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Research Article

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Some characteristics of epibiotic macroinvertebrates in Mediterranean mussel (*Mytilus galloprovincialis*) reared in a mariculture of Butrint Lagoon (Albanian coast of Ionian Sea)

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Abstract

The taxonomic analysis of the macroinvertebrates, which represents the association of biofouling on the mussels cultivated in the Butrint Lagoon, has identified 29 taxa that were included in 7 major taxonomic groups. The most significant number of taxa belonged to chordates (7) and molluscs (6). The seasonal average values of species diversity index (*D*) for the epibiotic macrofauna were: 0.596±0.056 (in summer); 0.638±0.078 (in autumn); 0.474±0.045 (in winter), and 0.682±0.069 (in spring). The evaluations according to seasonal averages gave the following values for the abundances (*A*,ind/0.1 m²) of epibiotic macrofauna in different parts of the mussel's strings: *A*=63.46±52.132 (upper part); *A*=49.62±42.485 (middle part) and *A*=30.49±22.004 (lower part). In the period August-October, 2023, the average values of the numerical abundance of the macroinvertebrates according to the three areas in which the mussel cultivation system is situated were: in the Manastir area, 67.3±17.085 ind/0.1m²; in "Mussel's House" area, 51.2±12.157 ind/0.1m² and in the Ksamil village area, 62.7±11.988 ind/0.1m². The analysis of variance did not confirm the significant differences between three areas (t<1.812;n=10; P>0.05).

Keywords: mussel, epibionts, biofouling, mariculture, barnacles, polychaets, numerical abundance, species diversity.

1. Introduction

Epibionts, which create biofouling, are communities of sessile organisms that use the hard surfaces of the submerged objects, including the shells of bivalve molluscs, such as mussels, to attach themselves. The composition of such communities includes algae, sponges, bryozoans, worms, barnacles, chordates, etc. Mussels provide a suitable substrate for sessile animals like anthozoans, bryozoans, hydrozoans, barnacles, gastropods or bivalves, for which the substrate is a limiting resource (Çinar et al., 2020). In the same way, mussel patches also offer benefits for mobile epifauna such as annelid polychaetes, nemertean worms, flatworms or crustaceans, since they can feed on sediment, biodepositions and other organisms that live/circulate in the mussel patches (Fernandez-Rodriguez et al., 2022).

Biofouling is a permanent component of the biological associations that are created in the system of infrastructures where mussels are cultivated, including rope or panel culture, longline culture or raft culture. The epibionts or biofouling organisms are fixed on buoys and floats, anchor blocks, pontoons, mooring lines, head ropes, culture ropes and on mussel shells—the species composition and abundance of biofouling changes in time and space. Significant temporal changes are driven by seasonality in marine invertebrate populations. The arrival of new recruits, periods of intense growth, or times of dormancy and regression all impact community development at different times of the year (Fitridge et al., 2012). Spatial variability in marine invertebrate communities varies on both the small and large scales and between temperate and tropical waters (Fraschetti et al., 2005). According to some authors (Tsuchiya, 2002; Çinar et al., 2020), the composition of macroinvertebrate groups associated with the black mussel is mainly influenced by prevailing environmental conditions and the degree of accumulation of fine particles, mainly derived from mussel faeces.

Scientific works in the field of aquaculture express different facts and opinions regarding the impacts of epibiont organisms on the infrastructure of cultivation systems, animals that are reared and production indicators. Biofouling in marine aquaculture is a specific problem where both the target culture species and/or infrastructure are exposed to a diverse array of fouling organisms, with significant production impacts. In shellfish aquaculture, the key impact is the direct fouling of stock, causing physical damage, mechanical interference, biological competition and environmental modification, while infrastructure is also impacted (Fitridge et al., 2012). Colonizing submerged surfaces by a range of organisms, a process termed biofouling, is a significant operational risk for the aquaculture industry globally. The impacts of biofouling on aquaculture include direct adverse effects on cultured species and on immersed infrastructure such as cages, nets and pontoons (Atalah et al., 2016). In the shellfish industry, the control of biofouling is centred around maintaining clean shells, as biofoulers have detrimental effects on the appearance and marketability and on the growth and condition of shellfish. While fouling organisms settle onto infrastructure such as ropes and floats, causing breakages and costly repairs, their

