ANNUAL VARIABILITY IN THE POPULATION DENSITY DISTRIBUTION OF APPENDICULARIANS IN COASTAL AREAS OF THE SOUTHERN ADRIATIC

Davor Lucic

Institute of Oceanography and Fisheries-Split, Laboratory of Plankton Ecology Dubrovnik,
Kneza Damjana Jude 12, HV-20001 Dubrovnik, Croatia

Abstract

Annual variability in the population density distribution of appendicularians was investigated in coastal areas of the southern Adriatic, Croatia. Appendicularians were registered in high abundances (>3000 ind.m^{-3}), especially for the juvenile specimens. In the moderately eutrophicated Gruz Bay, the total population densities in appendicularians significantly surpassed those registered in the oligotrophic Lokrum Channel (Student's *t*-test, $p<0.001$). Results indicated the existence of different density values for each 5-m depth interval.

Key-words: zooplankton, vertical profile, Adriatic Sea.

Appendicularians play important roles in transporting picoplankton production to higher trophic levels (1). Furthermore, the weight-specific filtering and growth rates are higher for appendicularians than for those of copepods (2, 3). During previous research on appendicularians in the Adriatic Sea, samples were collected using plankton nets of 250-300 (m mesh netting (4, 5, 6, 7). For these investigations, most of the appendicularian populations passed through the plankton nets, as proved by a sampling experiment (8). Consequently, accurate data on the quantitative composition of appendicularians could not be obtained from the samples.

This paper presents the results of a one-year study of appendicularian population density distributions at two stations (22-m depth) in the coastal waters of Dubrovnik (Fig. 1). The first station in the Lokrum Channel is located in an oligotrophic area that is directly influenced by offshore waters. The second station in the Gruz Bay is influenced by discharge from the karst River Ombla, offshore waters and slight anthropogenic eutrophication.

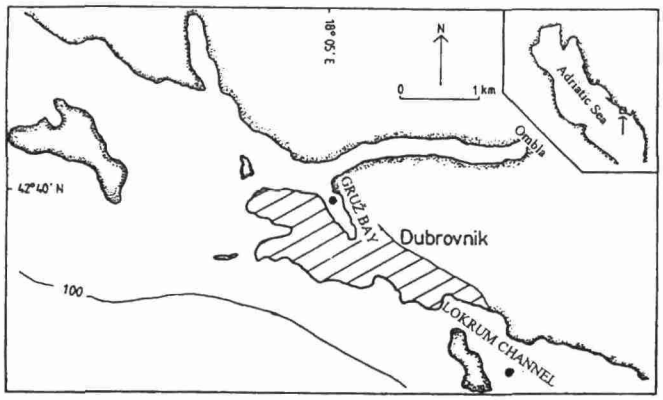

Figure 1. Location of the sampling station.

Thirteen daytime plankton samples were taken from March 1989 to May 1990. Appendicularians were sampled with a 250 l volume plankton sampler "Adriatic" (9), at 5-m intervals from the surface to the bottom using a gauze of 125 (m mesh netting. Temperature and salinity were determined by a Hydrobios LF 191 probe.

At both stations, an increase in surface temperatures in spring resulted in a thermal stratification of the water column as early as in May and a thermocline in summer, up to a 15 m depth. The vertical gradient weakened during autumn and a moderate temperature inversion occurred until springtime. The temperature range was from 12.3 to 25.4 °C in the Lokrum Channel and from 11.3 to 23.9 °C in the Gruz Bay. Salinity values recorded in the Lokrum Channel exceeded 37 psu below a 5 m depth and 38 psu below a 15 m depth. A minimum of 31.3 psu was recorded at the surface in August. The influx of waters from the River Ombla into the Gruz Bay resulted in low salinity values between 0 to 10 m depths, especially in spring, with a minimum of 26.7 psu at the surface in April. During the summer-autumn period, values >37 psu were found below 10 m depths.

