ACTA ZOOLOGICA BULGARICA

Acta Zool. Bulg., June 2025, 77 (2): 189-198

Aquatic Ecology
Research Article

Published online 14 June 2025
DOI: https://doi.org/10.71424/azb77.2.002834

Annual Cycle, Abundance and Species Composition of Appendicularia in the Bay of Boka Kotorska (Southern Adriatic, NE Mediterranean)

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Academic Editor: *Vesela Evtimova*

Abstract: Appendicularians often constitute a significant portion of mesozooplankton tunicates in marine ecosystems. This study examines the spatial variations in the annual cycles of functional groups of planktonic Appendicularia in response to environmental changes within the Bay of Boka Kotorska. Monthly sampling over the course of a year during 2008/09 was conducted at seven stations, each characterised by distinct hydrographic conditions. Appendicularians exhibited spatial variations in their annual cycles across the seven stations. Based on these findings, it is proposed that the observed spatial variations in the annual cycles of functional groups of planktonic Appendicularia may reflect changes in hydrographic conditions. We present hydrographic data alongside information on the presence, abundance and distribution of eight species of two genera: *Oikopleura dioica* Fol, *O. longicauda* Vogt, *O.fusiformis* Fol, *Fritillaria aequatorialis* Lohmann, *F. megachille* Fol, *F. pellucida* (Busch), *F. haplostoma* Fol and *F. borealis* Lohmann. We also provide an overview of the occurrence of the dinoflagellate *N. scintillans* and its relationship with Appendicularia in the Bay of Boka Kotorska.

Key words: Appendicularia, seasonal patterns, hydrographic conditions, estuarine-neritic fauna, zooplankton community

Introduction

Appendicularians are pelagic, transparent tunicates found throughout all seas and oceans. They tend to be more abundant in coastal waters than in open seas and are also found closer to the surface rather than in the deep layers (Skaramuca 1980). Appendicularians play a crucial role as filter feeders of organic matter in the sea, facilitating the direct transfer of energy from primary producers (phytoplankton) to secondary consumers, such as zooplankton, fish larvae and adult fish. They are among the fastest responders

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to increases in marine productivity (Vučetić 1957, Skaramuca & Bender 1983, Hopcroft & Roff 1995).

In the Adriatic Sea, this group of planktonic organisms has been thoroughly studied in the second half of the 20th century. The earliest reports on Adriatic appendicularians were based on incidental plankton observations near Trieste and Rovinj (Lohman 1896, Steuer 1902, Graeffe 1902). These authors recorded a total of six species: *Oikopleura longicauda*, *O. dioica*, *O. fusiformis*, *Fritillaria pellucida*, *F. borealis* and *Megalocercus abyssorum* Chun. Uebel (1912) provided data from two summer voyages aboard the "Rudolf Virchow", focusing solely on coastal waters of the Adriatic Sea and identified six new species: *Kowalewskia tenuis* Fol, *Appendicularia sicula* Fol, *F. formica* Fol, *O. cophocerca* Gegenbaus, *O. albicans* Leuckart and *Folia mediterranea* Lohmann. Only three species were consistently found, while the others were rare. Uebel (1912) also noted that the number of species in the Adriatic increased from north to south.

In the central Dalmatian archipelago, Gamulin (1948) identified 11 species, with *Oikopleura intermedia* Lohmann and *Fritillaria haplostoma* Fol being reported in the Adriatic Sea for the first time. Hure (1955, 1961) provided data on zooplankton in the Southern Adriatic and the Bay of Mali Ston, where *O. longicauda* and *O. dioica* were the most numerous appendicularians. Fenaux (1972, 1998) analysed appendicularians from the northern Adriatic, with *O. dioica*, *O. longicauda* and *O. fusiformis* being the most abundant species, and also reported *O. gracilis* Lohmann for the first time.

During winter, at two stations in the coastal waters outside the Bay of Boka Kotorska, Vukanić D. (1975) recorded ten species three of which were new to the Adriatic: *O. parva* Lohmann, *O. rufescens* Fol and *F. tenella* Lohmann. He noted that appendicularians was the second most numerous group in the plankton, after copepods. Skaramuca (1979, 1980) provided data from the eastern Adriatic coast, confirming significant presence of appendicularians in the zooplankton in the Adriatic Sea, registering 27 species and reporting five species for the first time: *Mesoikopleura haranti* Vernières, *F. gracilis*, *F. megachille*, *F. messanensis* Lohmann in Bückmann and *F. venusta* Lohmann.