attachment to the surfaces of cultured shells is more problematic (Fitridge et al., 2012). The direct economic costs of biofouling control to the aquaculture industry are substantial, with conservative estimates of 5–10% of production costs attributed to biofouling (Lane & Willemsen, 2004). Other direct impacts, which can be generated by epibiont organisms and damage the molluscs that are cultivated, are: the obstruction of the filtering activity, increase in the weight of the mollusc with the risk of its detachment from the ropes, the reduction of the spaces for fixing the larvae with the consequence of limiting the recruitment, obstructing the circulation of the water flow which is accompanied by asphyxiation of the molluscs, the erosion of the shell, etc (Witman & Suchanek,1984; Arakawa,1990; Adams et al.,2011). However, in addition to what was pointed out above, regarding the impacts of biofouling on the molluscs that are reared in mariculture farms, for specific issues, contrary opinions have been expressed in the scientific literature. According to Lesser et al (1992), where food is not a limiting factor, interspecific competition for food by the associated fouling community should not significantly limit the yield of mussels. Mussel epibionts appeared to have a negative impact on their basibiont since a reduced condition index was detected; however, this impact was rather weak and further data are required to generalize the consequences of epibiosis on farmed mussels (Antoniadou et al.,2013). The purpose of this study was to provide information on the presence of epibiont fauna in a Mediterranean mussel's aquaculture situated in the Butrint Lagoon (South-Eastern Ionian Sea), including aspects of taxonomy, species richness and seasonal as well as spatial dynamic of abundance.

2. Materials and methods

The study was carried out in a mussel aquaculture (or mitiliculture) system, situated in the Butrint Lagoon (Figure 1), during the production cycle between 2023 and 2024.

Figure 1.a. Butrint lagoon (Google Earth map);b. The panels of the aquaculture system, and c. The mussels at the end of the production cycle (Meli,2024).

The mitiliculture of Butrint Lagoon, which operates by applying the technology of the fixed suspended culture (hanged culture on single suspended ropes or tubular

nets), is a production system composed of 60 active concrete panels (Figure 1b). The dimensions of a panel are 120x15 m. The average depth of the lagoon in the areas where the panels are placed is from 3.0 to 3.5 m. In one panel, 1500-2000 culture strings are arranged, depending on the stage of cultivation and hydrological conditions. The average length of a string with mussels, in the growing stage, is about 2.0 m, while its average weight at the harvesting is about 10 kg. In the Butrint Lagoon, the production cycle is extended in 12 to 16 months, depending on the hydrological conditions.

The mussels were sampled during the growing stage, when the length of the shell was from 30 mm to more than 60 mm. For the study of the taxonomy of epibionts and the Simpson index (*D*), the samples were taken from different panels of the cultivation system, while for the study of the abundance of epibionts at different levels of the string length, the samples were taken in the Spring season of 2024, in a single panel, at 1-month intervals. The analysis of spatial differences for the abundance values (*A*) of the epibiont fauna was carried out on the basis of three samplings, with a one-month interval (August-October,2023) in three areas of the plant (Manastiri area," Mussel's House" area and near Ksamili village).

Initially, the processing of the sampled material was carried out in the Laboratory of the Centre for Mussel Depuration (Manastir/Butrint-Sarande). According to Çinar et al (2020), the mussels that were sampled were observed under a stereomicroscope, for sorting according to major taxonomic groups of epibiont organisms that were fixed on their shells. The resulting fractions of samples were photographed and further preserved in 70% ethanol and transported for analysis in the Laboratory of Aquaculture (University of Tirana). The species determination of epibiotic animals was carried out using the respective taxonomic keys and biological publications (Bellan,1969; Schmidt,1971; Seed,1996; Pollock,1998; Damianidis & Chintiroglou,2000; Hayward,2001; Novosel et al.,2019). The numerical abundance (*A*) (Chintiroglou et al.,2004), on a scale of 0.1 m^2 and the species diversity index according to Simpson (*D*) (Simpson,1949; Schleuter et al.,2010), were estimated according to the study topics. A number of individuals of the epibiotic species were deposited at the Museum of Natural Sciences, Tirana University.

