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INTER-RELATIONS BETWEEN THE MESOZOOPLANKTON COMMUNITY AND *SPRATTUS SPRATTUS* FROM THE ROMANIAN BLACK SEA AREA

Elena BISINICU[1], Aurelia TOTOIU[1], Florin TIMOFTE[1], George-Emanuel HARCOTA[1], Lucian OPREA[2]

[1]National Institute for Marine Research and Development "Grigore Antipa" Constanta, 300 Mamaia Blvd, 900581, Constanta, Romania
[2]Dunărea de Jos" University of Galati, Faculty of Food Science and Engineering, 47 Domnească Street, 800008, Galati, Romania

Corresponding author e-mail: ebisinicu@alpha.rmri.ro, bisinicu.elena89@yahoo.com

Abstract

Sprat is a small pelagic species, with a key-role in the marine ecosystem, acting as a link between plankton and production on higher trophic levels. Sprat individuals collected from stations along the Romanian Black Sea coast were measured and weighted and the food array was performed by analyzing the stomachal content. Sprat fed on a broad diversity of mesozooplankton components, such as copepods, cladocerans and meroplankton. Analyzing the mesozooplankton component, copepods and meroplankton represented the bulk of the community in the area. Variability in zooplankton abundance may create a pressure on the feedıng conditions for sprat populations.

Key-words*: Black Sea, food array, mesozooplankton, sprat, stomachal content.*

INTRODUCTION

Marine pelagic species, sprat - *Sprattus sprattus* is among the main zooplankton consumers in the Black Sea, forming alone the trophic base for several fish species.
Sprat (Figure 1) competes for food with other planktivorous organisms such as small pelagic fishes, juveniles, and gelatinous zooplankters (Mihneva et al., 2015).

Figure 1. *Sprattus sprattus*

Sprattus sprattus is a keynote species in the Black Sea, and stock dynamics is highly affected by the fisheries and environmental condition (Nicolae et al., 2018; Raykov et al., 2019).
In the daytime, it keeps to bigger depths and in the night, comes to surface**.** It forms important agglomerations and performs unregulated migrations between nutrition areas and spawning places determined by temperature conditions.
In the spring there is a tendency of movement towards the coast and northwards and toward offing in the autumn, but there are not specific migrations of spawning or feeding. Mostly, adults tend to remain under the thermocline, penetrating above its only in the spring and autumn (Totoiu et al., 2017).
Research on the food component of the sprat has shown that it is a planktivorous fish and consumes copepods, cladocera, eggs of various crustaceans, Balanus nauplii and cypris, Mytilus veligers, and in the summer months it descends close to the bottom, consuming Myside (Porumb, 1977).
Sprat passes to exogenous feeding at a length of 6.7 mm. The larvae feed on diatoms, flagellates, eggs, and young stages of copepods. Large larvae of sprat feed only on zooplankton. Sprat