In the Bay of Kotor (most landwards part of Boka Kotorska), Vukanić D. (1979) found four species: *O. dioica*, *O. longicauda*, *F. pellucida* and *F. haplostoma*, while Skaramuca (1980) reported only *O. dioica*. The first detailed data on appendicularians in the Bay of Boka Kotorska were reported by Vukanić V. (2012). According to her monthly research on zooplankton in the Bay of Boka Kotorska during 2004, the appendicularian fauna was represented by two genera: *Oikopleura* and *Fritillaria*. The genus *Oikopleura* was represented by *O. dioica*, *O. longicauda* and *O. fusiformis*, while the genus *Fritillaria* was represented by *F. aequatorialis*, *F. megachille*, *F. pellucida*, *F. haplostoma* and *F. borealis* (the same species detected in the present study).

Even though appendicularians comprise a significant portion of planktonic tunicates in marine environments and usually rank fourth in abundance within the Adriatic zooplankton community, after Copepoda, Cladocera and Chaetognatha (Fenaux 1968), they are inconsistently reported in the literature regarding coastal waters of the Southern Adriatic Sea. This contribution aims to describe the zonal diversity of appendicularians and the key environmental factors influencing their assemblage in the Bay of Boka Kotorska. The samples were collected from February 2008 to January 2009; a total of eight species of Appendicularia were identified. *Oikopleura dioica* was the most abundant species across almost the entire study area, followed closely by *O. longicauda*. The distribution of other taxa was limited to specific hydrological zones and conditions. All species which were detected in sufficient quantities exhibited significant correlation with the salinity, making them potential indicator species.

Materials and Methods

Study area

The sampling stations were situated in the coastal waters of the South-Eastern Adriatic Sea (Fig. 1). The Bay of Boka Kotorska consists of a network of interconnected inlets and it is the only indented part of the Southern Adriatic. It is influenced by interactive processes, including the influx of freshwater from the mainland and currents from the open sea. The bay extends deeply into the land, reaching 13 nautical miles inland. The surrounding terrain is karstic, characterised by aridity during the summer, while in autumn and winter it experiences the highest rainfall levels in Europe. A detailed description of the Bay is provided in Vukanić V. et al. (2024).

Sampling and laboratory procedures

The appendicularians were sampled monthly at seven stations, ranging from the inner bays of Kotor and Risan to the outer bays of Tivat and Herceg Novi. Central stations of each bay are labelled K1, R1, T1 and H1. Stations K2, K3 and R2 were situated in shallow waters near shellfish farms. Nansen closing

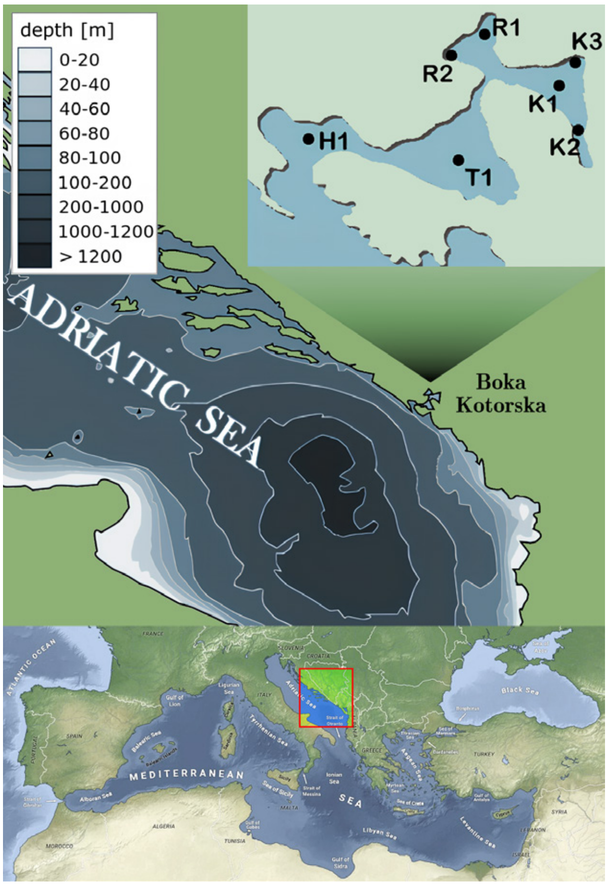

Fig. 1. Study area in the South-Eastern Adriatic Sea.

nets with mesh sizes of 150 and 250 µm and with openings of 0.5 m were used for vertical tows and with openings of 1 m - for horizontal tows. A limited number of older samples from 1986, 1998, 2002 and 2004 were examined for potential oversight or verification of the present species. The planktonic material was preserved in a 2.5% formaldehyde solution. Taxonomic identification and individual counting were performed using a Zeiss stereomicroscope at magnifications of ×25 and ×40. Alongside zooplankton sampling, basic hydrographic parameters were measured using a Multiline P4 device. Water samples were collected with 5 litre Niskin bottles. Physical parameters and zooplankton were sampled within the depth range of 0-10 m at shallow stations (K2, K3, R2), 0-20 m at the central stations of the inner bays (K1, R1) and 0-30 m at the central stations of the outer bays (T1, H1). The detailed procedure is described in Vukanić V. et al. (2024).