The data obtained from the evaluations were analyzed to calculate the mean (M), standard deviation (SD), and variance (Var%). Spatial and temporal differences in the mean values of the estimated parameters were tested using one-way ANOVA and Student's analysis, to prove their significance ($P<0.05$) (Zar,2010). Statistical analyses were performed using the computer program IBM SPSS Statistics 21.0 (2019) and the Microsoft Office Excel software version 2010.

3. Results and discussions

a) Species composition of epibiotic macrofauna

Table 1 presents the list of species, the major taxonomic groups (phylum) and the respective families for the epibiont macrofauna found on the shells of mussels that were reared in the mitiliculture of the Butrint Lagoon. Twenty-two epibiotic animals

were identified at the species level, 22 epibiotic animals, and at the genus level, seven epibionts (Figure 3 and Figure 5). The epibiont species belonged to seven major taxonomic groups; four species were Porifera, two species Cnidaria, four species Bryozoa, two species Annelida, six species Mollusca (two Gastropoda and four Bivalvia), four species Arthropoda and seven species Chordata. A total of 24 family groups were identified; four in the Phylum Porifera, two in the Phylum Cnidaria, four in the Phylum Bryozoa, two in the Phylum Annelida, five in the Phylum Mollusca, two in the Phylum Arthropoda and five in the Phylum Cordata see Table 1).

Table 1.The list of identified species of epibiont macrofauna, that were found in the mussel (M.galloprovincialis) reared in the aquaculture of Butrint Lagoon.

No	**Species**	**Phylum**	**Family**
1	*Cliona celata* (Grant,1826)	Porifera	Clionaidae
2	*Sycon* spp	"	Sycettidae
3	*Haliclona* spp	"	Chalinidae
4	*Pleraplysilla spinifera* (Schulze,1879)	"	Dysideidae
5	*Actinia equina* (Linnaeus,1766)	Cnidaria	Actiniidae
6	*Obelia dichotoma* (Linnaeus,1758)	"	Campanulariidae
7	*Cellaria* spp	Bryozoa	Cellariidae
8	*Schizotheca fissa* (Busk,1856)	"	Phidoloporidae
9	*Schizoporella magnifica* (Hincks,1886)	"	Schizoporellidae
10	*Scrupocellaria scrupea* (Busk,1851)	"	Candidae
11	*Serpula vermicularis* (Linnaeus,1767)	Annelida	Serpulidae
12	*Sabella spallanzanii* (Gmelin,1791)	"	Sabellidae
13	*Patella vulgata* (Linnaeus,1758)	Mollusca (Gastropoda)	Patellidae
14	*Murex* spp	"	Muricidae
15	*Modiola barbata* (Linnaeus,1758)	Mollusca (Bivalvia)	Mytilidae
16	*Ostrea edulis* (Linnaeus,1758)	"	Ostreidae
17	*Crassostrea gigas* (Thunberg,1793)	"	"
18	*Ruditapes decussatus* (Linnaeus,1758)	"	Veneridae
19	*Balanus perforatus* (Bruguiere,1789)	Arthropoda	Balanidae
20	*Balanus amphitrite* (Darwin,1854)	"	"
21	*Balanus balanus* (Linnaeus,1758)	"	"
22	*Chthamalus fragilis* (Darwin,1854)	"	Cthamalidae
23	*Didemnum vexillum* (Kott,2002)	Chordata	Didemnidae
24	*Ascidia* spp	"	Ascidiidae
25	*Botryllus schlosseri* (Pallas,1766)	"	Styelidae

