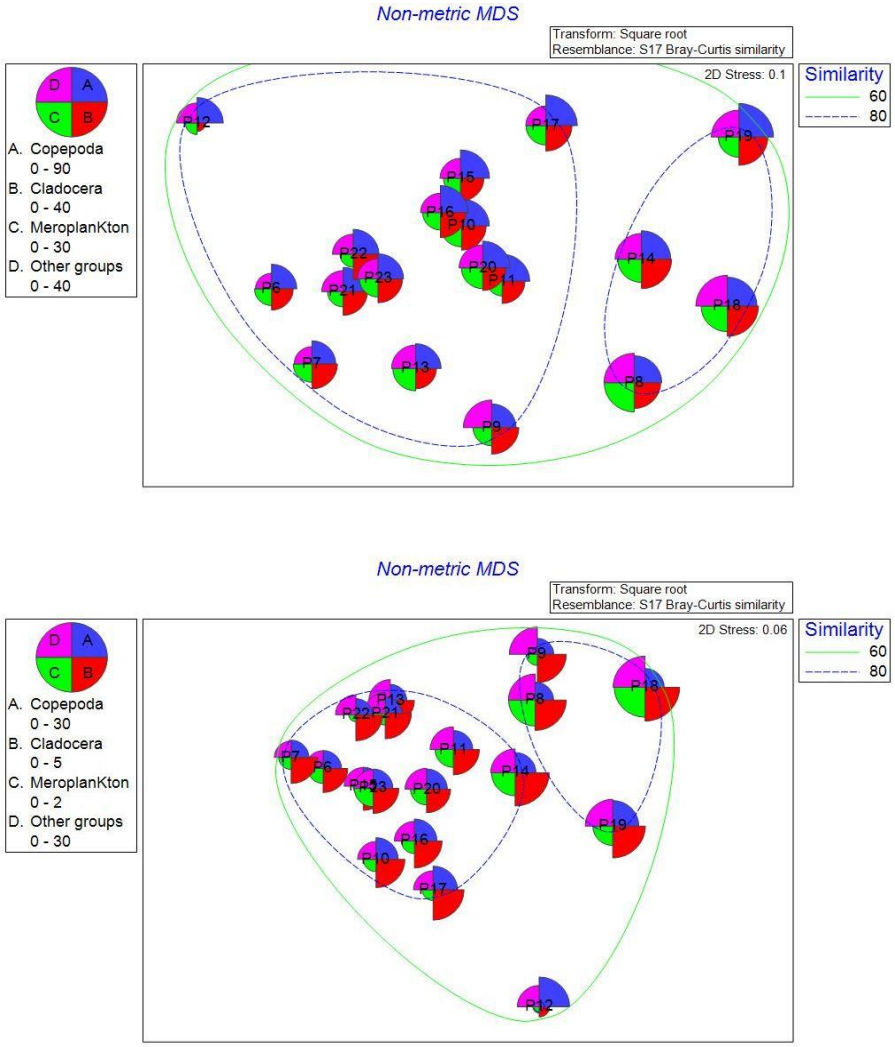

Fig. 6. NMDS analysis of fodder mesozooplankton density (up) and biomass (down) in 2020

In 2021, the same situation as in 2020 was encountered, the fodder component being dominant in term of densities, with the highest value in station P19 (78 ind/m^3). However, in terms of biomass, in some of the sampling stations, the non-fodder component was dominant, which indicates that smaller organisms dominated during this period. As in 2020, clusters of 60% and 80% similarities were recorded.

