Ichthyoplankton Community Structure in Relation with Zooplankton Component in the Romanian Black Sea *(Aurelia Țoțoiu, Cristina Tabarcea, Elena Bișinicu, George – Emanuel Harcotă, Florin Timofte, Andra Oros, Victor Cristea)*	**"Cercetări Marine" Issue no. 50** **Pages 126 - 140**	**2020**

ICHTHYOPLANKTON COMMUNITY STRUCTURE IN RELATION WITH ZOOPLANKTON COMPONENT IN THE ROMANIAN BLACK SEA

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ABSTRACT

Ichthyoplankton and zooplankton were studied from samples collected from the Romanian Black Sea area, in 2019. The aim of the paper is to show the interrelation between ichthyoplankton, microzooplankton, mesozooplankton and gelatinous zooplankton and to analyse the spatio-temporal distribution of these components. The communities were analysed both from qualitative and quantitative point of view, giving an insight over the component dynamics. Prey-predator relation is strongly related to marine organism's development stage, environmental conditions, trophic interactions. The reproduction of the fish species and the development of the larvae is closely related to the environmental conditions, the breeder's stock state, the trophic base, but also to the relation between prey-predator.

Key-Words: ichthyoplankton, microzooplankton, mesozooplankton, gelatinous zooplankton

AIMS AND BACKGROUND

The ichthyoplankton, consisting of fish eggs and larvae is an essential component of pelagic ecosystem due to its complex interactions with the other plankton species at different trophic levels. The biological and ethological characteristics of the species, the ecological links between the ichthyofauna and the other components of the marine ecosystem, are of great concern because they provide useful information for effective conservation measures

contributing to their sustainable management.

Zooplankton comprises a wide variety of animals – including larvae, juvenile and adult stages – of almost all taxa at the zoological scale. Analysed marine zooplankton community is formed by the following size fractions: **microzooplankton** (20-200 μm, ciliates and a large part of rotifer species), **mesozooplankton** (0.2-20.0 mm, larger rotifers, mainly planktonic crustaceans, meroplanktonic larvae of some benthic invertebrates, etc.), and **macrozooplankton** (organisms larger than 20 mm). Between zooplankton and ichthyoplankton reciprocal feeding relationships of significant ecological relevance occur (Sanvicente-Añorve et al., 2006).

Microzooplankton, especially tintinnids, have a larger potential to regenerate plant nutrients and higher growth rates than metazoan competitors, therefore there is an indirect link for ichthyoplankton as food for larger mezozooplankton grazers, also an direct link as food for some fish larvae (Godhantaraman N., 2004).

The abundance and diversity of mesozooplankton is extremely important for planktivorous fish and fish larvae, playing a regulatory role in the abundance and distribution of marine resource (Ndour et al., 2018).

Zooplankton community structure serves as a critical trophic link between the autotrophic and higher trophic levels (Bisinicu et al., 2019).

Globally, the abundance of macrozooplankton has increased significantly, making it a feature in many marine ecosystems. When conditions are favourable, jellyfish biomass grows to an unexpectedly high level, for example in the late 1980s, the population of *Aurelia aurita* in the Black Sea was estimated at 300-500 million tons (Grishin et al., 2007).

Both the ichthyoplankton and the macrozooplankton components have uneven distributions, influenced by environmental factors. Hence, analysis of the ichthyoplankton should not only address the mere description of the presence or absence of species, but it should also focus on the type and nature of the interactions established between the populations and their environment; such interactions are presumably complex and highly variable as well (Sanvicente- Añorve et al., 2006).

The aim of the paper is to analyse the spatio-temporal distribution of ichtyoplankton and the other three zooplanktonic components, to establish the interactions between them in relation to environmental conditions influencing the organism's development.

EXPERIMENTAL

Ichthyoplankton, microzooplankton, mesozooplankton and macrozooplankton samples were collected from ten stations located along the Romanian Black Sea area, in August 2019 (Fig.1). The samples were stored in 500 ml plastic bottles and preserved in 4% buffered formaldehyde solution.