20.30 mm in length consume nauplii and copepodite stages of copepods, mollusk larvae and eggs of invertebrates. The most common food items of 30 mm and longer (adult inclusive) sprat are calanoids, *Pseudocalanus* mainly in winter, *Eurytemora* and *Acartia* mainly in summer and autumn. In summer, cladocerans (*Bosmina, Evadne* and *Podon*) also occur in the food (Ojaveer and Aps, 2003). Many studies document that sprat feeds preferably on large coldwater zooplankton such as *Calanus euxinus*, *Pseudocalanus elongatus* and *Parasagitta settosa* in the Black Sea. The eurytherm copepods (*Acartia spp*.) and meroplankton larvae can represent an important food component, especially in the young individuals' diet (Mihneva et al., 2015).
The mesozooplankton consists of pelagic organisms, mainly by copepods, cladocerans, meroplanktonic larvae of benthic invertebrates, and other groups, constituting the fodder component.
In the Black sea mesozooplankton includes *Noctiluca scintillans*, representing the non fodder component.
Despite of the fact that this prevalent species is classified as a genus of heterotrophic, pigment-less dinoflagellate alga, it has traditionally been monitored as a member of the mesozooplankton community. This is a consequence of its non-photosynthetic, heterotrophic lifestyle and its large size (200-700 μm), corresponding to the size/length of mesozooplankton organisms.
Knowledge of zooplankton dynamics is essential for understanding the pelagic ecosystem. For instance, availability of suitable zooplankton affects growth and survival of fish that feed on it as well as variations in zooplankton abundance and community composition may affect recruitment of important commercial fish species, in both open and coastal waters (Díaz-Gil et al., 2014, Nicolae et al., 2015).
Zooplankton communities are also of great interest as potential indicators of climate change in the marine environment (Hays et al., 2005).
Mesozooplankton have vital importance in the feeding of commercially valuable fish species and their larvae. Mesozooplanktonic organisms occupy, according to their size range and variety of feeding habits, a key position in pelagic food webs, representing the food source of small pelagic fishes (Alcaraz and Calbet, 2009)
Among the biotic factors, the mesozooplankton structure is closely linked to dynamics of sprat weight, condition factor, stomach fullness index and fat accumulation (Mihneva et al.,2015).
The zooplankton' s presence and abundance are the reason why fish species find in the Black Sea Romanian waters the most favorable area for feeding, reproduction and growth (Porumb F., 1986).
The aim of this paper was to record information of mesozooplankton's diversity and to identify the food composition of sprat, providing data regarding the diet description for this pelagic fish in the Romanian Black Sea area. Feeding behaviour of sprat in relation to size, as well as abundance, composition and distribution of potential prey could be established.

MATERIALS AND METHODS

Both mesozooplankton and sprat samples were collected from stations located along the Romanian Black Sea coast (Figure 2), during surveys organized by NIMRD in the warm season of 2019. The collected samples were preserved in formaldehyde for further analysis in the laboratory.

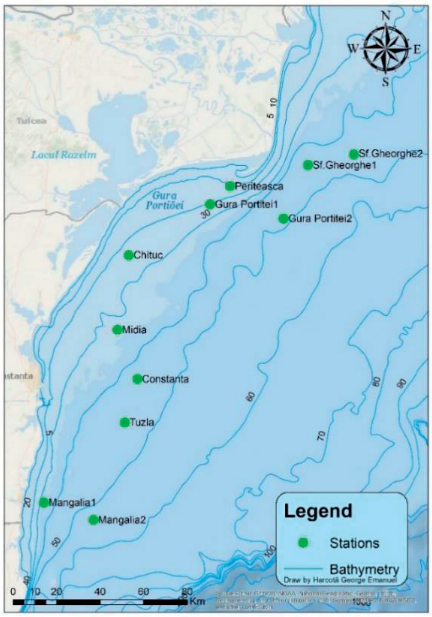

Figure 2. Map of sampling stations

Sampling of sprat was made using the pelagic trawl for juveniles by surface trawling (0-5m) at 1.5-2 Nd speed, the duration of the trawling being 15 minutes and the horizontal opening of the 14 m trawl (Figure 3).

Figure 3. Trawl for sprat sampling

Collecting of mesozooplankton samples was performed using a Juday net (0.1 m^2 mouth opening area, 150 μm mesh size) by vertical hauls (Figure 4).

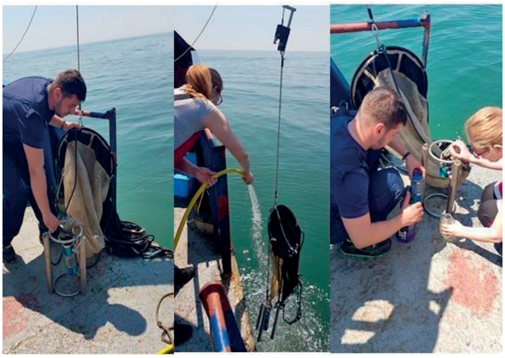

Figure 4. Mesozooplankton sampling

According to the methodology, the mesozooplankton sample was homogenised, and quantitative and qualitative processing was performed in the Bogorov chamber, under Olympus SZX10. 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 examined in a Petri dish (Figure 5).

