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Quantitative and Qualitative Analysis of Juvenile Fish Populations of the Romanian Black Sea Coast during 2016 -2017

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Abstract. The quantitative and qualitative analysis of juvenile stages of the most important fish species is essential for the study of fish stocks. Between 2016 and 2017, studies were carried out to determine the distribution and abundance of sprat, anchovy, horse mackerel and whiting juveniles, which showed variations between the two years. Fish species stocks in the Romanian waters have been investigated in relation with abiotic environmental conditions and the evolution of the trophic base. During 2016 - 2017, four research surveys at sea were organized with the research vessel "Steaua de Mare 1" in Romanian waters, as following: in May 2016 and May 2017 - 5 working days with pelagic trawl for sprat and whiting juveniles; in September 2016 and September 2017 - 5 working days with pelagic trawl for anchovy and horse mackerel juveniles. Sampling of juvenile fish samples was made using the pelagic trawl for juveniles by surface trawling (0-5 m) at 1.5-2 knots speed, the duration of the trawling being 15 minutes and the horizontal opening of the trawl 14 m. Using observations recorded in 2016 and 2017, it can be said that the state of the fish stock is quite unstable, with major fluctuations from one year to another, caused by environmental modification and fishing pressure on the fish populations. These short lived pelagic species require environmentally friendly reproductive growth and development conditions, as well as commercial fishing measures for ensuring restocking and increase of stocks.

Keywords: analysis, juvenile, fish, abundance, biomass, environmental modification

Introduction

The research of fish juveniles in the Romanian marine area contributes to the knowledge of the changes that occurred in the qualitative and quantitative structure of the ichthyofauna, as well as in the behavior of the different species of fish (Radu et al. 2002, 2004, 2007, 2008a). The biological and ethological characteristics of the species, the ecological links between commercially important species and the auxiliary species are important elements for their conservation and management. A first measure to conserve species and maintain population density is to establish the level of completion. Under these circumstances, the study of the distribution and abundance of juvenile fish species is an important part of determining the status of the populations of the species concerned (Radu et al., 2008b).

The qualitative and quantitative structure of the catches recorded in the Romanian marine area had a variable evolution depending on the state of the fish populations, the fishing effort deployed, the type of gear used and the conditions for the formation and maintenance of the fish agglomerations, especially in the coastal

zone. Small pelagic fish species of economic interest in the Romanian marine area are generally characterized by: a short life cycle, early sexual maturity, spawning every year, with egg-laying in portions in some species, with populations composed of a small number of age groups (Nikolski, 1962).

At the Romanian Black Sea coast, the most important small pelagic species from the commercial point of view are sprat (*Sprattus sprattus*), anchovy (*Engraulis encrasicolus*) and horse mackerel (*Trachurus mediterraneus ponticus*).

Sprattus sprattus (Linnaeus, 1758) is a marine small pelagic species. It forms important agglomerations and performs unregulated migrations between foraging areas and spawning places determined by temperature conditions. In spring there is a tendency of movement of the shoals towards the coast and northwards and towards the offing in the autumn, but there are not exist specific migrationsfor spawning or feeding. Sprat winters in the offing at depths of 80-100 m; in April - May, it nears the littoral area in exploitable quantities, while in summer it avoids high water temperature by performing migrations from the coast to the offing (Radu et al., 1998; Maximov et al., 2011).

Engraulis encrasicolus (Linnaeus, 1758) is a marine, pelagic, gregarious, coastal species, forming large schools. Migrations are irregular, from open sea to the coast and vice versa, depending on water temperature and food. In March - April (when water reaches the temperature of 13-14°C), it migrates from the northern part to the western and eastern Black Sea coasts, where it feeds intensively. Migration for wintering begins in October and follows the same route. Larvae and juveniles are mostly found in the spawning area, where they also feed (Radu et al., 2011).