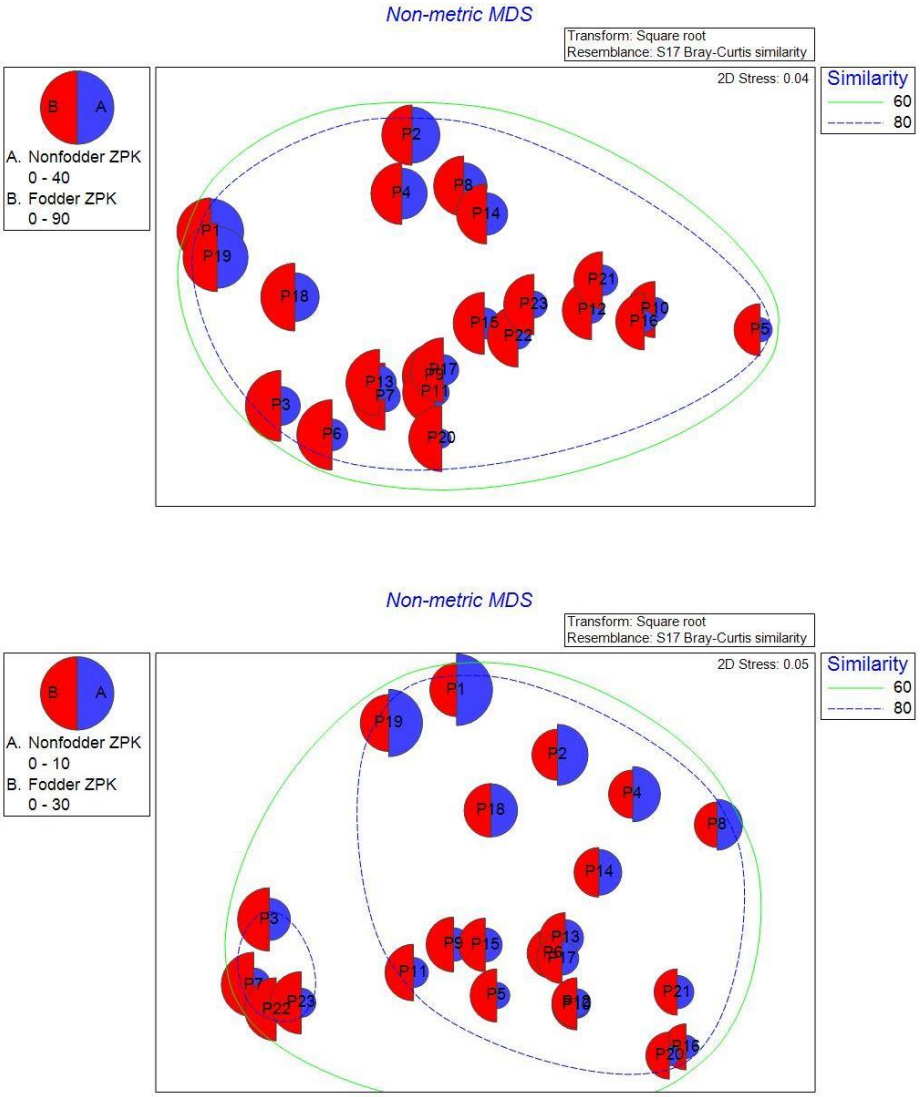

Fig.7. NMDS analysis of total mesozooplankton density (up) and biomass (down) in 2021

In 2021, copepods and species belonging to Cladocera represented again the bulk of the community, Copepoda being best represented in station P18 and Cladocera in station P11. Clusters with 60% and 80% similarities were again formed, based on the quantitative structure of the fodder component, copepods and cladocerans being the main contributors (Fig. 8).

