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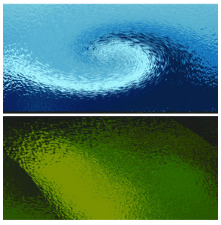

RESEARCH ARTICLE

Abra segmentum (Mollusca: Pelecypoda) of the Lesina Lagoon (Southern Adriatic coast, Italy): Observations on variations in the population in relation to the main environmental parameters.

Adele Fabbrocini*, Ombretta Di Matteo and Raffaele D'Adamo

National Research Council – Institute of Marine Science
via Pola 4, 71010 Lesina (FG) ITALY
*Corresponding author: tel.+39-0882-992702-05; fax+39-0882-991352; e-mail address: adele.fabbrocini@fg.ismar.cnr.it

Abstract

1 - The aim of this work was to evaluate the effects of the main chemical and physical environmental parameters on the dynamics of the population of A. *segmentum* living in the Lesina Lagoon, as a part of a wider study aimed at characterizing all the phases of the species' reproduction cycle in relation to the specific environmental conditions of the Lagoon.

2 - Sediment samples were collected at monthly intervals by using an Ekman scoop from May 2003 to May 2005; at each sampling site temperature, salinity and pH were recorded by multiparametric probe; in the laboratory the A. *segmentum* specimens were sorted by a 1 mm mesh sieve and the shell length was measured.

3 - During the two years of samplings, density levels tended to increase, a trend that was inversely correlated with the recorded decrease in salinity (Pearson's r=-0.66).

4 - Differences in the size class patterns were also found: in the 2003-04 samplings, the ≥ 13mm individuals represented the 20%÷50% of the total population, while juveniles disappeared on July 2003 and clearly reappeared only on February 2004. In 2004-05 samplings, juveniles were always recovered, while the oldest specimens, although increased in number, were never higher than 10% of the total population.

5 - The decreasing trend of salinity is supposed to be most important factor involved in the observed increase in population density, and in the consequent differences in the size class patterns.

Keywords: *Abra segmentum*, Lesina lagoon, population dynamics, temperature, salinity.

Introduction

The Lesina Lagoon is situated on the Adriatic coast of Southern Italy, on the northern side of the Gargano promontory (41.88°N; 15.45°E). It is a brackish basin (0.7-1.5 m deep), long and narrow in shape (about 22 Km in length and no more than 3 Km in width, lying along an East-West axis), with a surface area of 5100 ha, and is separated from the sea by a narrow strip of sand (De Angelis, 1964; Ricci-Lucchi et al., 2006). From the hydrological point of view, it is characterised by limited exchange with the sea (through the channels known as Schiapparo and Acquarotta), modest freshwater inputs and weak hydrodynamics (water residence time of 70-100 days, Ficca et al., 1996; Manini et al., 2002). The sediment is clayey-mud; the silt-clay fraction (having a grain size of <63 µm) accounts for about 90% of the total, the remainder being composed mainly of fragments of shells and other detrital organic matter; the Total Organic Matter (TOM) content is particularly high, varying between 8 and 15% (Fabbrocini et al., 2005b). The bed is partially covered by seagrass meadows of *Zostera* spp. in the western section and *Ruppia* spp. in the central-eastern section; the macrozoobenthic

populations are characterised by a low degree of diversification and are composed mainly of molluscs, annelids and crustaceans (Bedulli and Sabelli, 1990; Cozzolino, 1995a; Cozzolino, 1995b; Piscitelli et al., 2000; Nonnis-Marzano et al., 2003).

The bivalve detritivore *A. segmentum* (Récluz, 1843, sometimes described as *Abra ovata*, Philippi 1816), highly abundant among the macrobenthic fauna of the brackish lagoons of the Mediterranean (Sprung, 1994), is among the main components of the macrozoobenthos of the Lesina Lagoon (Bedulli and Sabelli, 1990; Cozzolino, 1995a; Nonnis-Marzano et al., 2003), where it lives buried in the sediment, providing one of the main sources of food for the valuable fish species, such as *Sparus aurata*, that grow to adulthood in the Lagoon.