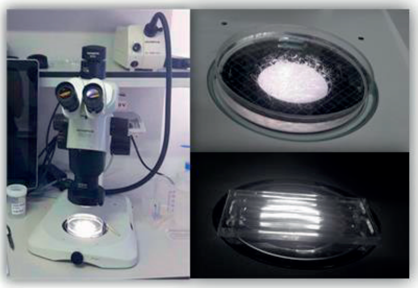

Figure 5. Analysis of mesozooplankton samples

The number of individuals and mean individual weights were used for estimating the density as $ind{\cdot}m^{-3}$, respectively the biomasses as $mg{\cdot}m^{-3}$ wet weight (Korshenko and Alexandrov, 2014). The study of the food array was performed by analyzing the gastro-intestinal content at sprat (Figure 6).

The length of each sprat specimen was measured, each fish was weighted, and after dissection the stomach was removed and stored in formalin solution until identification. The stomachs were cut longitudinally, and the contents of each stomach were transferred to a petri dish and identified under a binocular microscope (Figure 5). Food remains, which were not recognizable due to an advanced stage of digestion, were recorded as semi digested food. The qualitative analysis consisted of a complete identification of the organisms in the gut contents.

Figure 6. Sprat stomachal content analysis

A hierarchical cluster analysis was performed using the Bray-Curtis similarity in PRIMER. The data were square-root-transformed to handle zero-inflation and the few large values typical for density data sets, and standardized by range, which is one of the possible standardizations for the Bray-Curtis similarity coefficient.

RESULTS AND DISCUSSIONS

The mesozooplankton was represented by 17 species. Copepoda represented the bulk of the community, with seven species, followed by the meroplanktonic component with five species (Table 1).

Among the marine zooplankton, copepods are the most familiar and dominant constituent since they comprise around 55-95% of the total zooplankton abundance in the marine pelagic system (Angara, 2013)

Cladocera was represented by one species and other groups by three species (Table 1).

Table 1. List of identified mesozooplanktonic species

No.	Scientific Name Accepted	Scientific Name Author	Phylum	Class	Order
1	*Noctiluca scintillans*	Macartney Kofoid & Swezy, 1921	Myzozoa	Dinophyceae	Aphragmophora
COPEPODA					
2	*Acartia (Acartiura) clausi*	Giesbrecht, 1889	Arthropoda	Hexanauplia	Calanoida
3	*Pseudocalanus elongatus*	Boeck, 1865	Arthropoda	Hexanauplia	Calanoida
4	*Paracalanus parvus*	Claus, 1863	Arthropoda	Hexanauplia	Calanoida
5	*Centropages ponticus*	Karavaev, 1895	Arthropoda	Hexanauplia	Calanoida
6	*Calanus euxinus*	Hulsemann, 1991	Arthropoda	Hexanauplia	Calanoida
7	*Oithona similis*	Claus, 1866	Arthropoda	Hexanauplia	Cyclopoida
8	*Harpacticoida*	Sars M., 1903	Arthropoda	Hexanauplia	Harpacticoida
CLADOCERA					
9	*Pleopis polyphemoides*	Leuckart, 1859	Arthropoda	Branchiopoda	Onychopoda
MEROPLANKTON					
10	Bivalvia	Linnaeus, 1758	Mollusca	Bivalvia	
11	Gastropoda	Cuvier, 1795	Mollusca	Gastropoda	
12	Polychaeta	Grube, 1850	Annelida	Polychaeta	
13	Balanus	Costa, 1778	Arthropoda	Hexanauplia	Sessilia
14	Decapoda	Latreille, 1802	Arthropoda	Malacostraca	Deacpoda
OTHER GROUPS					
15	*Parasagitta setosa*	J. Müller, 1847	Chaetognatha	Sagittoidea	Aphragmophora
16	*Oikopleura (Vexillaria) dioica*	Fol, 1872	Chordata	Appendicularia	Copelata
17	*Mesopodopsis slabberi*	I. Van Beneden, 1861	Arthropoda	Malacostraca	Mysida

Regarding the mesozooplankton quantitative structure, the non fodder component recorded the highest density values in Mangalia, Midia and Gura Portitei 2, in the other sampling stations reaching lower densities (Figure 7).