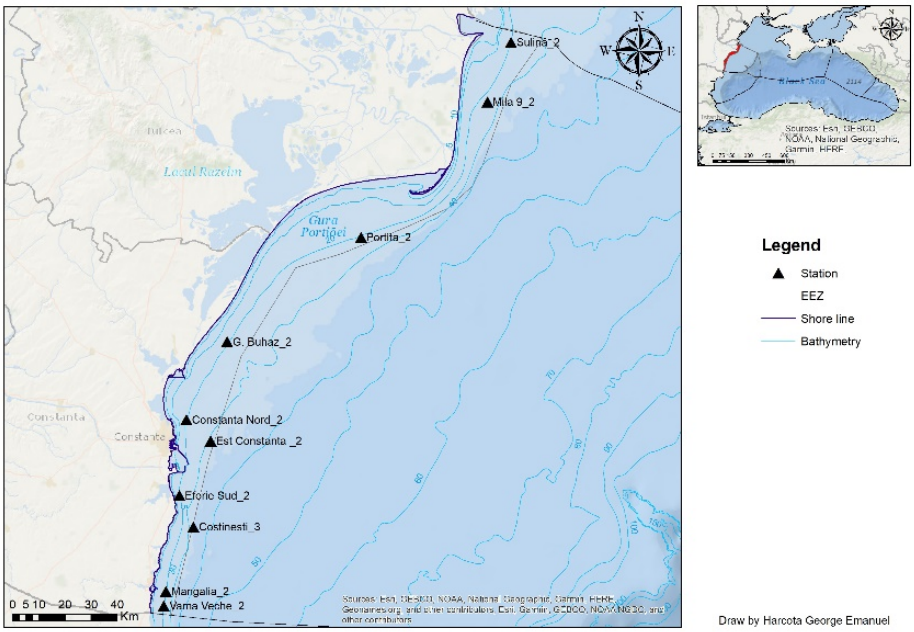

Fig. 1. Sampling stations

Ichthyoplankton and macrozooplankton were collected using a Hansen-type net with 70 cm diameter and 300 μm mesh size, by towing the net vertically in the water column (from 2 m above the seabed to the surface), at low speed (0.5-1 m/s). After collection, the net was lifted on the ship deck and gently washed with seawater in order to release organisms that were trapped in the net mesh (Fig.2).

Fig. 2. Ichthyoplankton and macrozooplankton sampling procedure

Each collected sample was further processed by sorting the organisms under stereomicroscope (Olympus SZX10), for qualitative and quantitative structure. The ichthyoplankton and macrozooplankton samples were analysed by two different methods.

The qualitative and quantitative composition of ichthyoplankton was determined taking into account the main distinguishing features for fish eggs: their shape and diameter, presence or absence of the fat drops, the diameter and appearance of the fat drops, the homogeneity or segmentation of the larva, the size of the perivitelline space. To determine the larvae stage, meristic, morphometric characteristics, pigmentation, body shape and position of the anal orifice were considered (Dekhnik, 1973).

Qualitative analysis of fish eggs and larvae consisted in identifying them to species level. From the quantitative point of view, the results were expressed in individuals per cubic meter (ind/m^3). The spatial distribution of ichthyoplankton and juveniles was mapedusing density values.

The macrozooplankton organisms in the collecting glass were carefully moved to a bucket and immediately identified, counted, and measured. The large specimens were washed with sea water, above the container in which the sample was extracted from the net. All organisms in the sample were measured (depending on the species: width, aboral length, respectively total length). The individuals were measured using a ruler, by positioning them directly on the laboratory table or on plotting paper (for large specimens of *Aurelia aurita*). In the case of small specimens, a gridded Petri dish, filled with water, was used to measure them without body deformation.

The density and wet biomass of gelatinous organisms were expressed as ind./m3 and mg./m3, respectively. The calculation of these parameters was performed according to the recommendations of the Macroplankton (or Gelatinous Plankton) Monitoring Guidelines.

The **microzooplankton samples** were collected from the surface layer (0m) by Niskin bottles (Fig.3).

In the laboratory, the samples were concentrated to a final volume of 10 ml by repeated sedimentation. The final volume was completely analysed under the inverted microscope (Olympus XI 51) using 200x and 400x magnification factors. The taxonomic identification of tintinnids was made according to the shape and dimensions of the lorica, indicated by literature.

For qualitative and quantitative analysis, both empty tintinnids and those with protoplasm were considered as mechanical and chemical disturbances associated with collection and fixation procedures have been demonstrated to cause cell detachment (Thompson et al., 2005). The density of organisms was expressed as individual species/litter (ind./l). The lorica volume was calculated according to the total length and aboral diameter of the lorica, and to the geometric form assumed for each species. Biomass was

expressed as carbon biomass (µgC/l) using the specific biovolume conversion formula for formalin conserved material (Verity et al., 1984). M**esozooplankton samples** were collected using the Juday net (0.1 m^2 mouth opening area, 150 µm mesh size) by vertical hauls (Fig. 4).