26	*Styela plicata* (Lesueur,1823)	"	"
27	*Ciona intestinalis* (Linnaeus,1767)	"	Cionidae
28	*Phallusia* spp	"	Ascidiidae
29	*Clavelina* spp	"	Clavelinidae

Figure 2 shows the results of the estimations for the values of frequencies (*F*%), according to the number of species included in each of the seven identified Phyla. The respective values of *F*% were: *F*% = 6.90 for Cnidaria and Annelida (calculated separately), *F*% = 13.75 for Porifera, Bryozoa and Arthropoda (calculated separately), *F*% = 20.75 for Mollusca and *F*% = 24.20% for Chordata. It turned out that among the seven phyla identified, chordates had the largest number of species in the community of epibiont animals that coexist with the mussel in the aquaculture system of Butrinti Lagoon.

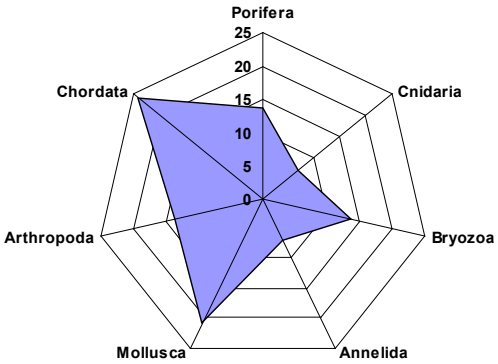

Figure 2. The diagram of the species frequencies (F%) for seven major taxonomic groups (Phylum) of the epibiont organisms.

Figure 3. Different species of the community of epibionts on the mussels reared in the aquaculture of Butrint Lagoon: Stylea plicata, Balanus balanus, B.amphitrite, Schizoporella magnifica, Scrupocellaria scrupea, Ostrea edulis, Sabella spalanzanii (photos according to authors, 2024).

b) **Seasonal changes in the values of the species diversity index (*D*) for the fauna of epibionts**

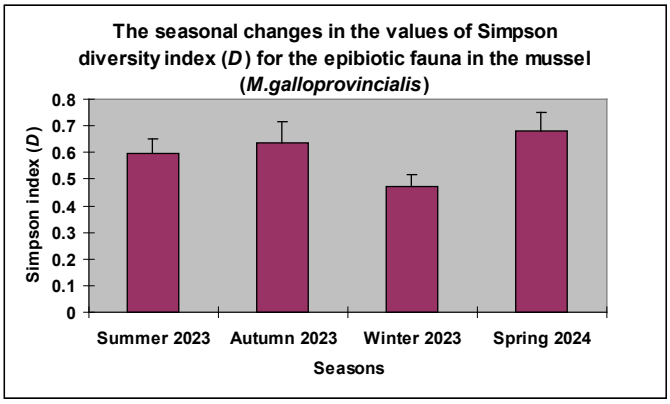

Figure 4. The seasonal variability in species diversity index (D) for the epibiotic macrofauna that developed in a mussel population reared in Butrint Lagoon.

The average values (M) estimated for the species diversity index (*D*) according to four seasons (Figure 4) and the values of two biometric indicators (SD and Var%) were:
Summer 2023 0.596±0.056 (Var%=9.4)
Autumn 2023 0.638±0.078 (Var%=12.2)
Winter 2023 0.474±0.045 (Var%=9.5)
Spring 2024 0.682±0.069 (Var%=10.1)
The highest average values for the Simpson index (*D*) were estimated for the spring and autumn seasons, and the lowest values for the winter and summer seasons. The evaluation of the seasonal dynamics for the values of the species diversity index of the epibiotic macrofauna confirms that the extreme temperatures that characterize Butrint Lagoon, both those of the summer season and those of the winter season, do not favor high values of biodiversity in the animals that compose this community.