The occurrence of *Trachurus mediterraneus ponticus* (Aleev, 1956) at the Romanian littoral is closely related to water warming up to 14°C in the last decade of May. The nearness of the shoals to our littoral is favored by the salinity of 12-16‰ and southern winds. Horse mackerel remains in front of Romanian littoral until October. In this period, depending on environmental variations, horse mackerel shoals perform movements on the whole littoral between the coast and open sea (Radu et al., 1998; Maximov et al., 2011).

Material and Method

For correctly assessing the tendencies and changes occurring in the stocks abundance from one survey to the other, or from one year to the other, standard fishing and assessment techniques were utilized, so that the results can be reproduced and compared.

In order to determine the intensity of the sprat, anchovy and horse mackerel stock completion at the Romanian littoral, the results of four complex research surveys conducted at sea in May 2016 and 2017, September 2016 and 2017 were analysed by the team of the National Institute for Marine Research and Development "Grigore Antipa" Constanţa. 144 sampling hauls were performed with the Danilevski pelagic trawl, designed by the Institute’s specialists, using the research vessel “Steaua de Mare 1” (Fig. 1).

The sampling of juvenile fish was made using the pelagic trawl for juveniles by surface trawling (0-5 m) at 1.5-2 kts speed, the duration of the trawling being 15 minutes and the horizontal opening of the 14 m trawl (Fig. 2).

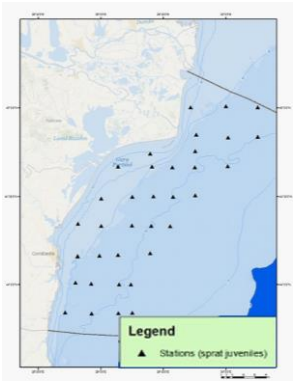

Fig. 1. Research vessel "Steaua de Mare 1" and distribution of the sampling points.

Fig. 2. Fishing activity with pelagic trawl for fish juveniles.

The biological samples were analysed in the laboratory to establish the quantitative structure of species. The results were expressed as number of specimens/hauling and ind./SqNm and were used to determine the completion of each fish species' stocks.

The distribution of juveniles was done by marking on the distribution maps the catch values obtained through sampling hauling with the juvenile trawl. Taking into consideration that during sampling for fish juveniles were observed high quantities of jellyfish, the latter's biomass was also calculated in the surveyed area, establishing the influence degree on juveniles' agglomerations.

Results and discussions

As a follow-up of analyzing the 144 samples collected during 2016-2017, the following species' juveniles were emphasized: sprat, anchovy and horse mackerel, along with whiting (*Merlangius merlangus euxinus* Nordmann, 1840)

The values of sprat juveniles' catches ranged from one station to the other and from on year to the other. 2016 was quantitatively more representative compared to 2017. The estimated relative abundance for sprat juveniles in May 2017 was less than 57 times than in the same period of the previous year. Sprat juveniles' catch was 239 times higher in 2016 than in 2017, and its abundance 61 times higher (Fig 3).

At the same time, in 2017, the total biomass of jellyfish in the investigated area was 12.7 times higher than in 2016, reaching 268,345 tons. The jellyfish average in 2017 (t/SqNm) was 18 times higher at depths exceeding 30 m (Fig. 4).