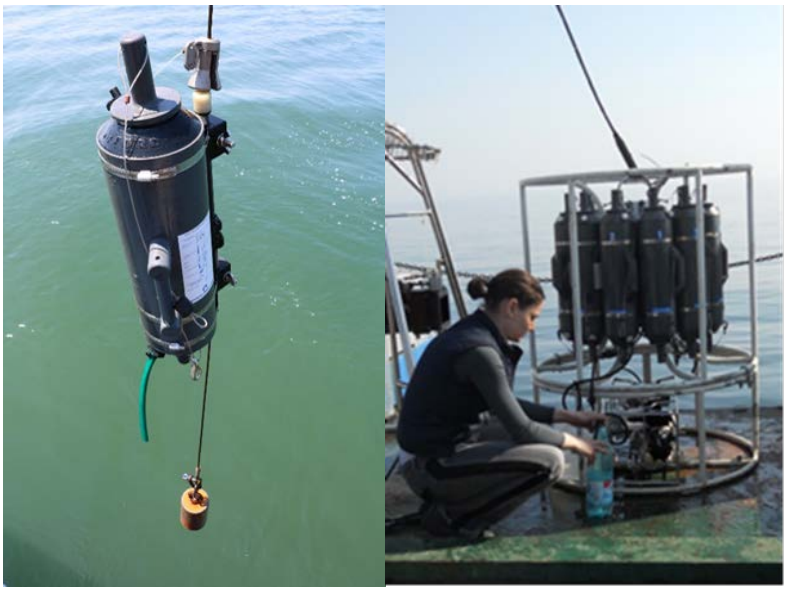

Fig. 3. Microzooplankton sampling

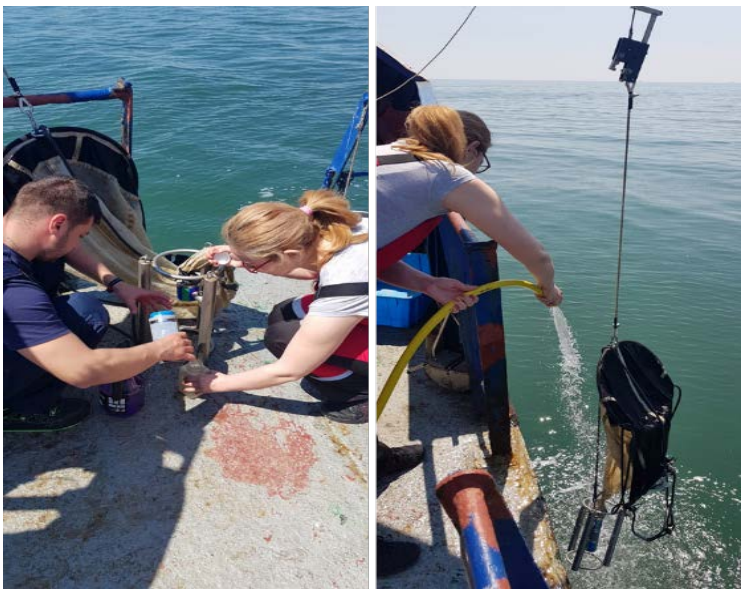

Fig. 4. Mesozooplankton sampling procedure

Subsequently, the mesozooplankton samples were homogenised, and organisms were determined and counted in the Bogorov chamber, under Olympus SZX10 stereomicroscope. In the subsample(s) all plankters were counted until each of the three dominant taxonomic groups reached 100 individuals. For estimation of large animals' numbers, the whole sample was observed (Fig.5).

All species were identified taxonomically to the species level except the meroplankton larvae. The number of individuals and averaged individual weights were used for estimating the density (ind·m^{-3}), and biomass (mg·m^{-3}), respectively as wet weight (Alexandrov et al., 2014).

Fig. 5. Stereomicroscope Olympus SZX10- sampling analysis

To assess the relationships between the four planktonic components, the Spearman's correlation index, available in software PAST 3.20, was used. Acceptance of the alternative hypothesis (existence/lack of statistically significant relationship between the analysed parameters) was considered significant at values lower than 0.05 (Hammer et al., 2001).

Bray-Curtis similarity index for abundance data was used for establishing the relationships between the analysed components.

RESULTS AND DISCUSSION

Data regarding species composition and distribution can be used as indicators of habitat degradation, fishing pressure, water contamination and can reveal changes that may occur in the marine environment.

In the analysed samples, the ichtyoplankton was represented by three species *(Engraulis engrasicolus*, *Trachurus mediteraneus ponticus* and

Scorpaena porcus), microzooplankton by 22 species, mesozooplankton by 19 species and macrozooplankton by four species (*Pleurobrachia pileus, Aurelia aurita, Beroe ovata, Mnemiopsis leidyi).*

Ichtyoplankton was dominated by anchovy occurring in the entire Black Sea area; its optimal reproduction is determined by the adaptability of the species to biotic and abiotic factors. Depending on the climatic conditions, anchovy's reproduction may change from one annual cycle to another.

The bulk of the microzooplankton component was represented by the following species: *Tintinnopsis minuta*, *Eutintinnus lasus-undae*, *Eutintinnus tubulosus* and *Metacylis mediterranea.*

In summer when the pelagic production can be dominated by the microbial loop, microzooplankton represents a key component of the food web dynamics (Tian et al., 2003).