Statistics

In biological studies, the relationships between species abundances and environmental parameters are commonly analysed using Pearson's or Spearman's correlation. To calculate Pearson's correlation coefficient between variables x and y for a dataset of N points, the covariance of the two variables is divided by the product of their standard deviations. The Spearman's correlation method, often favoured for non-linear relationships, replaces the raw values of variables with their ranks (assigning a rank of 1 to the lowest value and N to the highest). Ranking is often advantageous when dealing with variables that have irregular distribution and outliers which could skew mean value calculation and disproportionately affect the results.

However, there are cases when this approach is less effective. One case involves smooth variables. For instance, sea temperature typically follows a sinusoidal pattern due to water's response to diurnal and seasonal fluctuations in energy input, and (not only) in our study, it is often averaged over depth because multiple temperature measurements relate to a single observation of the outcome variable (species abundance in this case). There are no outliers that benefit from the ranking; however, values near the smooth extrema are ranked, despite being very close in value, which distorts the results. The second case includes the-so-called zero-inflated datasets. If the observations are often nil, it may be beneficial to assign full weight to outliers, as many of them are not glitches but carry important information.

So, we have chosen to apply three different (but closely related) methods. In case of frequent (in both space and time) appearances of species, Spearman's or mixed Spearman's correlation (Malović et al. 2023) was used. The latter was applied on temperature only, which means that only the y variable (abundance) was ranked in this case. In case of rare appearances of species, both Pearson's (giving full significance to outliers in zero-inflated datasets) and Spearman's coefficients were calculated and the larger absolute value was singled out.

Results

Abiotic parameters

Salinity data clearly indicated the significant influence of freshwater inflow, particularly in the surface layer and in shallow coastal habitats. The research year of 2008/09 was rainy in all seasons, with salinity values ranging from 2.3 to 38.7 psu. The average temperature at all locations reached the minimum in January (8-13°C at the top layer or around 13°C weighted average value, Table 1). The maximum was reached in July (in most cases) or August (averages around 25°C with top layer from 24 to over 28°C, Table 1).

Table 1. Statistics of abiotic parameters across the Boka Kotorska Bay.

Temperature [°C]	min.	mean	max.	std.dev.
top layer	8.20	17.06	28.60	5.26
weighted average	12.37	17.71	25.49	3.51
bottom layer	12.90	17.60	26.10	3.23
Salinity [psu]	**min.**	**mean**	**max.**	**std.dev.**
top layer	2.30	22.58	38.17	11.22
weighted average	21.19	34.31	38.39	3.63
bottom layer	31.42	37.02	38.71	1.37
pH factor	**min.**	**mean**	**max.**	**std.dev.**
top layer	5.63	8.14	9.40	0.47
weighted average	7.16	8.15	8.42	0.24
bottom layer	6.45	8.14	8.40	0.29
Dissol. O_2 [ml/l]	**min.**	**mean**	**max.**	**std.dev.**
top layer	4.31	7.57	23.50	3.22
weighted average	4.72	7.34	23.92	3.28
bottom layer	4.37	7.62	33.70	4.29

The temperature distribution in the Bay of Kotor (home to stations K1, K2 and K3), the innermost part of the Bay of Boka Kotorska, oscillated significantly by month and by depth. Surface temperatures increased from January to July-August and then declined towards December. A thermocline formed at a depth of 14 metres and downwards in May and persisted until August. Later in autumn and winter, a uniform temperature field gradually established.

The Bay of Risan (R1 and R2 stations) belongs to the enclosed inner waters of Boka Kotorska and is directly connected to the Bay of Tivat via the Verige Strait. During heavy rainfall periods, a large volume of freshwater flows into this small bay. The coastal spring Sopot becomes a powerful waterfall and submarine springs upwell visibly. Minimum temperatures occur in January and maximum - in July. Closer to the seabed, the fluctuations in all parameters, particularly salinity (reaching higher values), were less pronounced. In most instances, oxygen saturation levels exceeded 100%.

The Bay of Tivat (T1 station), situated between the aforementioned inner bays of Kotor and Risan and the Herceg Novi Bay, exhibited hydrographic characteristics intermediate between them; in neither the influence of freshwater inflow was particularly strong, nor was the influence of saltier open sea water dominant.

At the Bay of Herceg Novi (H1 station), the influence of the open sea was the most pronounced. A small temperature gradient persisted in the first three and last two months of the year. The thermocline was not clearly defined. Salinity values were somewhat higher than in the inner bays, as expected.