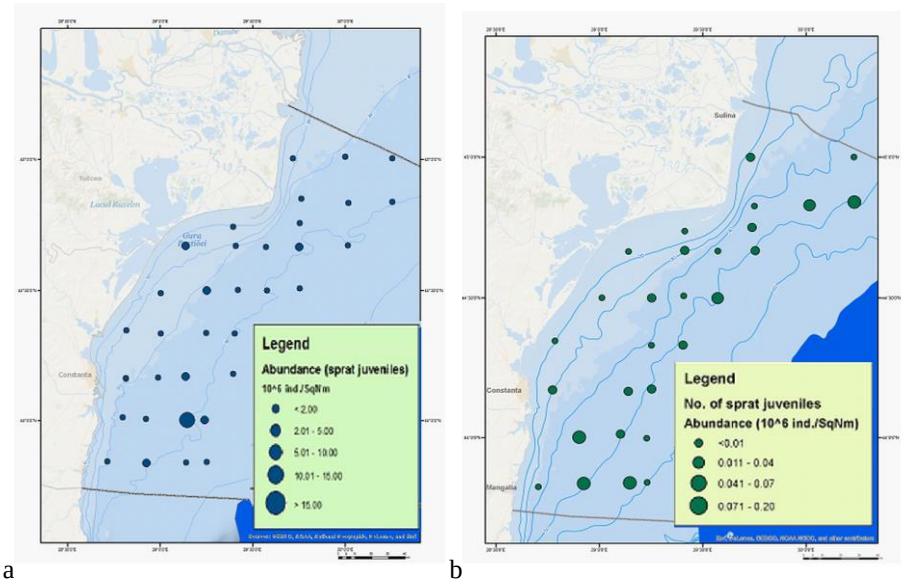

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Fig. 3. Distribution of sprat juveniles' ABUNDANCE during 2016 (a) - 2017 (b).

In addition to juvenile sprats in the samples collected in April 2017, specimens of whiting juveniles were also identified. Their total abundance was 0.00184 10^6 ind./SqNm on an area of 3,279.202 SqNm.

Table 1 comprises the results obtained in May 2016 and May 2017 for sprat and whiting juveniles. By comparing the two analysed periods, the very low values of catches for May 2017 stand out.

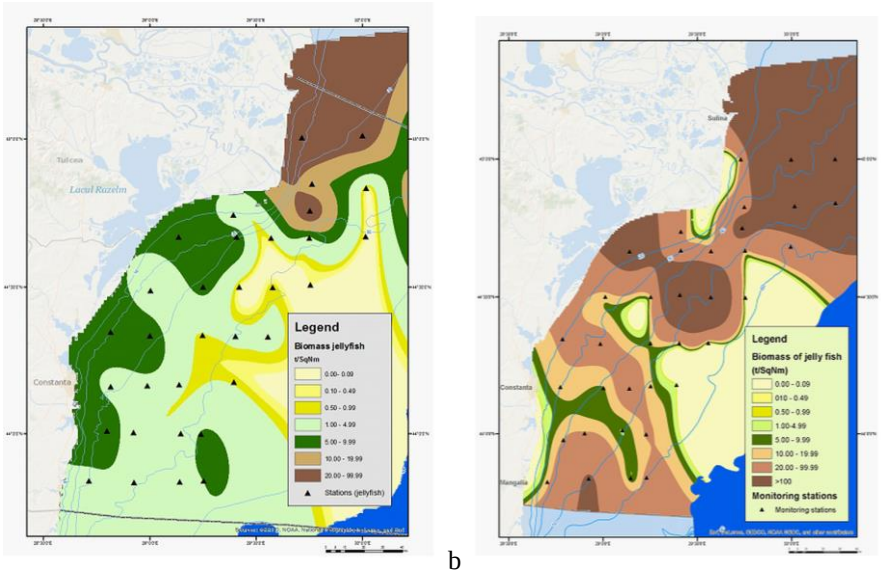

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Fig. 4. Distribution of jellyfish AGGLOMERATIONS during 2016 (a) - 2017 (b).

Table 1. Quantitative analysis of sprat and whiting juveniles in May 2016 and May 2017.