The mesozooplankton community was mainly represented by eight species of copepods, five meroplanktonic species, and four Cladocera species, only the fodder zooplanktonic component being taken into consideration. Among marine zooplankton, the copepods are the most familiar and dominant constituent, representing 55–95% of the total zooplankton abundance in the marine pelagic system (Angara E.V., 2013).

The macrozooplankton component was represented by the dominant species *Pleurobrachia pileus*, which was found in high quantity in all sampling stations.

Jellyfish feed at high rates on zooplankton and ichthyoplankton and may affect the fish populations (Purcell et al., 2001).

The ichthyoplankton component was present in eight out of the ten analysed stations, in Sulina 2 and Mila 9 2 no egg or fish larvae being found. The ichthyoplankton density varied from one station to another, the highest being reported in Portita 2 station (22.8 ind/m^3) (Fig.7).

Microzooplankton was present in higher quantities in three out of the ten stations, the highest value being in Mila 9 2 station (64000 ind/m^3). The lowest values were recorded in stations located in the middle part of the Romania marine coast (Fig.8).

The mesozooplankton component recorded density variations, with the maximum recorded in Constanta North 2 (27031 ind/m^3), in Sulina 2 and Mila 9 2 stations registering the lowest values (Fig.9).

Macrozooplankton was best represented in station Eforie South 2 (11.09ind/m^3), and no jellyfish species were identified in station Portita 2. The lowest densities were registered in stations Mangalia 2 and Vama Veche 2 (Fig.10).