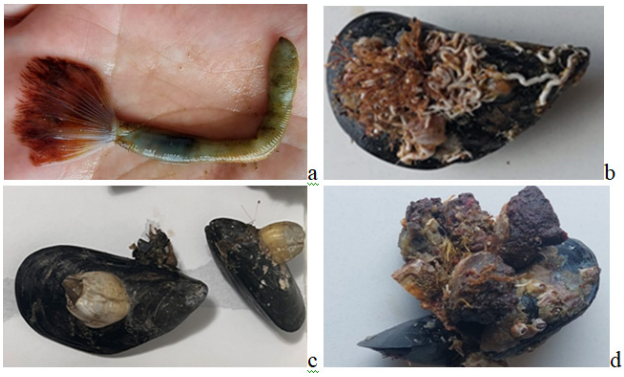

Figure 5. a. Sabella spalanzanii; b. limestone gallery created by the annelid Serpula vermicularis; c. Balanus aphitrite; d. Stylea plicata (photos according to authors, 2024).

However, the Student's t-test was performed to verify the significance of the differences (P<0.05) between the average values of the *D*-index in the comparisons between different seasons. Significant differences were found when the average values of the Simpson index (*D*) were compared between pairs of the seasons Winter-Spring (*t*=2.54; P<0.05), Autumn-Winter (*t*=2.05; P<0.05) and Summer-Winter (*t*=1.81; P<0.05). No significant differences were found when the average values of the Simpson index (*D*) were compared between pairs of seasons: Summer-Autumn (*t*=0.45; P>0.05), Autumn-Spring (*t*=0.51; P>0.05 and Summer-Spring (*t*=1.05; P>0.05). The calculated *t*-values confirm the fact that the low temperatures of the winter season have been a stronger limiting factor compared to the high temperatures of the summer season for the degree of biodiversity of the fauna that generates the biofouling community in the mussels of the Butrint Lagoon.

c) **The numerical abundance (*A*) of the epibionts at different levels of the string's length**

In addition to the above methodical protocols, it should be noted that this assessment was carried out by counting only the individuals of the epibiotic macrofauna that were visible in the surface part of the string, leaving out of the calculation those that were placed on the mussels located inside the string. Selection was made for the sampled strings. A small boat was used to perform the manipulations and the different procedures during the quantitative evaluations. The string was removed entirely from the water and secured on the panel's crossbars. The epibionts are numbered separately, in three equal levels of the string's length, on a surface of 0.32x0.32 m (approximately 0.1 m²).

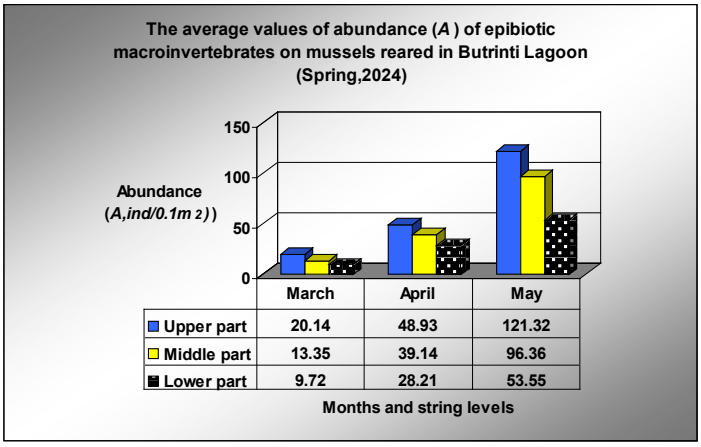

Figure 6. The average values of numerical abundance (A, ind/0.1m²) of the epibiont organisms (calculated as a whole) on the mussel (M.galloprovincialis) reared in a suspended culture, according to three levels of the string length (or water profundity) in three months of the Spring season.