Sprat juveniles	**Depth (m)**	**2016**	**2017**
Average catch (t/Nm^2)	0-30 m	0.544153	0.006132881
	30-60 m	1.580497	0.0054
	Total	**1.378986**	**0.005767698**
Average catch (10^6 ind./SqNm)	0-30 m	0.727544	0.009373
	30-60 m	1.401161	0.022685
	Total	**1.270170**	**0.0209001**
Total catch in the investigated area (t)	0-30 m	414.7943	4.6749423
	30-60 m	3977.9967	13.59262
	Total	**4521.973783**	**18.9134486**
Total catch in the investigated area (10^6 ind.)	0-30 m	554.5888	7.144711
	30-60 m	3526.6222	57.096
	Total	**4165.144793**	**68.53586**
Whiting juveniles	**Depth (m)**	**2016**	**2017**
Average catch (t/Nm^2)	0-30 m	0	0.00193537
	30-60 m	0	0.00075524
	Total	**0**	**0.000630**
Average catch (10^6 ind./SqNm)	0-30 m	0	0.000135
	30-60 m	0	0.001069
	Total	**0**	**0.0088678**
Total catch in the investigated area (t)	0-30 m	0	1.475285
	30-60 m	0	1.9008874
	Total	**0**	**2.065999**
Total catch in the investigated area (10^6 ind.)	0-30 m	0	0.103135
	30-60 m	0	2.689553
	Total	**0**	**2.907914**
Jellyfish	**Depth (m)**	**2016**	**2017**
Average catch (t/Nm^2)	0-30 m	11.86096	41.7164731
	30-60 m	5.1333744	90.775
	Total	**6.441813**	**81.832447**
Total in the investigated area (t)	0-30 m	9041.31	31799.4245
	30-60 m	12921.00	228474.742
	Total	**21124.01**	**268345.126**

Anchovy juveniles were more present in the samples analyzed in 2016 compared to the samples collected and analyzed in 2017.

The biomass of anchovy juveniles was 79.673816 t/area surveyed in September 2016 and 10.588375 t/area surveyed in September 2017 (Fig. 5). Average catches ranged from 0.024296 t/SqNm in 2016 and 0.003228 t/SqNm in 2017.

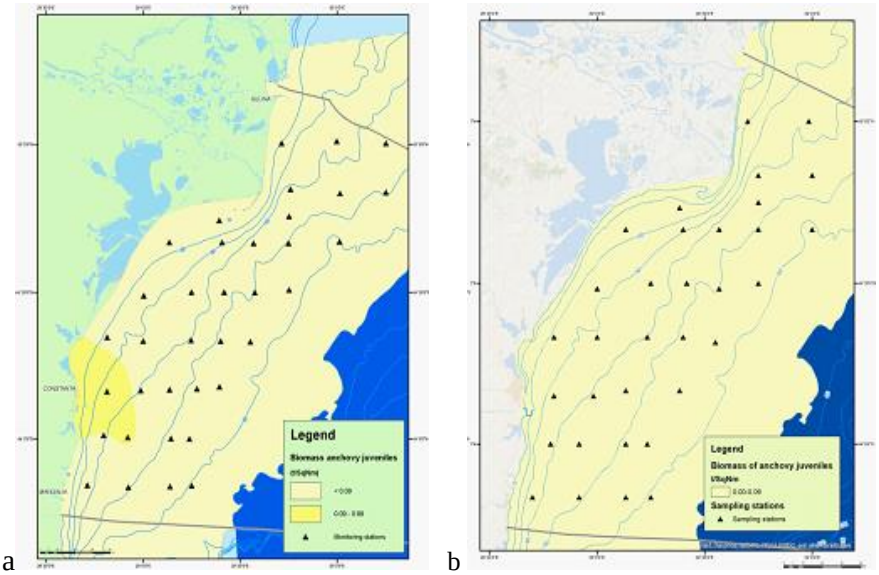

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Fig. 5. Distribution of anchovy juveniles' BIOMASS during 2016 (a) - 2017 (b).

The average catch was 0.05439 10^6 ind./SqNm in 2016 and 0.002546 10^6 ind./SqNm in September 2017 (Fig. 6).