Acartia clausi and *Pseudocalanus elongatus* had the highest density values in Periteasca station, being dominant species in all the analysed samples, the other copepods recording lower density values (Figure 7).

Bivalvia and Balanus which belong to the meroplanktonic component, were best represented from the quantitative point of view in Periteasca, Gura Portitei 1 and Chituc stations.

From other groups, *Oikopleura dioica* was the species with the highest density values, the other two species recording low density values (Figure 6).

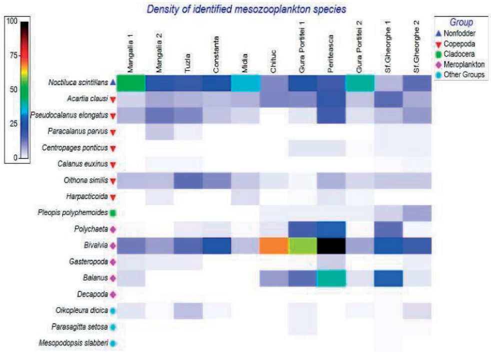

Figure 7. Shade plot showing the density (ind·m^{-3}) of mesozooplankton species

Analysing the similarities between the sampling stations, Chituc and Gura Portitei 1 have a similarity of over 90% (Figure 7). This is due to the fact that in these stations the mesozooplanktonic component was best represented from the quantitative point of view. High similarities (80%) were recorded between Sf. Gheorghe 2 and Constanta stations and Mangalia 2 and Tuzla, mainly driven by the species densities in the area (Figure 8). The more abundant a species is within a group or analysed area, its contribution to the intragroup similarities will be of great importance.

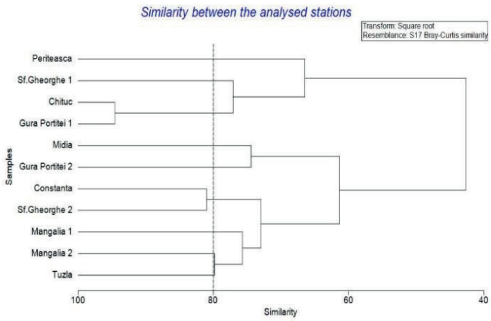

Figure 8. Bray-Curtis similarity matrix between the sampling stations

For the identification of sprat stomachal content, 100 fishes with length between 60-100 mm and a medium weight between 1.51-4,17 gr were analysed (Figure 9). Sprat, as a cold-water species attains much higher biomass during cold years and lower biomass in warm years (Shiganova and Öztürk, 2010).

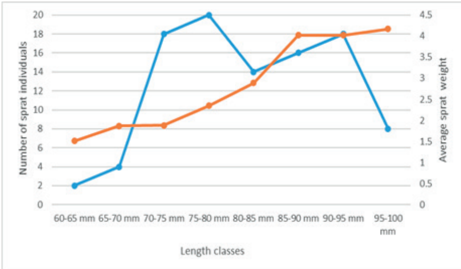

Figure 9. Distribution of average no. samples and medium weight of *Sprattus sprattus by* length classes

After analysing the sprat's stomachal content, species belonging to Copepoda, meroplankton and other groups were identified.

The major groups/species found in the sprat's stomach were represented by the following: Copepoda (a) Bivalvia (b) , Balanus nauplii (c), Balanus cypris (d), *Oikopleura dioica* (e) (Figure 10).

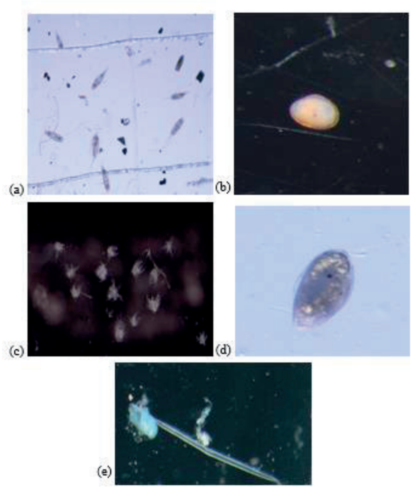

Figure 10. Major mesozooplankton groups/species found in the sprat's stomach

Individuals of *Sprattus sprattus* consumed mainly Copepoda species and food elements that belong to the meroplanktonic component. The highest consumption of copepods was in Periteasca, followed by Gura Portitei and Mangalia 1 and Midia (Figure 11).