The numerical values in the diagram of the Figure 6 confirm that the highest abundance of the epibionts was reached in the upper part of the mussel's strings, i.e., near the surface of the basin, in the month of the May (*A*=121.32 ind/0.1m²), while the lowest abundance was estimated for the mussels situated on the lowest parts of the strings (about 1.50-2.10 m under the basin's surface), in the March (*A*=9.72 ind/0.1m²). The evaluations according to seasonal averages gave the following values for the abundances (*A*,ind/0.1 m²) of epibiotic macrofauna in different parts of the strings: *A*=63.46±52.132 (upper part); *A*=49.62±42.485 (middle part) and *A*=30.49±22.004 (lower part). According to our estimations, the prevalence of epibiosis in mussels, or the percentage (%) of mussels with epibionts to the total number of mussels that were in the sampling squares (0.1 m²), for the Spring season, according to their position in the hanged strings, had these average values: 41.5 % for the mollusks that were fixed in the upper 1/3 of the string, 36.4% for the mollusks that were in the middle and 24.6% for the mollusks that were fixed in the lower 1/3 of the string. The intensity of epibiosis or the average number of epibiont invertebrates, per mussel, according to their position in the haged strings, had these average values:2.25 ind/mussel in the mussels that were fexed in the upper 1/3 of the string,1.96 for the mussels situated in the middle and 1.74 for mussels that were fixed in the lover 1/3 of the string. The highest values of prevalence (62.7%) and intensity (3.37 epibionts/mollusc) of the epibiosis were estimated in May, for mussels that were fixed in the upper 1/3 of the strings. The smallest values of these parameters (respectively, 16.8% and 0.81 epibionts/mollusc) were found in March, for mussels that were positioned in the lower 1/3 of the strings.

***d)* Spatial differences for the abundance values (*A*,ind/0.1 m²) of the epibionts in the mitiliculture of Butrint Lagoon**

In the three sampling areas of the mitiliculture plant,the quantitative assessments were carried out for the epibionts that were positioned in the upper half of the strings.

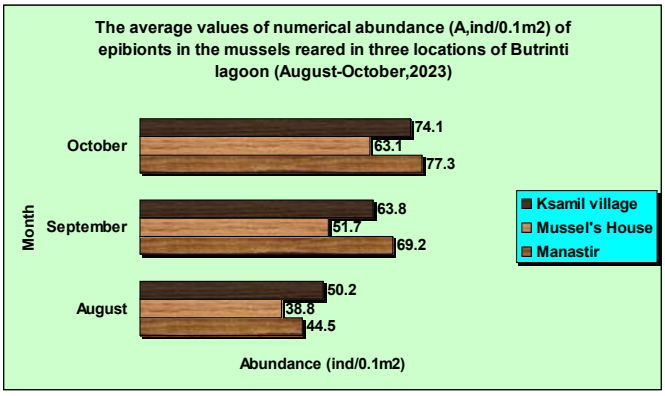

Figure 7. The average values estimated for the abundance of epibiotic macroinvertebrates, which were fixed on the mussels reared in three parts of the Butrint Lagoon's mitiliculture (August-October, 2023).

The average quarterly values for the numerical abundance of the macroinvertebrates that compose the community of epibiont organisms, according to the three areas in which the mussel cultivation system is situated, were: in the Manastir area,67.3±17.085 ind/0.1m²; in "Mussel's House" area, 51.2±12.157 ind/0.1m² and in Ksamil village area,62.7±11.988 ind/0.1m².The resulting values affirmed that in the Manastir area, the mussels were more "infected" by the epibiont fauna, and that in the area of "Mussel's House", the epibiont had the smallest average values of the numerical abundance. However, for the values that we demonstrated above, the analysis of variance did not confirm the significant differences when the quarterly average values of numerical abundance, which characterised the three analysed areas, were compared in pairs ($t<1.812; n=10; P>0.05$).

4. Discussions

Different authors have pointed out that dense colonies of mussels, which are created on the hard surfaces of the underaquatic objects as well as in aquaculture systems, attract many hydrobionts, which in juvenile stages are components of zooplacton and the adults are sessile organisms. The currents generated by mussels can attract invertebrate larvae from the surrounding water. This mechanism favours the settlement of native and alien species in the mussel's patch (Saier, 2002). Many of these attracted larvae need hard substrates to settle and develop, so they attach to mussels' valves, where they benefit from shelter and nutrients. As a consequence, mussel patches are an ideal environment for the settlement and development, as they provide them with substrate, shelter and food (Tsuchiya & Nishihira,1985).