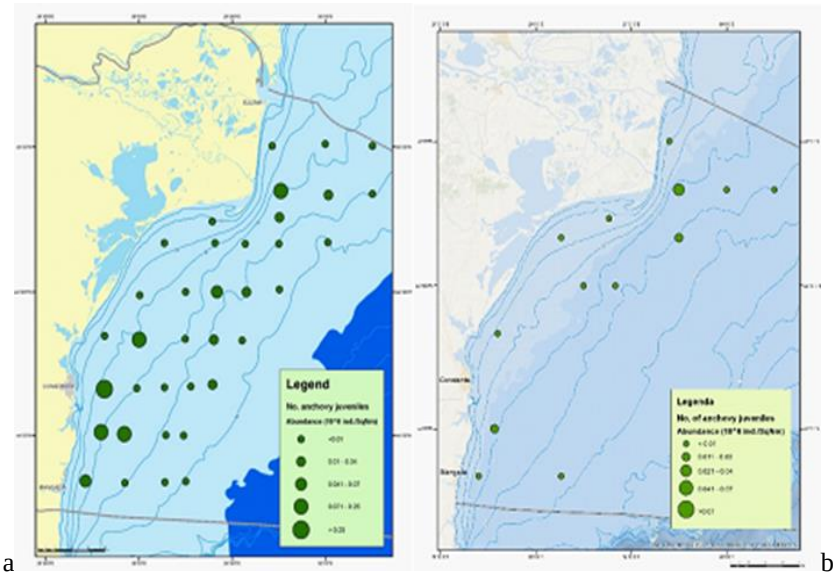

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Fig. 6. Distribution of anchovy juveniles' ABUNDANCE during 2016 (a) - 2017 (b).

The horse mackerel juveniles' biomass was higher in the southern part of the Romanian coast in September 2017, but with very low values over the same period analyzed in 2016. The biomass of horse mackerel juveniles was 94.311224 t/area surveyed in September 2016 and 22.113067 t/area surveyed in September 2017

(Fig. 7). Average catches ranged from 0.02876042 t/Nm^2 in 2016 and 0.00674 t/Nm^2 in 2017 (Fig. 8).

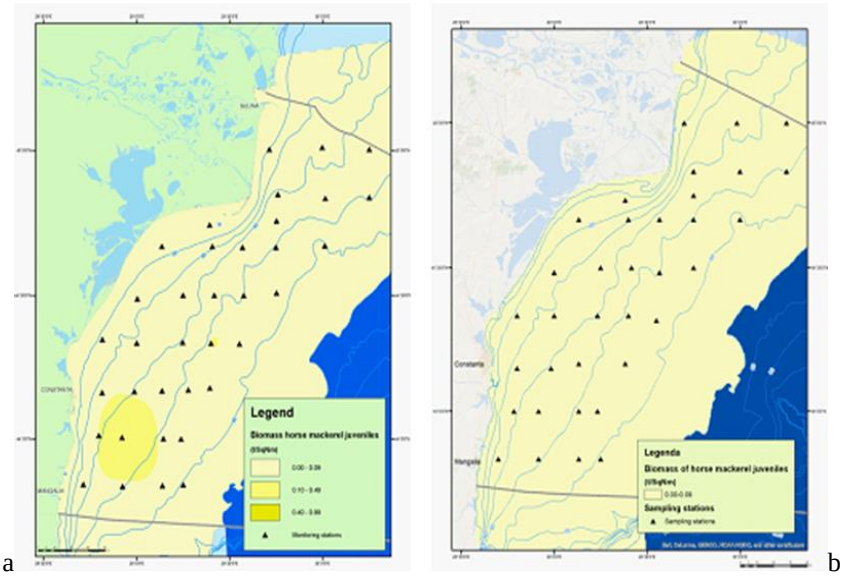

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Fig. 7. Distribution of horse mackerel juveniles' BIOMASS during 2016 (a) - 2017 (b).