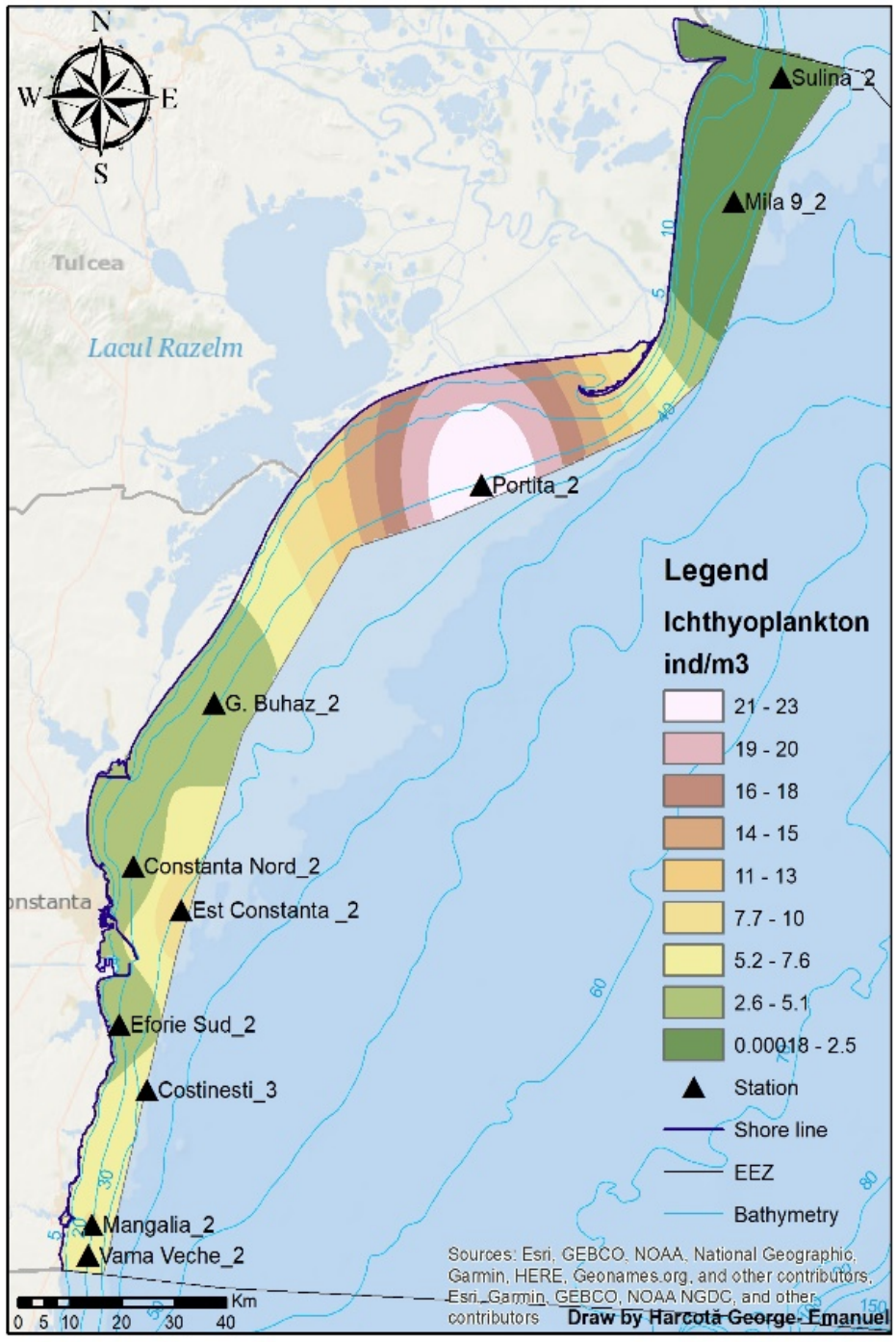

Fig.7. Distribution of ichthyoplankton densities in the Romanian Black Sea area

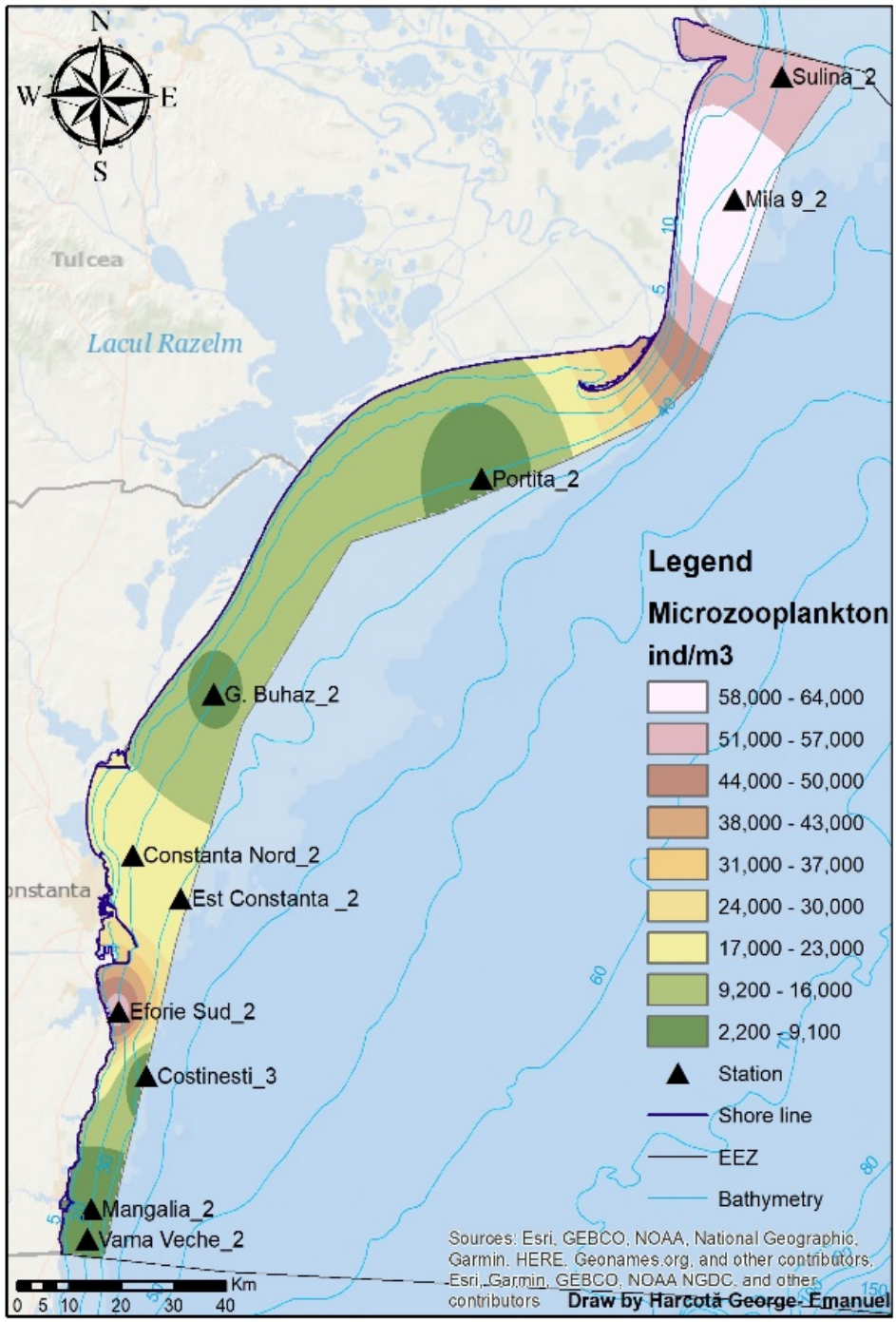

Fig.8. Distribution of microzooplankton densities in the Romanian Black Sea area

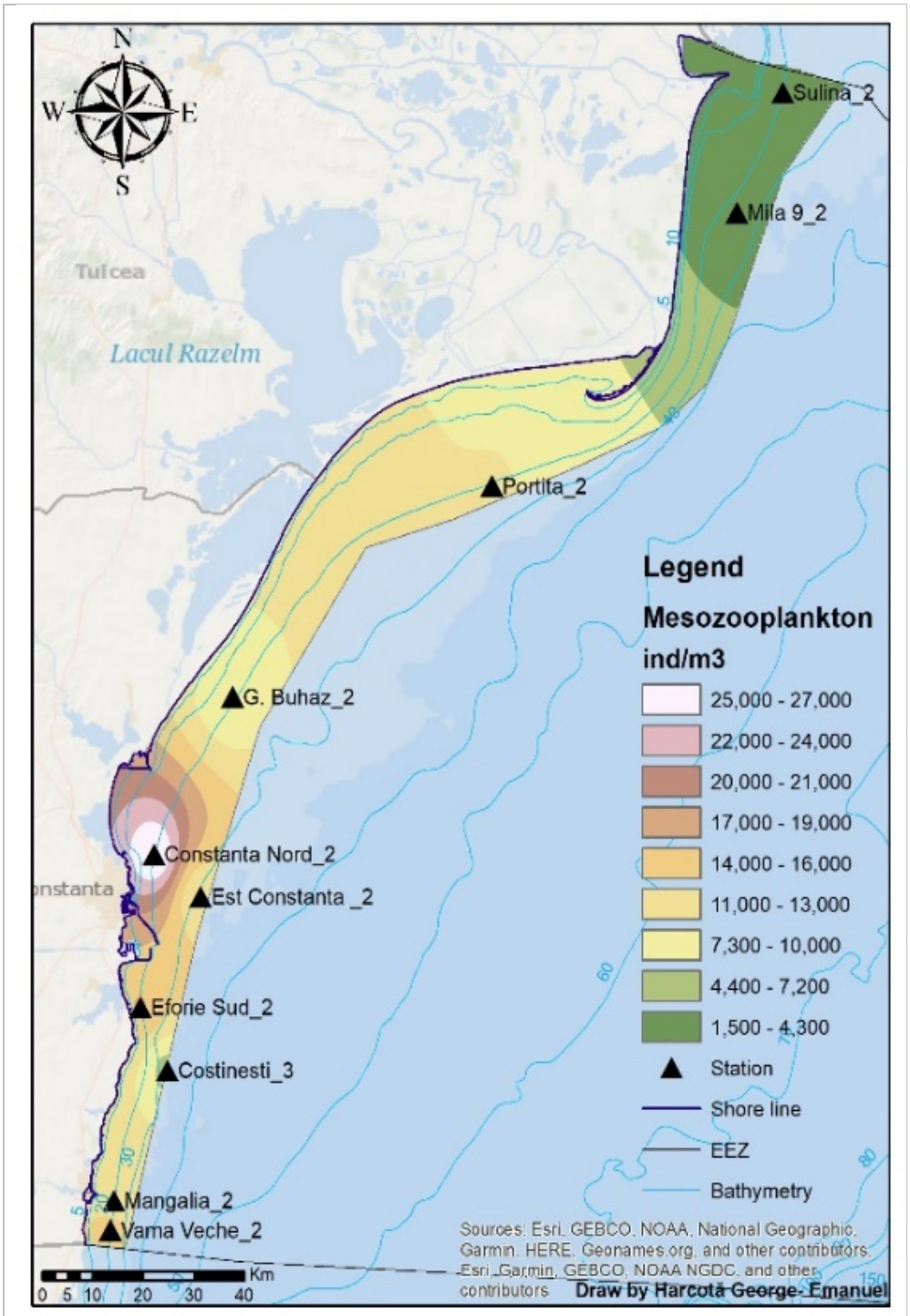

Fig.9. Distribution of mesozooplankton densities in the Romanian Black Sea area