The broad seasonal variations in the chemical-physical parameters that usually characterise coastal lagoons, together with the availability of food, can have a considerable effect on the dynamics (including the reproductive cycle and fluctuations in density, growth and survival) of the sessile fauna populations that live and reproduce in them (Rossi et al., 2001). This paper presents data concerning the effects of the main environmental parameters on the dynamics of the population of *A. segmentum* in the Lesina Lagoon, and are part of a broader study aiming to characterise the various phases of the reproductive cycle of *A. segmentum* in relation to the specific environmental conditions of the Lesina Lagoon.

Materials and Methods

Samples of sediment were taken using a Ekman scoop, which sampled 0.04m^2 of the bottom, each month from May 2003 to May 2005. For each sampling from 3 to 5 replicates were performed. No sampling was carried out in October-03, January, April and September-04 and January and April-05 due to adverse weather conditions.

The sampling area, lying between 41°52'32" and 41°53'30" N and between 15°25'24" and 15°27'57" E, was situated in the central part of the lagoon, which is characterised by lesser biocenotic animal and plant instability, because it is less influenced by the channels which link the lagoon to the sea and is furthest from urban discharges (Fig. 1). Temperature levels (°C), salinity (PSU) and pH were measured on the bottom at each sampling point, using a multiparametric probe (YSI 556MPS).

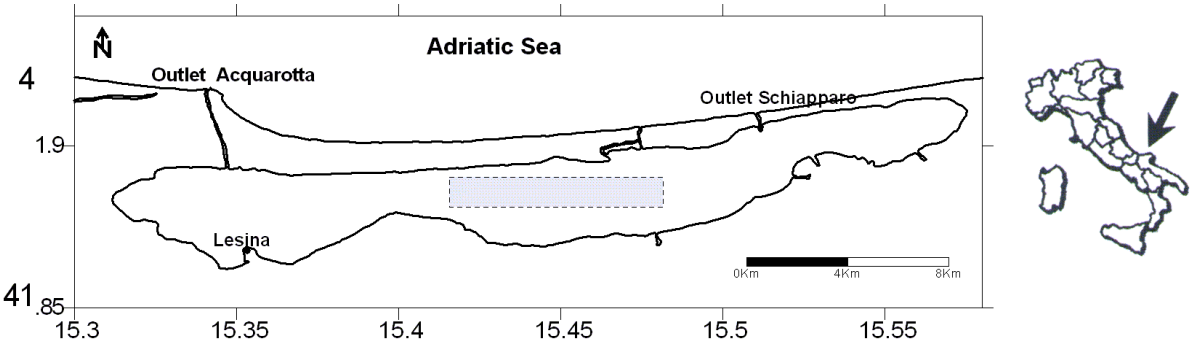

Figure. 1 - Lesina Lagoon and sampling area.

The sediment was passed through a 1 mm-mesh sieve and the exemplars of *A. segmentum* were removed and observed by stereomicroscope in order to carry out a preliminary identification of sexually mature individuals. The length of the valves was measured by callipers (with an accuracy of 0.05 mm), and the individuals were sorted into 1 mm size classes. Even if finer than 1

mm mesh sieves are known to better retain smallest macrobenthic individuals (Bachelet, 1990), due to the characteristics of the Lesina sediments, they could not be used as they were clogged up by its high detrital component.

Statistical analysis was performed using the STATISTICA 5.5 programme; relationships between environmental parameters and population density were determined using Pearson Correlation Analysis.

Results

Figure 2 shows the patterns of the main environmental parameters recorded in the sampling area. The temperature and pH values followed similar patterns in the two years, with no peaks or anomalous values with respect to the seasonal averages. In contrast, while salinity followed a cyclical seasonal pattern, closely linked to the rains and evaporation, it was characterised by a pattern of linear decline over the two-year period (R^2=0.64).