Our assessments on the taxonomy of epibiotic macroinvertebrates, in the mussel cultivation system of the Butrint Lagoon, noted the presence of 29 taxa. The largest number of taxa belonged to chordates and molluscs (respectively, 7 and 6 taxa), and the smallest number to cnidarians and annelids (respectively, two taxa). It seems that the number of taxa we found for epibiotic macroinvertebrates in the mitiliculture system of the Butrint Lagoon was much smaller compared to what was encountered on aquaculture facilities installed in marine environments. Giangrande et al (2020) had identified 117 taxa of macroinvertebrates that caused biofouling in two cage culture farms that reared sea bream (*Sparus aurata*) and sea bass (*Dicentrarchus labrax*) in Mar Grande (Ionian Sea) (93 taxa) and the Gulf of Gaeta (Tyrrhenian Sea) (75 taxa). The major taxonomical divisions were similar in our study and in the study of the mentioned authors. However, in the study of Giangrande et al. (2020), the dominant groups were annelids (28 taxa) and chordates (25 taxa). The authors affirm that the large number of species was also caused by the presence of allochthonous species (17% of the total number of identified species). In the site of Mar Grande, the community was characterized by the highest species richness and diversity, and this fact was mainly supported by a higher number of alien species, and mainly confirming the area as a hotspot of alien biodiversity (Lezzi & Giangrande, 2018; Giangrande et al.,2020).

In the two studies that we are commenting on, the dominance of filter-feeding species in the community is noted. This species is part of the group of ascidian cordates, molluscs and polychaete annelids. According to some authors, the high values of the abundance of filter feeding groups is explained by the location of the aquaculture facilities in semi-enclosed, sheltered or lagoon areas, which are characterized by reduced hydrodynamic forces and high levels of organic particles, mostly derived from uneaten food and faeces coming from the fish rearing cages or mollusks fixed in ropes. Indeed, filter-feeding macroinvertebrates are commonly found to be dominant in aquaculture fouling communities (Fernandez-Gonzalez & Sanchez-Jerez, 2017; Fitridge et al., 2012; Pica et al., 2019; Giangrande et al.,2020). The dominance of ascidian chordates, especially in the early stages of biofouling creation, is considered an indicator of a lack of allochthonous terrigenous freshwater inputs in the areas where the aquaculture facilities are located (Giangrande et al.,2020). This fact brings back to attention an old problem of the Butrint Lagoon and precisely that of the insufficiency of exogenous fresh water flows, which would not only improve the overall water situation in this basin, but it will also become a factor for controlling the development of biofouling.

According to our evaluations on the variability of the values for the species diversity index (*D*) of the epibiont fauna, depending on the seasonal factor, it was proven that this indicator of biodiversity had the highest values in the seasons of Spring and Autumn. In some biocenological studies, the factors that determined the structure of biofouling communities were analyzed, according to the species composition and the successions that occurred for the dominances (Mook,1981; Fava et al., 2016; Sokołowski et al., 2016; Giangrande et al.,2020; Fortič et al.,2021). Among the factors that were identified, we mention the environmental parameters (Giangrande et al., 2020), trophic levels of the waters (Pica et al.,2019), the season when colonization started (Fortič et al.,2021), reproductive biology (Greene et al.,1983), predation (Mook,1981; Fortič et al.,2021), shell surface and its chemistry in molluscs (Scardino et al.,2003) and the correlation of species-specific development cycles with the annual period (Antoniadou et al.,2013). The typical environmental constraints of the geographical areas drove the entire course of the fouling development during the year, conditioning the succession process from the early stages of colonisation to the resulting end points (Giangrande et al.,2020). In particular, ascidians were the dominant component in the most eutrophic site, and they were very abundant at the fouling succession endpoint in another aquaculture plant located along the Southern Adriatic coast (Apulia) (Pica et al., 2019).