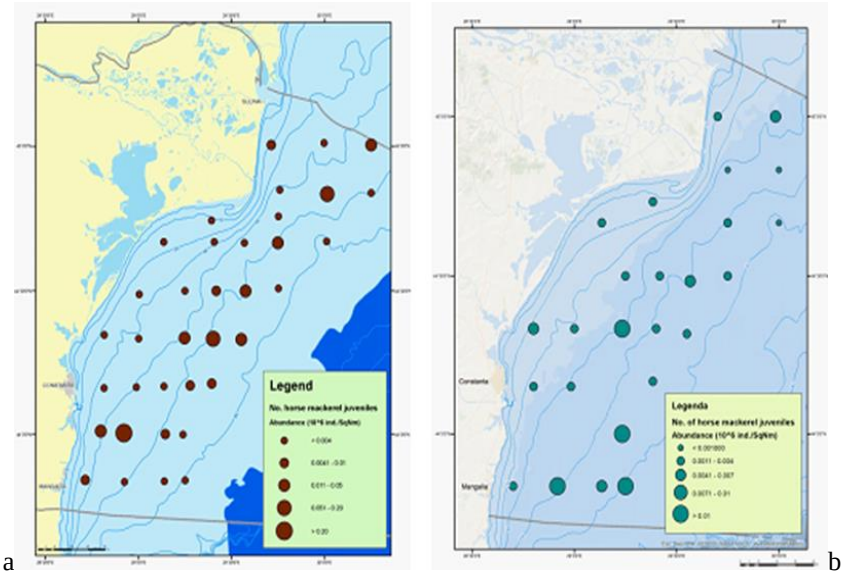

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Fig. 8. Distribution of horse mackerel juveniles abundance during 2016 (a) - 2017 (b).

In September 2017, the jellyfish biomass values were very high, especially in the northern part of the Romanian coast. The barrel jellyfish *Rhizostoma pulmo* recorded very high biomass values in the northern part of the Romanian coastal zone (8072.298 t/area surveyed) (Fig. 9).

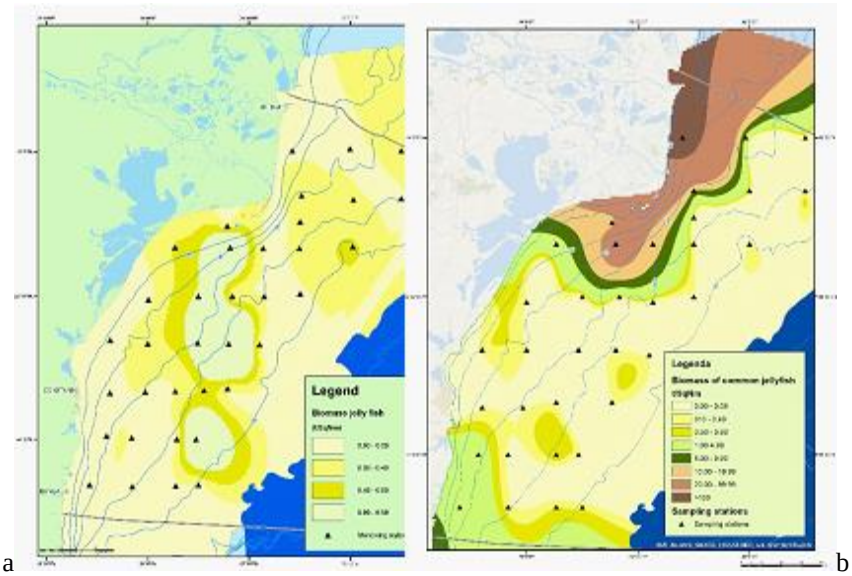

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Fig. 9. Distribution of jellyfish agglomerations during 2016 (a) - 2017 (b).

Similarly to sprat, the catch values of anchovy and horse mackerel were extremely low in 2017 compared to 2016. The occurrence of jellyfish in large amounts may be a cause of the drop in anchovy and horse mackerel catches and biomass (Table 2).