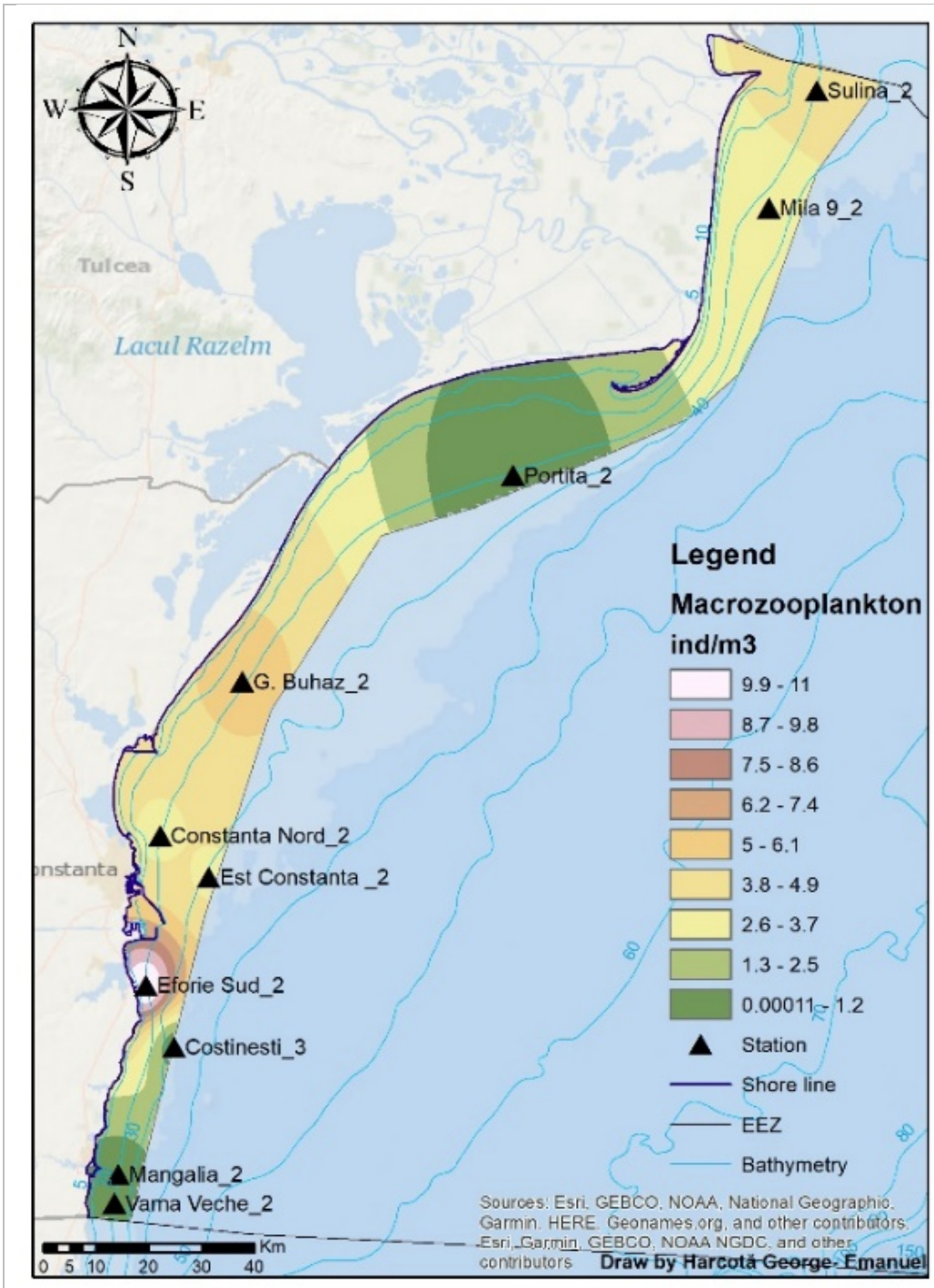

Fig.10. Distribution of macrozooplankton densities in the Romanian Black Sea area

Obviously, there is a direct cause-effect relationship between ichthyoplankton and its main food source: micro- and mesozooplankton (Fig.11). When abundance of trophic zooplankton components is high, the ichthyoplankton abundance is low (Fig.11).