Fortič et al. (2021) had found that, when the colonization of the substrates started in the summer season, the dominant epibionts were the serpulids (Annelida), while when the colonization started in the Winter season, the dominant ones were the bryozoans. Overgrowth by asexual reproduction gives bryozoans a competitive advantage over solitary animals and allows them to dominate in some environments (Greene et al., 1983). The effect of the placement season is the result of many factors, but there are two main ones. The first is the seasonality of species, i.e. their reproductive period

and the time of their settlement, and the second is the interaction between other organisms, which results in the occurrence of species in the specific phase of fouling development. We hypothesized that over time, the composition of the community would become more stable and that its changes over time would be more related to the actual season and less to the time of placement (Fortič et al.,2021). Antoniadou et al. (2013) analyzed the epibiont communities in farmed mussels and found that the structure of epibiotic assemblages exhibited limited variability at the spatial scale, in general. On the contrary, substantial temporal variability with decreased diversity and abundance/cover values during the cold period of the year was assessed, in accordance with the life cycles of species involved and prevailing environmental conditions. Shell surface texture and chemistry appear to play an important role in defining the settlement levels of fouling organisms; however, this is very dependent upon the scale of surface roughness encountered (Scardino et al.,2003). Predation selectively reduces some components of biofouling by favoring the dominance of the species that are not consumed by predators. Predation is a factor that can have a major influence on the development of the fouling community. Predation of selected species or taxa influences the composition of epibenthic communities, which consequently are dominated by species that are not exposed to the pressure of local predators (Mook,1981). Fortič et al. (2021) had found in the benthic epifauna communities of the Gulf of Trieste (Northern Adriatic Sea) thirteen species of sea slugs (Nudibranchia; Gastropoda), which are known to feed on hydrozoans, bryozoans, ascidians and sponges.

We found differences in the abundance of biofouling organisms as well as in the indicators of the prevalence and intensity of the occurrence of epibiosis at different levels of the length of the mussel's strings (or water depth). Based on the data of vertical distribution of the dissolved oxygen content in the water column of the Butrint Lagoon (Çako et al.,2013; Topi et al.,2013; Moisiu et al.,2016), we believe that the rapid reduction of the oxygen content as well as the increase in the content of the hydrogen sulfide and turbidity, with the increase in the depth of the water, must have been the environmental factors that have caused an impact on the rates of recruitment of the epibiotic macroinvertebrates. In fact, there are no specific studies on the bathymetric analysis of biofouling associations in mariculture systems, including those that produce bivalve molluscs. However, Guenther et al. (2010) expressed that the fouling communities generally decrease in biomass and become less diverse in deeper waters. It is necessary to point out that, as in all biocenoses, in the biological associations that are characteristic of biofouling organisms, the systematic or periodic action of natural factors, which control the species structure as well as the quantitative indicators, causes alterations of the relative levels. Fitridge et al. (2012) concluded that:" Although spatial and temporal differences exist in the overall composition and biomass of fouling communities, in general, a common suite of sessile, suspension-feeding organisms dominates. These include diverse organisms, including barnacles, bivalves, bryozoans, polychaetes, ascidians, hydroids, sponges and algae.

5. Conclusion

The study promises modest information on the variability of biological association, which was created in a mussel cultivation system with hanging strings. The mussel's shell serves as a support not only for the organisms that create the primary biological association, which characterizes the biofouling, but also for other sessile organisms that settle on the mussel's epibionts, like barnacles and other bivalves. In this way, the mussel acts as an engineering organism as long as it directly or indirectly causes the modification of the environment. It is important that we will be informed if these generated modifications are positive for the ecosystem as a whole, as well as for the goals of the aquaculture farm, in particular, or do they also contain negative factors. Future studies can focus on these directions, while there are references, sometimes contradictory, that discuss the negative impacts of the epibiont fauna on the molluscs that are reared.

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