Species composition

Three species of the genus *Oikopleura* were identified, while the genus *Fritillaria* was represented by five species (Table 2). Overall shares of juveniles and identified species are presented in Fig. 2.

Oikopleura dioica Fol is an euryhaline circumglobal species typical of coastal environments, including brackish estuaries and bays. It thrives in warm tropical and subtropical waters. This species is distinctly neritic in the Adriatic Sea, being almost evenly distributed across all sampling stations in the Bay of Boka Kotorska. It appeared in relatively large numbers, recording two peaks: a lower peak in March (outer bays) or May (inner bays) and a higher peak in August, influenced by increases in temperature and salinity, reaching 3,400 ind.m^{-2} at K1 (Fig. 3). Species quantitative contribution relative to adults of Appendicularia was relatively high at 40.8% (over all locations and time points) and it was noticeably the smallest in the Risan Bay. Abundance of *O. dioica* was strongly positively correlated with salinity (Spearman's p=2.2.10^{-6}).

Oikopleura longicauda is a semi-cosmopolitan surface species present throughout the Adriatic Sea and the Bay of Boka Kotorska. It was not recorded at inner bays (near Kotor and Risan) during the win-

Table 2. Species list of Appendicularia registered at each station.

Species	K1	K2	K3	R1	R2	T1	H1
Oikopleura dioica Fol	+	+	+	+	+	+	+
Oikopleura longicauda (Vogt)	+	+	+	+	+	+	+
Oikopleura fusiformis Fol							+
Fritillaria pellucida (Busch)	+			+		+	+
Fritillaria haplostoma Fol	+	+	+	+		+	+
Fritillaria aequatorialis Lohmann	+	+		+		+	+
Fritillaria megachille Fol				+		+	+
Fritillaria borealis Lohmann							+
Number of registered species	5	4	3	6	2	6	8

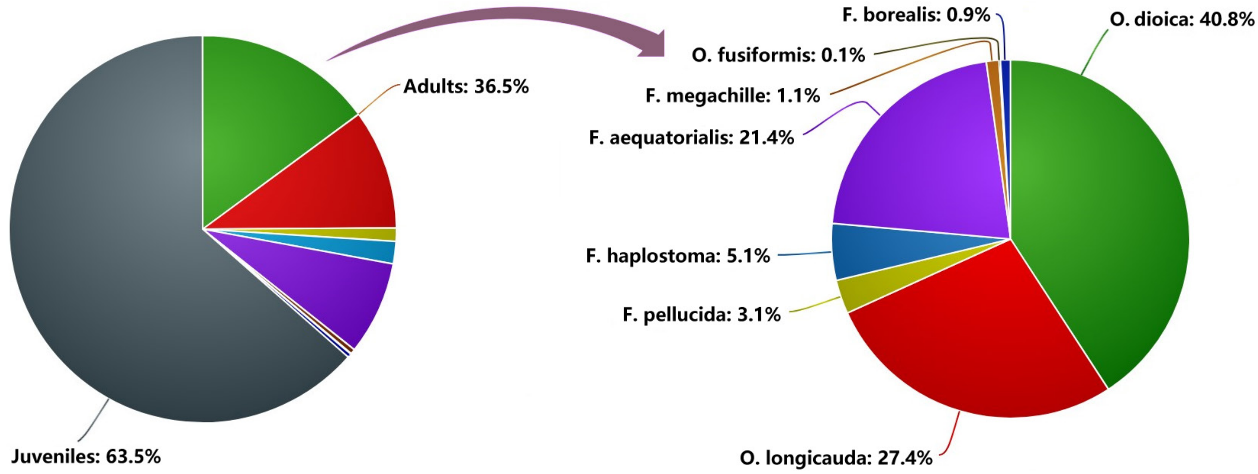

Fig. 2. Overall percentage of juveniles and adults of Appendicularia.

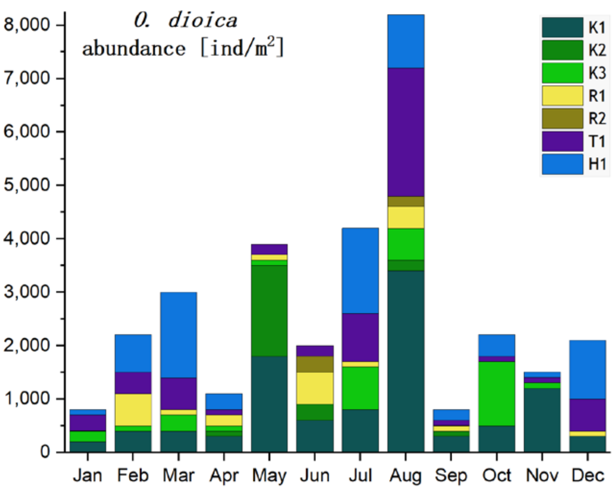

Fig. 3. Abundance [ind.m^{-2}] of *Oikopleura dioica*: spatio-temporal variations.