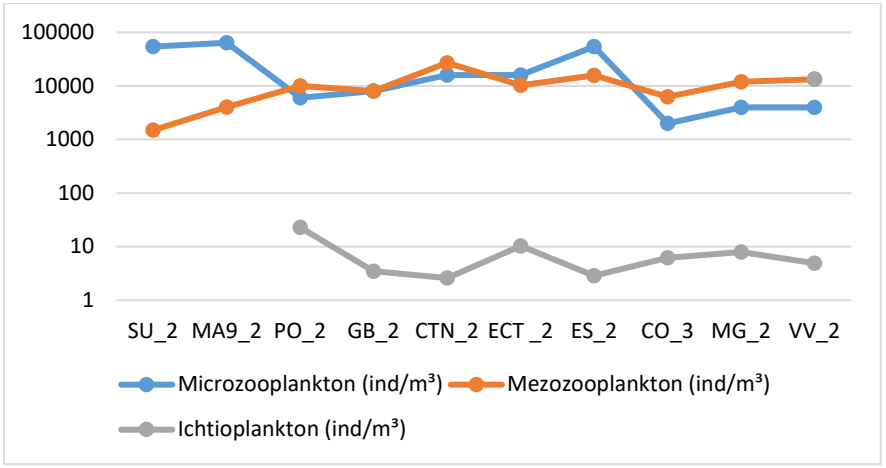

Fig. 11. Direct relationships between microzooplankton, mesozooplankton and ichthyoplankton density

Also, there is a direct relationship between macrozooplankton and ichthyoplankton, showing that ichthyoplankton as well as the other analysed zooplankton components represents a valuable food source for macrozooplankton (Fig. 12).