From the meroplanktonic components, Bivalvia was highly consumed by sprat in Mangalia 1, Midia and Chituc. Balanus nauplii were preferred as food source only in three stations (Mangalia, Midia, Chituc) while the cypris stage was consumed only in Midia station (Figure 11).

Oikopleura dioica was found in the stomachal content at sprat from Periteasca station. Sprat individuals presented semidigested food in stations Gura Portitei, Sf.Gheorghe 1 and Sf.Gheorghe 2 (Figure 11).

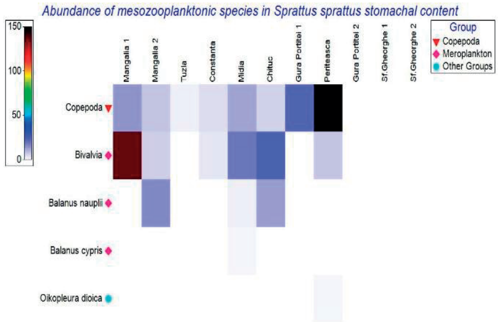

Figure 11. Shade plot showing the mesozooplanktonic species consumed by *Sprattus sprattus*

The Bray-Curtis matrix showed a very high similarity between Periteasca, Gura Portitei 1 and Tuzla stations since in this stations, sprat preferred Copepoda as a major source of food (Figure 12). Another high similarity was between Mangalia 2 and Chituc and Constanta and Midia. In these stations, sprat individuals consumed copepods and meroplanktonic components in similar quantities (Figure 12).

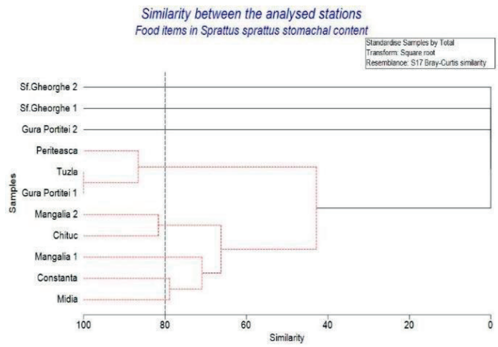

Figure 12. Similarity matrix between the stations based on the *Sprattus sprattus* stomachal content

Copepods are the most important mesozooplanktonic group constituting the primary food supply of fish larvae. Many organisms of commercial importance in many parts of the world depend mostly on copepods as a food source at the planktonic larvae stage (Yildiz and Feyzioğlu, 2014).

CONCLUSIONS

The mesozooplankton community was represented by 17 species. Copepoda represented the bulk of the community, with seven species followed by the meroplanktonic component with five species.

From the quantitative point of view, Copepoda and the meroplanktonic elements recorded the highest density values in all the analysed stations.

Stomach content analysis showed that Copepoda was preferred as food source, being followed by meroplankton.

Bivalvia was main source food for *Sprattus sprattus,* other organisms such as Balanus nauplii and Balanus cypris stages being consumed in smaller quantities.

Copepods were consumed in high amounts in Periteasca, Gura Portitei, Mangalia 1 and Midia.

Bivalvia was highly consumed in Mangalia 1, Midia and Chituc. Balanus nauplii were preferred as food source only in three stations (Mangalia, Midia,Chituc) while the cypris stage was consumed only in Midia station.

The Bray-Curtis matrixes showed that the analysed stations recorded high similarities driven mainly by the species abundance values, both for the mesozooplankton community and for the food items consumed by *Sprattus sprattus* individuals.

Taking into considerations the analysis we made, we conclude that the production of species involved in the trophic chain mesozooplankton organisms) represent a trophic base proper for the fish nutrition and lead to a good environment in which the sprat can develop in proper conditions appropriate for growth, reproduction and new generations sustainability.

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