Table 2. Quantitative analysis of anchovy and horse mackerel juveniles in relation to jellyfish biomass in September 2017 and September 2017

Anchovy	**Depth (m)**	**2016**	**2017**
Average catch (t/Nm^2)	0-30 m	0.007183	0.001376
	30-60 m	0.029186	0.003599
	Total	**0.024296**	**0.003228**
Average catch (10^6 ind./SqNm)	0-30 m	0.0329	0.001104
	30-60 m	0.0605231	0.002830
	Total	**0.05439**	**0.002546**
Total catch in the investigated area (t)	0-30 m	5.47617	1.049166
	30-60 m	73.4591	9.059594
	Total	**79.673816**	**10.588375**
Total catch in the investigated area (10^6 ind.)	0-30 m	25.123292	0.85682
	30-60 m	152.3322	7.125119
	Total	**178.3806**	**8.350178**

Horse mackerel	**Depth (m)**	**2016**	**2017**
Average catch (t/Nm^2)	0-30 m	0.00114668	0.0041
	30-60 m	0.036665	0.0072
	Total	**0.02876042**	**0.00674**
Average catch (10^6 ind./SqNm)	0-30 m	0.001610993	0.001598
	30-60 m	0.033882007	0.003359
	Total	**0.0267106**	**0.003065**
Total catch in the investigated area (t)	0-30 m	0.874084	3.183853
	30-60 m	92.245523	18.264734
	Total	**94.311224**	**22.113067**
Total catch in the investigated area (10^6 ind.)	0-30 m	1.22801	1.218768
	30-60 m	85.27853	8.455400
	Total	**87.589683**	**10.053994**
Jellyfish	**Depth (m)**	**2016**	**2017**
Average catch (t/Nm^2)	0-30 m	0.474805	34.536
	30-60 m	0.490493	1.137
	Total	**0.487**	**6.704**
Total in the investigated area (t)	0-30 m	361.932346	26326.0459
	30-60 m	1234.53	2863.777
	Total	**1596.99**	**21984.4197**

Conclusions

Using observations recorded in 2016 and 2017, it can be concluded that the state of the fish stock is quite unstable, with major fluctuations from one year to another, caused by environmental modification and fishing pressure on the fish population. The fluctuations are determined both by environmental modification and fishing pressure on the population, implicitly on spawning stock. The presence of competitors for food, but also the temperature during reproduction may be the most important causes for reductions in the number of juveniles. The appearance of *Rhizostoma pulmo* jellyfish in a very large quantity, a major competitor for food, may be one of the main causes for the decrease in the number of sprat, horse mackerel and anchovy juveniles. The environmental conditions existing at the Romanian littoral allowed the formation and maintenance of very large agglomerations of gelatinous species, especially common jellyfish and barrel jellyfish. These short life pelagic species need environmentally friendly reproductive

growth and development conditions, as well as commercial fishing measures for ensuring restocking and growing stocks.

Surveys realized along of the years confirmed that productivity oscillations, namely completion volume, are closely linked with the environmental factors variation, between which decisive are water temperature and quantity and quality of the trophic base. Through modification of the spawning intensity and completion, the fish populations create adaptations of self-control of the shoal size in concordance with degree of food ensuring (Radu et al., 2017). A certain coincidence between growth of the fish juveniles and the growth of the trophic plankton sometimes constitute one of the most important factors which determine respective generation productivity, as shown by results obtained so far in the frame of the project "IntelliGent Oceanographically-based short-term fishery FORecastIng applicaTions" (GOFORIT) (Nenciu et al., 2016). Therefore, the level of completion of the small pelagic species stocks in the Romanian Black Sea waters is strongly related to the dynamics of abiotic environmental conditions and the evolution of the zooplanktonic trophic base.

Acknowledgement

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