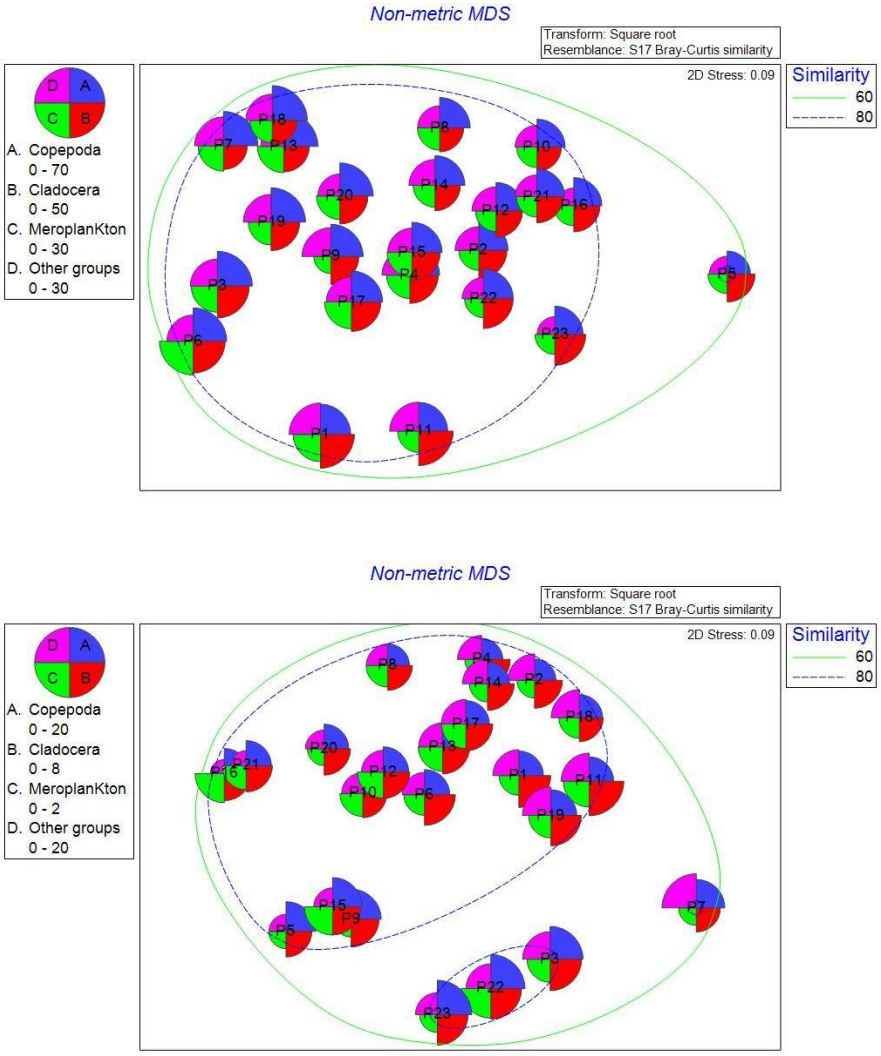

Fig. 8. NMDS analysis of fodder mesozooplankton density (up) and biomass (down) in 2021

Branchiostoma lanceolatum (European lancelet) is known as a rare species in the Black Sea and it was reported in the area, in association with *Ophelia limacina, Polygordius lacteus, Glycera* sp. Lepadogaster fish, various Nematodes, Myside and two species of Synapta, on coarse sands habitats [4].

During the expeditions carried out in 2020 and 2021 in the Romanian Black Sea waters, larvae of *B.lanceolatum* (Fig. 9) were identified in the mesozooplanktonic samples.

In 2020 *B. lanceolatum* larvae appeared in 3 stations and in 2021 in only one station (Fig. 10, Table 1).

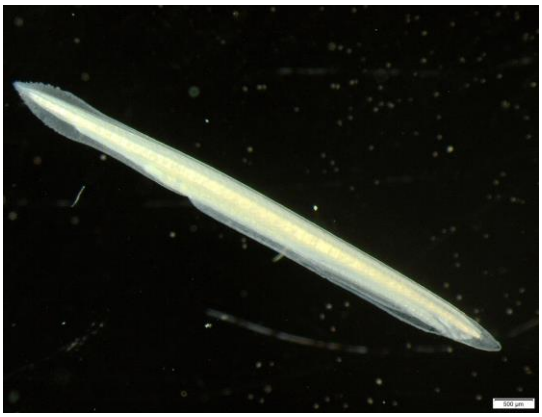

Fig. 9. *Branchiostoma lanceolatum* larvae (original photo)