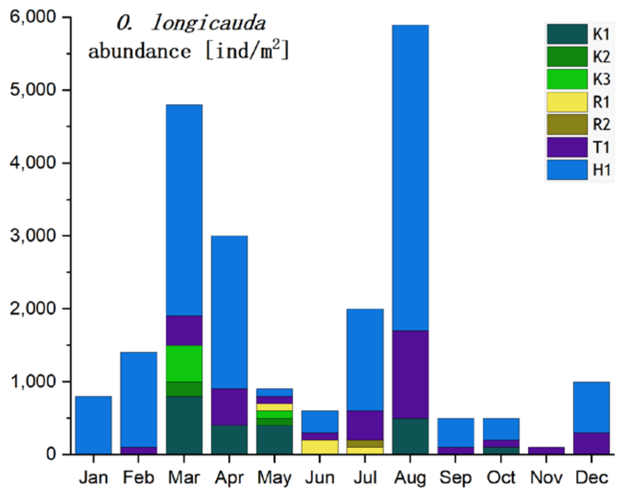

Fig. 4. Abundance [ind.m^{-2}] of *Oikopleura longicauda*: spatio-temporal variations.

ter months. It exhibited two peaks of abundance, in March and August (Fig. 4). The quantitative contribution markedly increased from the inner waters to the outer Herceg Novi Bay. The overall percentage of its quantitative contribution relative to adult appendicularians was 27.4%. Abundance of *O. longicauda* was also strongly positively correlated with salinity (Spearman's $p<1.10^{-7}$).

Oikopleura fusiformis is an eurythermal and widely distributed neritic and oceanic species with limited tolerance for estuarine waters. This surface species is found in warm tropical and subtropical waters. We recorded it only in September in small numbers, at 100 ind.m^{-2} near Herceg Novi, representing a percentage share of 0.1% of the population of adult appendicularians.

Fritillaria aequatorialis was occasionally present throughout the Bay of Boka Kotorska. A local maximum of 14,700 ind.m^{-2} was recorded near Tivat in July. The overall percentage share within adult appendicularians was 21.4% (mostly due to this appearance), making this species quantitatively important. It exhibited a slight salinity preference (low significance, Spearman's p=12%).

Fritillaria megachille is a semi-cosmopolitan species found in warm and temperate regions of all oceans. It occurred sporadically in the Bay, with an uneven distribution and a small number of individuals. We only recorded it during the winter-spring season, with a maximum abundance of 300 ind.m^{-2} recorded near Tivat in April. The percentage of its quantitative contribution relative to adult appendicularians was low - 1.1%. Due to the small number of individuals of the species, the statistics was not convincing, yet it indicated negative correlation with temperature and oxygen (Spearman's p=4% for both).

Fritillaria pellucida is a semi-cosmopolitan, pelagic species that prefers cooler waters and is rare or absent when temperature exceeds 20°C. It was present almost year-round in the bay, with a small number of individuals and an uneven distribution. It was more abundant during the winter, with a maximum of 800 ind.m-² recorded near Herceg Novi in December. The percentage share within adult appendicularians was 3.1%. *Fritillaria pellucida* was correlated positively with salinity (Spearman's *p*=0.8%).

Fritillaria haplostoma is a semi-cosmopolitan species found in warm and temperate oceans and it occurs more frequently in coastal than in pelagic waters. In Boka Kotorska Bay, it appeared exclusively from April to July (Fig. 5). It peaked at inner bays in May and, more abundantly, at outer bays in June (with a maximum of 1,500 ind.m^{-2} near Herceg Novi). The percentage contribution relative to adult appendicularians was 5.1%. *Fritillaria haplostoma* exhibited a positive connection with concentrations of dissolved oxygen (Pearson's *p*=1.2%).

Fritillaria borealis is a circumglobal species that prefers cold waters but can tolerate large amplitudes of temperature and salinity. It is present throughout the year in the Adriatic Sea, with maximum abundance occurring in winter. However, we only recorded it at the H1 station (directly communicating with the open sea) in June, where it had an abundance of 700 ind.m^{-2}. The percentage of its quantitative contribution within adult appendicularians was 0.9%.