In the Lokrum Channel, *Oikopleura longicauda* was the dominant species and contributed with 50.3% of the total abundance of appendicularians (Table 1). *Oikopleura dioica* dominated in the Gruz Bay and contributed with 45.9% of the total appendicularians. Both species were present in plankton throughout the year. *O. longicauda* was more abundant in the warmer season, and *O. dioica* during winter and spring. Among other appendicularian species, an increased number in *Oikopleura fusiformis* was recorded in fall, whereas *Fritillaria pellucida* was abundant in winter. *Fritillaria borealis* was present in all seasons, but never occurred in high numbers. In the Lokrum Channel, the species *Oikopleura cophocerca*, *Oikopleura graciloides*, *Oikopleura parva* and *Fritillaria haplostoma* occurred mostly in winter and *Kowalevskia tenuis* in summer. However, in spite of a relatively small sample volume (250 l), the previously established qualitative composition was confirmed (6).

Table 1. Appendicularian species found in Lokrum Channel and Gruz Bay, with their mean and Std abundance (Mean ± Std, ind.m^{-3}), maximum values of abudance (Max, ind.m^{-3}) and mean percentage of the total appendicularians abundance (%) during 1989/90.

	Lokrum Channel			Gruž Bay		
Species	Mean ± Std	Max.	%	Mean ± Std	Max.	%
Oikopleura cophocerca	1.1 ± 4.3	9	0.2			
Oikopleura dioica	41.9 ± 59.7	360	11.4	318.3 ± 416.8	1827	45.9
Oikopleura fusiformis	73.5 ± 164.2	750	18.9	98.4 ± 182.2	505	14.2
Oikopleura graciloides	1.5 ± 4.6	27	0.4			
Oikopleura longicauda	188.1 ± 272.6	1656	50.3	151.6 ± 227.3	1155	21.9
Oikopleura parva	0.3 ± 1.5	9	0.1			
Fritillaria borealis	12.5 ± 22.7	80	3.3	17.2 ± 35.7	72	3.0
Fritillaria haplostoma	2.5 ± 7.8	36	0.7			
Fritillaria pellucida	54.6 ± 191.4	1440	14.6	104.1 ± 336.1	1872	15.0
Kowalevskia tenuis	0.5 ± 2.7	9	0.1			

In addition, we have observed that in the shallow parts of the sampled area, daytime appendicularian density values were not uniformly distributed from the surface to the bottom. Therefore, the results obtained on the basis of the vertical hauls gave only average values per water column and did not reveal accurate total appendicularian numbers. In the Lokrum Channel, aggregations of juvenile specimens were recorded in increased numbers at all layers (Fig. 2). Their total number was 1.7 times more than that of adults. As many as 1590 ind.m^{-3} were noted at depths of 5 m in August, 1368 ind.m^{-3} at 20 m in December and 1836 ind.m^{-3} at 10 m in February. The majority of adults were found in layers below 15 m depths, except for February, due to the intrusion of *F. pellucida* (Fig. 2). Higher numbers were found in August, 1660 ind.m^{-3} and in late May, 1755 ind.m^{-3}.

In the Gruz Bay, total appendicularian population densities significantly surpassed those registered in the Lokrum Channel (Student's *t*-test, $p<0.001$). Most of the juvenile specimens were found at 5 and 10 m depths (Fig. 3), namely in the layers where surface brackish and offshore waters mingled. According to Vilicic *et al.*, (10) the highest concentrations of picoplankton can be found in these surface waters as many as 2828 ind.m^{-3} were recorded at depths of 5 m in August and 3200 ind.m^{-3} at 10 m in February. The total in juvenile specimens at this station was 1.9 times more than that of adults. As opposed to the Lokrum Channel, adult aggregations in the Gruz Bay were recorded throughout the water column. The highest values of 2181 ind.m^{-3} and 3890 ind.m^{-3} were noted at 15 m depths in August and in February, respectively (Fig. 3). In the Gruz Bay high average densities of bacterioplankton (2.6 x 10^9 cells l^{-1}) and nanophytoplankton (1.37 x 10^6 cells l^{-1}) tripled those recorded for open coastal waters (10, 11, 12). This is the reason why we consider the high appendicularian numbers in the Gruz Bay comparable only to the results presented by Uye and Ichino (13) for the eutrophic coastal area in the Seto Inland Sea, Japan. These authors have reported values of 10 to 50 ind.l^{-1} on the basis of samples collected during the night with vertical hauls using a plankton