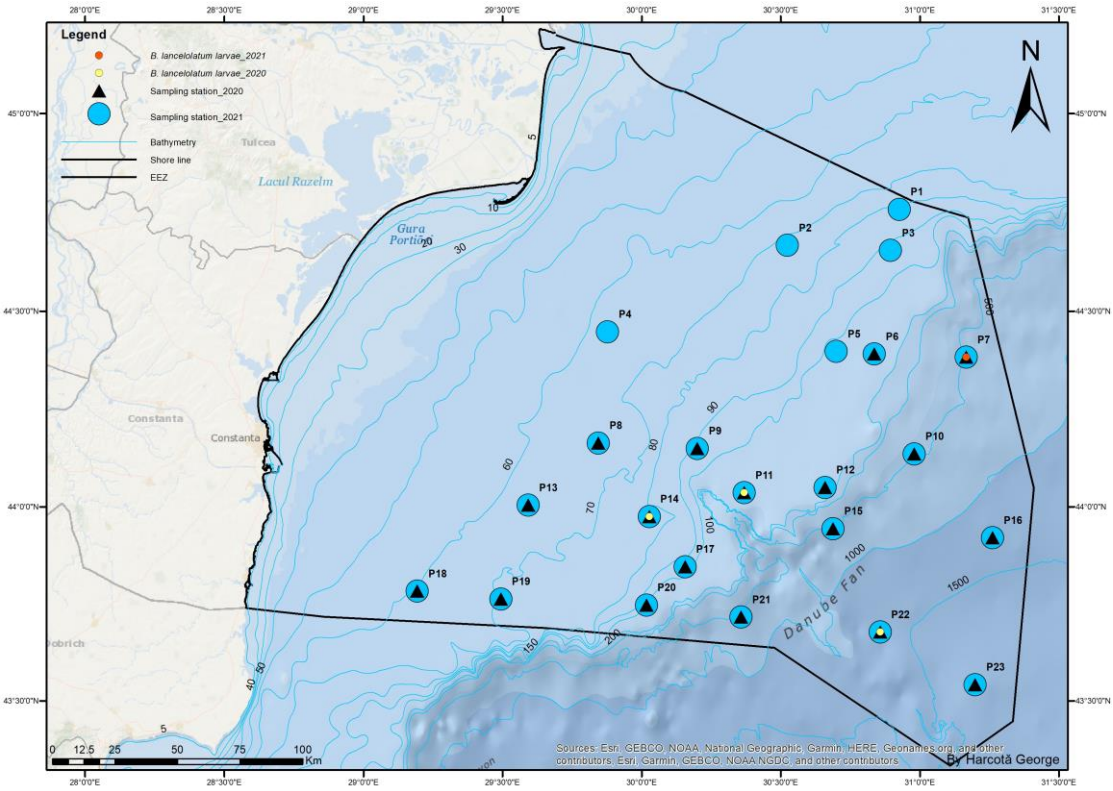

Fig. 10. Map of sampling stations, with emphasis on the presence of *B. lanceolatum* larvae

Table 1. Number of identified *B. lanceolatum* larvae and physicocemical parameters

Station	P11	P14	P22	P7
Year	2020	2020	2020	2021
No. of ind.	1	1	1	1
Longitude	30.36	30.02	30.85	31.16
Latitude	44.03	43.97	43.67	44.38
Bottom depth (m)	120m	80m	1380m	500m
Sampling depth (m)	110-35m	75-40m	130-100m	40-18m
Temperature ^{0}C	8.94	9.33	8.67	22.69
Salinity PSU	19.07	14.29	19.62	18.45
Substrate type	circalittoral mixed sediment	circalittoral mixed sediment	lower bathyal sediment	lower bathyal sediment

The European lancelet, once very abundant, became increasingly rare after the early 1900s because of eutrophication and organic pollution [9, 10]. The severe decline of *B. lanceolatum* populations on a global scale during the last decades is attributed to the expansion of muddy areas in the bottom sediments of coastal areas due to eutrophication and pollution [11,12].

Indeed, the presence of the adult benthic forms of this species has been associated with the good environmental quality of its habitat [13] which is the sub-littoral coarse-grained sediments [14].

According to this research and published literature review, until now only the larval stage of amphioxus was identified at the Romanian Black Sea shore. According to Prof. M.T. Gomoiu, fifty years ago an adult of *B. lanceolatum* was found in benthic samples, but the data were never published (personal communication). These findings show that future research is needed to find out if stable populations are present at the Romanian Shore.

Conclusions

Conclusion (1)

The qualitative structure of the mesozooplankton community in 2020 and 2021 did not show high variations, copepods being represented by the highest number of species (9 in 2020 and 8 in 2021).

Conclusion (2)

Both in 2020 and 2021, species *Acartia clausi, Pseudocalanus elongatus and Oithona similis* recorded the highest density values. Cladoceran *Penilia avirostris* dominated in 2020 and 2021, meroplankton was better represented in 2021 and the chaetognath *Parasagitta setosa* recorded the highest density values in 2020.

Conclusion (3)

In 2020 and 2021, the mesozooplankton's fodder component was dominant, the non-fodder category recording lower densities and biomass values.

Conclusion (4)

In both years, Copepoda and Cladocera were the most abundant fodder groups, contributing most to the mesozooplankton's community structure.

Conclusion (5)

The second reporting of *Branchiostoma lanceolatum* larvae in mesozooplankton samples from the Romanian Black Sea waters is of great interest, considering the rather rare occurrence of this organism in the mentioned area. The reconfirmation of *B. lanceolatum* larvae might be a step in reassessing the status of the species, which in the Romanian Black Sea waters is considered vulnerable.

Acknowledgment

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