In the meroplanktonic community of the Bay, we recorded a significant number of larval forms and juvenile stages in the zooplankton (Fig. 6). The percentage of juveniles within total Appendicularia

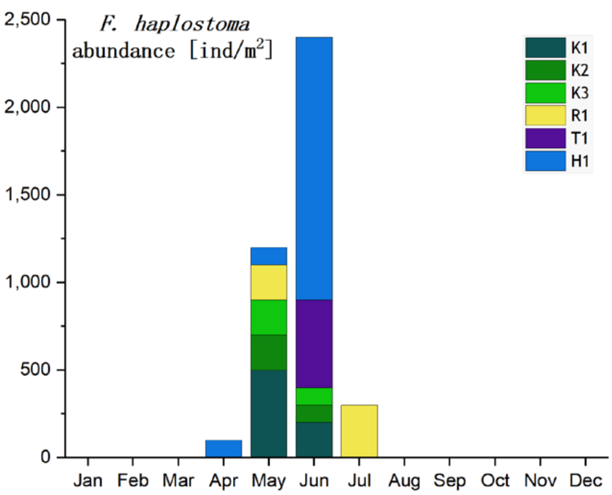

Fig. 5. Abundance [ind.m^{-2}] of *Fritillaria haplostoma*: spatio-temporal abundance variations.

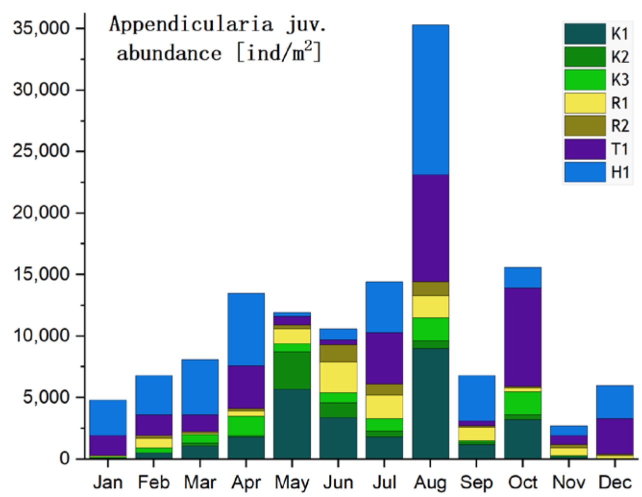

Fig. 6. Abundance [ind.m^{-2}] of Appendicularia (juv.): spatio-temporal variations.

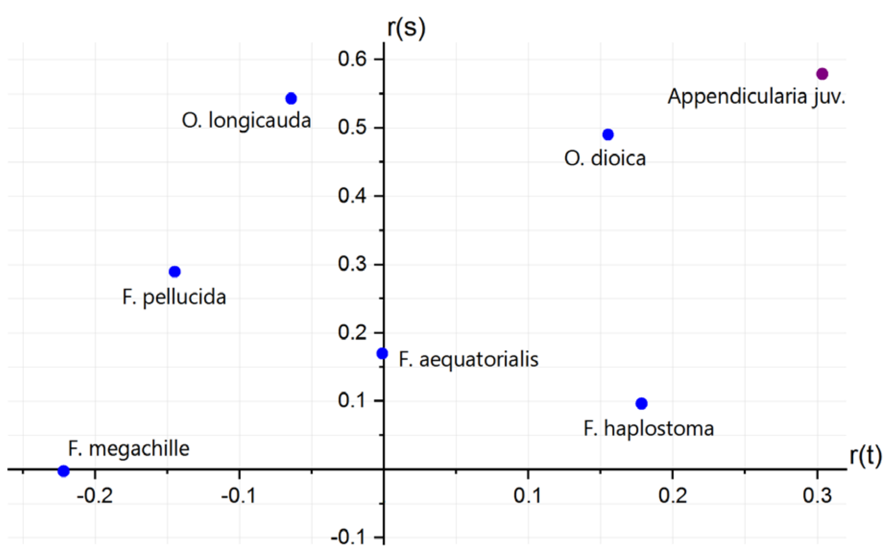

Fig. 7. Correlation among species with sufficient occurrences (including juveniles) and temperature and salinity.

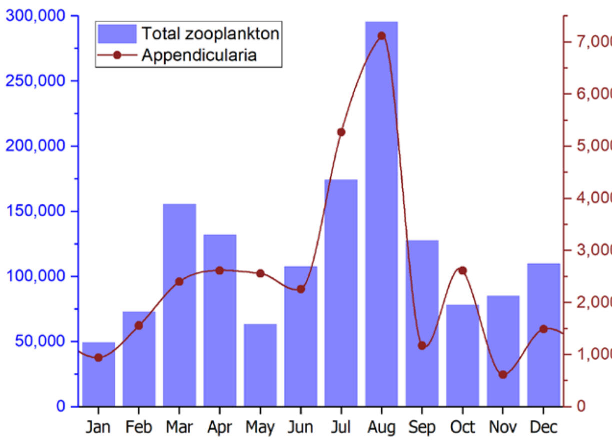

Fig. 8. Abundance [ind.m^{-2}] of Appendicularia and total zooplankton, averaged across locations: temporal variation.