In total, 1059 exemplars of *A. segmentum* were recovered; the number of individuals found in the replicates performed for each sampling varied widely, suggesting a non-homogeneous distribution of the population; because of this the average density was characterised by a high standard deviation (70-100%). As shown in Fig. 3, the average

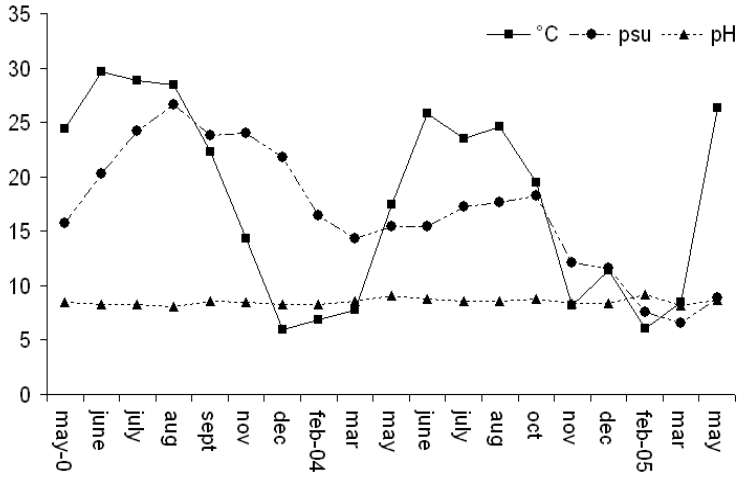

Figure. 2 - Trend of the main physical and chemical parameters at the water-sediment interface.

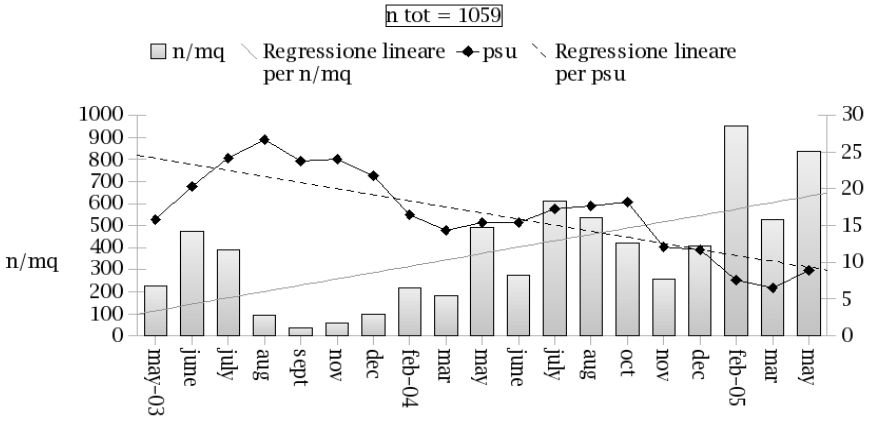

Fig. 3 - Trend of the *A. segmentum* population density (individuals/m2) in relation to the salinity (psu) trend. Dotted line: salinity linear regression; continuous line: population density linear regression.

density of the population followed a fairly annual cyclical pattern, more pronounced in the first sampling year than in the second one. In both the sampling years the greater densities were recorded in the summer months,

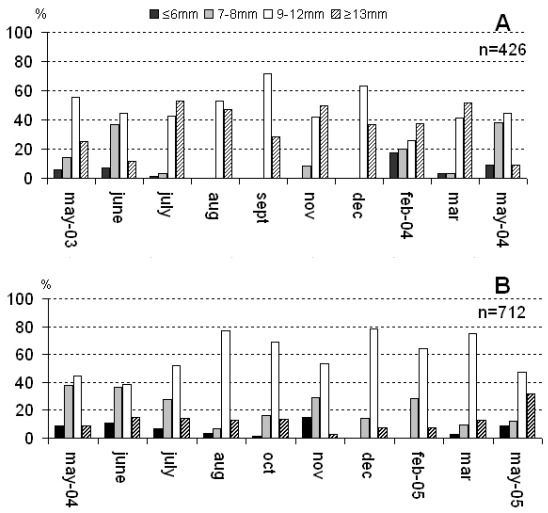

Figure. 4 - Frequency histograms (%) of the shell length (mm) during the two years of samplings. Note that the individuals recovered on May 2004 (n=79) are counted in both the A and B histograms.

with a subsequent fall in the number of individuals in the autumn and a new increase in population starting from February. A rise in the population density of *A. segmentum* was observed) over the sampling period as a whole (R^2=0.41); this increase was inversely correlated with the fall in salinity recorded from 2003 to 2005 (Pearson's r = -0.66, P < 0.05); conversely, no significant correlations were observed with temperature and pH .