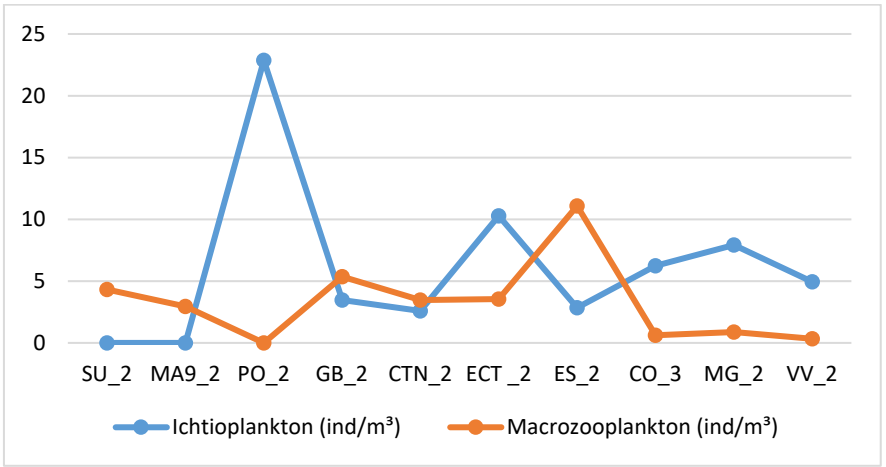

Fig. 12. Direct relationships between macrozooplankton and ichthyoplankton density

Significant correlations ($p < 0.05$) occurring between planktonic components, evinced specific trophic chains, such as: micro-ichthyo-macrozooplankton and micro-meso-macrozooplankton, macrozooplankton being the final link for both trophic chains (Table 1).

Table 1. Correlations between ichtyoplankton and the other planktonic components

	Microzoo plankton (ind/m³)	Mezozoo plankton (ind/m³)	Ichthyo plankton (ind/m³)	Macrozoo plankton (ind/m³)
Microzooplankton				
Mezozooplankton	-0.16			
Ichthyoplankton	**-0.68**	0.21		
Macrozooplankton	0.64	0.02	-0.51	

A similarity of 0.88 was registered between stations Sulina 2, Mila 9 2, Portita 2, Gura Buhaz 2 since they are included in the same marine reporting unit-waters with variable salinity. The other stations included in other marine reporting unit (coastal waters), recorded high similarities of 0.80 (Constanta North 2 - East Constanta 2) and 0.96 between Mangalia 2 and Vama Veche 2 (Fig.13).

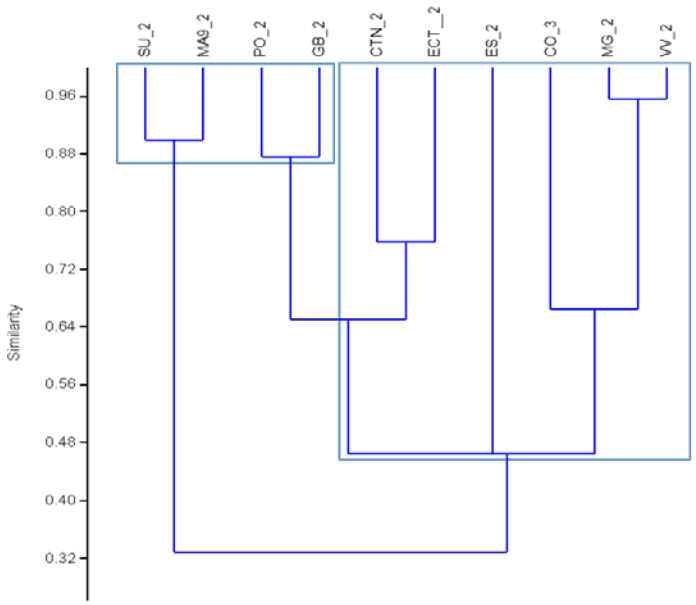

Fig. 13. Bray-Curtis similarity between stations based on plankton density

There is an obvious gradient from the Northern to the Southern part, the environmental conditions influencing the structure of the planktonic communities. In waters with variable salinity, there are species appearing mainly in samples influenced by freshwater input, which are often associated with nutrient enrichment (Kotov et al., 2016), planktonic communities being composed from both freshwater and marine species. In coastal waters, community structure is based mainly on marine species.

CONCLUSIONS

Microzooplankton and mesozooplankton were best represented from both qualitative and quantitative point of view, leading to a balanced trophic base for ichthyoplankton.

There is a direct cause-effect relationship between ichthyoplankton and the other trophic planktonic components. When abundance of trophic zooplankton is high, the ichthyoplankton abundance is low and vice-versa.

Another direct relationship was observed between macrozooplankton on one hand and ichthyoplankton, mesozooplankton and microzooplankton on the other hand. The occurrence of macrozooplankton in the same analysed area influences the ichthyoplankton's community structure as well as the other two planktonic components (micro and mesozooplankton), leading to the conclusion that microzooplankton feeds on the other three components.

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