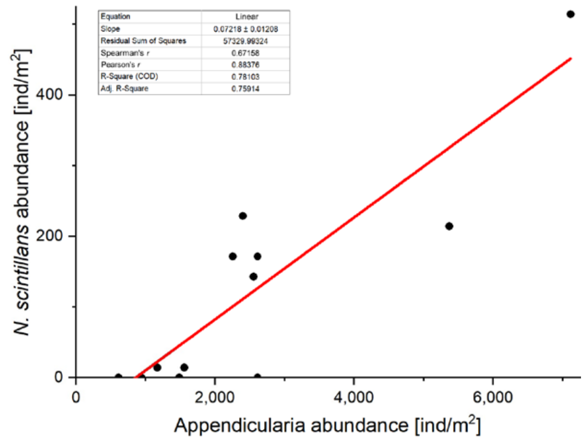

Fig. 9. Scatter diagram of monthly abundance (averaged across locations, [ind.m^{-2}]) of Appendicularia (total) and *N. scintillans*.

was 63.5%. Their percentage was higher at the inner bays (up to 88.8% at R2) and dropped to 57-61% at the outer stations. Peaks of abundance occurred in April (5,900 ind.m^{-2} at H1) and August (12,200 ind.m^{-2} at H1), and we also noted a smaller increase in juvenile individuals in October (over 2,000 ind.m^{-2} on average). Appendicularia (juv.) were positively correlated with salinity (Spearman's $p<1 \cdot 10^{-8}$) and temperature (Spearman's p=0.5%).

A diagram of species and juveniles in correlation with temperature and salinity is given in Fig. 7. Principal component analysis was not performed because of the irrelevancy of pH factor (no dependencies detected) and the strong connection between the salinity and oxygen concentration (information duplication). Average monthly abundance of Appendicularia in comparison to total zooplankton is presented in Fig. 8.

Dinoflagellate *Noctiluca scintillans* (Macartney) Kofoid & Swezy has notable influence on soft-bodied plankton, including appendicularians, by competing for resources and altering the structure of planktonic communities during its blooms. In our research, the presence of *N. scintillans* was recorded from February to September, with the highest numbers observed near Tivat, reaching 3,300 ind.m^{-2} in August. The correlation between our data for *N. scintillans* and Appendicularia (total) is presented in Fig. 9.

Discussion

The Bay of Boka Kotorska constitutes a unique biotope. Its distinctiveness is due not only to its geographical location but also to specific biotic and abiotic environmental factors (Magaš 2002). Appendicularia in Boka Kotorska have rarely been explored, with available data derived from a short-term study (Skaramuca & Bender 1983) and a research conducted only near Kotor (Vukanić D. 1979).

Appendicularians were the third most abundant planktonic group in Boka Kotorska Bay, following copepods and cladocerans. According to our 2008/09 data, two genera of Appendicularia were present: *Oikopleura* and *Fritillaria*. The genus *Oikopleura* included *O. dioica*, *O. longicauda* and *O. fusiformis*, while *Fritillaria* comprised *F. aequatorialis*, *F. megachille*, *F. pellucida*, *F. haplostoma* and *F. borealis*. Their species diversity increased longitudinally from the inner Bay of Kotor towards the outer Bay of Herceg Novi, which has direct connection with the open sea. The only species showing an increase in biomass towards the inner waters of the bay was *O. dioica*.

During this study, the typical pattern of two annual abundance peaks (one smaller in winter-spring and one larger in summer) of Appendicularia was confirmed conclusively for *O. longicauda* and, to some extent, for *O. dioica*. Seasonal abundance variations were evident for species of Fritillaridae which were detected in sufficient numbers (*F. haplostoma* and *F. aequatorialis*).

Statistical analysis showed that all Appendicularia exhibited more or less significant positive correlation with the salinity. Juvenile Appendicularia exhibited preference for both temperature and salinity. There were no significant correlations with pH. Negative oxygen preference was detected in most instances, which we deemed indirect correlation due to strong connection between the concentration of dissolved oxygen and the salinity (Spearman's $p=2.8 \cdot 10^{-6}$). This link is explained by substantial influence of freshwater rich in oxygen in the Boka

Kotorska system. Salinity preference is probably the primary (causal) correlation, not the opposite, because the detected salinity peaks were stronger and because Appendicularia have previously been reported to be relatively tolerant to oxygen fluctuations (Acuña et al. 1995). Although salinity correlation reports may vary depending on the region (Forneris 1965, Spinelli et al. 2013, Kalarus & Panasiuk 2021, Khames et al. 2023), their existence shows that species of Appendicularia are above average in sensitivity to salinity fluctuations, which can influence their distribution and abundance.