An attempt to describe the size classes distribution was made even though, due to the low number of individuals collected, no statistical analysis was performed and in Fig. 4 they were grouped in larger than 1mm classes. As shown in Fig. 4 (A and B), the 9-12mm individuals always ranged from 40% up to 80% of the total recovered ones; on the contrary, the frequency pattern of the small size (≤ 8mm) and the large size (≥ 13mm) individuals strongly varied in the two sampling years (May 2003-04 vs May 2004-05). In the first year of samplings (Fig. 4A), the "old" individuals represented the 20%÷50% of the total population, while juveniles disappeared on July 2003 (less than 5%) and clearly reappeared only on February 2004. On the contrary, in the second year of samplings (Fig. 4B), juveniles were always recovered, while the oldest specimens, although increased in number, were never higher than 10% of the total population, up to May 2005.

Discussion

The *A. segmentum* population in the Lesina lagoon showed an increase in density and differences in the class size patterns during the two years of samplings.

The recorded increase in density population was significantly correlated only with salinity, which experienced, apart from the typical seasonal fluctuations, a downward linear trend (Figures 2-3), as a consequence of the increase in rainfall in the area, which in the period 2002-2004 rose from 600 to 850 mm/year (as measured by the Weather Station of the *Consorzio di Bonifica della Capitanata* land-improvement consortium of the province of Foggia).

On the other hand, the temperature pattern was substantially similar in the two years of sampling, (min 5 °C; max 30 °C; Fig. 2); studies carried out in areas other than the Mediterranean have shown that even very high summer temperatures have no influence on the reproduction and survival of *A. segmentum* and *A. tenuis*, which are put at risk only by winter temperatures of below 2 °C (Denis, 1981; Dekker and Beukema, 1999).

Nor does the availability of food seem to be a determining factor in the population dynamics of the *A. segmentum* considered in this study; indeed, by feeding on organic matter in the

sediment, detritivores are able to exploit even very poor nutritional resources, even where levels of organic matter are typically below 5% (Lopez and Levinton, 1987; Charles et al., 1995). Although the various components of the organic particulate matter in the sediment can have widely varying nutritional value, the levels of organic matter (8-15%) found in the sediment of the Lesina Lagoon (Fabbrocini et al., 2005b, relative to 2003) should amply cover the nutritional needs of its detritivore populations (Charles, 1993); this hypothesis is supported by the fact that in both years of sampling, the maximum size of the valves was more than 14 mm, similar to values recorded by other Authors in areas with high food availability (Denis, 1981; Nicolaidou and Kostaki-Apostolopoulou, 1988), and much larger than has been observed (about 9 mm) in populations living in areas with higher winter mortality and poor food availability (Sprung, 1994). In addition, studies carried out, in the same area and in the same period, on the hard substrate macrozoobenthic communities revealed some changes in the community assemblages, again related to the salinity drop (Nonnis Marzano et al., 2007).
It has to be pointed out, however, that *A. segmentum* coming from different areas show sometimes different population dynamics, even in the number of generation per year, the life span, the duration of pelagic and meiofaunal stages (Bachelet et al., 1986; Sprung et al., 1994), so that Reizopoulou and Nicolaidou (2007) suppose that "*A. segmentum* may adopt different strategies under different environmental conditions".
The analysis of the histological sections of the gonads, still in progress, will make it possible to identify the spawning periods of *A. segmentum* in both the years of samplings, evidencing any eventual difference in the reproductive success, in order to overcome the lack of informations about the first life stages of these bivalves in the Lesina lagoon, during the study period.

Conclusions

In conclusion, the population of *A. segmentum* in the Lesina lagoon showed a linear upward trend in the two years of sampling, inversely correlated with salinity. Considering that availability of food is not a limiting factor and that the temperature and pH patterns were broadly similar in the two years of sampling, it may be supposed that the decreasing trend of salinity would be most important factor in the observed increase in population density, and in the consequent differences in the size class patterns.

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