Oikopleura dioica had the highest abundance in nearly the entire studied area and was observed at all sampling stations. It is predominantly a neritic species, thriving in eulittoral planktonic communities (Skaramuca 1980, Bouquet et al. 2018). *Oikopleura dioica* is predominantly present in the waters with lower salinity, specifically between 36 and 36.45 psu, but found across the waters of the continental shelf (Furnestin et al. 1966). It is consistently present in the appendicularian fauna of the Bay of Boka Kotorska (Vukanić D. 1979).

Fritillaria aequatorialis has been found in the Atlantic and Mediterranean, always in low numbers in the areas relevant to our catches, being recorded near Messina (Lohmann 1899), the coast of Algeria (Bernard 1958), at Villefranche (Fenaux 1968, Fenaux et al. 1998) and in Egyptian Mediterranean waters (Zakaria 2006). In Villefranche-sur-Mer, this species was encountered sporadically in coastal waters, in small numbers during autumn and winter and never in the waters with temperatures below 15°C (Fenaux 1967, Fenaux et al. 1998). Its distribution was significantly correlated with temperature and salinity, likely making it a good indicator species. Vukanić V. (2012) recorded *F. aequatorialis* in the Adriatic Sea for the first time, during a study on the coastal waters of the Southern Adriatic Sea.

We also recorded the small dinoflagellate *N. scintillans*. The species is often causing the blooms during the warmer part of the year and is known to affect the soft-bodied plankton community (Ollevier et al. 2021). The seasonal trend of Appendicularia was similar to that of *N. scintillans*. We recorded late spring and summer peaks of both *N. scintillans* and Appendicularia at approximately the same time.

The dominance of organic matter filter feeders (such as Appendicularia) in the sea during the summer period (Paffenhöfer & Orcutt 1986, Turner & Graneli 1992, Vanderploeg 1994) can be attributed to the combination of warm, calm waters and the high abundance of prokaryotic picoplankton (Agawin et al. 1998, Gorsky & Fenaux 1998, Eske et al. 2025). Occurrence of *N. scintillans* in the Boka Kotorska Bay during the spring-summer season suggests the possibility of marine blooms triggered by increasing temperatures, when this species proliferates rapidly. Several studies have noted inverse relationships with copepods in the overall zooplankton community, most likely due to *N. scintillans* preying on zooplankton and their eggs, as well as competition for similar food sources (Fonda Umani et al. 2004, Yılmaz et al. 2005, Isinibilir et al. 2008).

Our study has shown a significant positive connection between the spatially averaged abundances of *N. scintillans* and total abundance of Appendicularia (Pearson's p=1.4.10^{-4}). However, lack of significant correlation between localised data supports the hypothesis that this species shares similar preferences but is not directly linked to Appendicularia. According to Ollevier et al. (2021), a Zero-Inflated Negative Binomial (ZINB) model reveals that Appendicularia are significantly positively correlated with *N. scintillans*, contrary to expectations. The dynamics of Appendicularia are more likely regulated by similar environmental factors as those of *N. scintillans*, rather than *N. scintillans* exerting a direct positive effect on Appendicularia, especially considering that its peaks occurred later than those of Appendicularia. Studies have shown that certain phytoplankton blooms, such as coccolithophores or *Phaeocystis*, had a strong positive impact on the nutrition of both *N. scintillans* and Appendicularia (Lancelot et al. 2002, Amelina et al. 2017). Appendicularia feed within a mucous house, which processes large volumes of water and concentrates small particles inside the house before ingestion (Deibel 1986). Both *N. scintillans* and Appendicularia are considered fine particle feeders (Amelina et al. 2017) and their similar dynamic trends may be linked to their capacity for non-selective food uptake.

Conclusion

The Boka Kotorska Bay exhibited all the characteristics of closed coastal waters in the Eastern Adriatic. The zooplankton community was predominantly composed of eurythermal and euryhaline species, alongside open-sea species that enter the Bay from the deep waters of the Southern Adriatic but soon perish. The living conditions in the Boka Kotorska differ significantly from those in the open sea. The pronounced fluctuations in ecological factors within the Bay, driven by strong influences from the surrounding land and reduced impact from the open sea, create specific ecological conditions for the growth and development of the characteristic estuarine-neritic fauna. Our research identified three species of the genus *Oikopleura* and five species of Fritillaria. After the winter-spring peak, the abundance of Appendicularia declined until June, when it began to rise again towards the summer-autumn maximum. Also, the species *F. aequatorialis* was registered in the Boka Kotorska Bay in significant numbers compared to other adult Appendicularia. This study provides new data on ecological fluctuations and their impact on zooplankton community in a closed neritic biotope such as the Boka Kotorska Bay.

Acknowledgements: This work was supported in part by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia through the grants 451-03-65/2024-03/200123, 451-03-66/2024-03/200287 and 451-03-66/2024-03/200002.

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Received: 16.10.2024
Accepted: 11.04.2025