POPULATION DYNAMICS OF THE INTERTIDAL MYTILID

BRACHIDONTES RODRIGUEZII (BIVALVIA)

ON A ROCKY SHORE

M.L. ADAMI, A. TABLADO & M.A. SODOR(1)

Key words: Mussel, Brachidontes rodriguezii, intertidal, rocky shore, spatial variations, temporal variations, Argentina.

ABSTRACT

Population dynamics of the intertidal mytilid Brachidontes rodriguezii (Bivalvia) on a rocky shore. The mytilid Brachidontes rodriguezii is the key species that structures the intertidal benthic community of rocky shores from Buenos Aires Province. The aim of this work was to study the temporal-spatial dynamics of the population of B. rodriguezii from two localities (Quequén and Necochea) by analysing the variations of production and recruits density in vertical and horizontal slopes of the substrate throughout the year. The statistical analyses indicated that both the temporal and spatial variations of B. rodriguezii production were significant. In Necochea the production was higher in summer than in the other seasons, whereas in Quequén maximum production values were in winter. The population always showed a high percentage of recruits throughout a year, with a maximum of 58% recruits in Necochea during the summer. The differences found showed significantly spatial and temporal heterogeneity in the population patterns of B. rodriguezii.

INTRODUCTION

Intertidal mytilid populations usually form multistratified complex matrices with density-dependent effects on their survival and growth (Guiñez and Castilla, 1999). These matrices present a high heterogeneity in their structure (Suchanek, 1978, 1985), and have been considered both microhabitats that enhance the establishment of assemblages of different sessile and mobile organisms (Tokeshi et al., 1989), and communities in themselves (Reish, 1964; Penchasazadeh, 1973; Suchanek, 1978).

The little mussel, Brachidontes rodriguezii (d’Orbigny, 1846), forms beds on the intertidal rocky shore, monopolizing the primary substrate and competitively eliminating other sessile organisms (Adami, 2005). It develops best in the middle intertidal zone, where it displays several layers and higher densities (>150,000 ind.m⁻²) (Penchasazadeh, 1973). In other mytilids, this arrangement leads to a three-dimensional matrix with processes of self-thinning due to competition for food and space (Suchanek, 1985; Alvarado and Castilla, 1996). These processes, which occur in crowded animal and plant populations, play an important role in determining population dynamics and community structure (Westoby, 1984;
Weller 1987; Marquet et al., 1990, 1995; Fréchette and Lefaiivre, 1990; Petraitis, 1995; Fréchette et al., 1996).

Most of the studies on mussel beds carried out in the southwestern Atlantic Ocean have focused on the structure and dynamics of the whole community (Penchaszadeh, 1973; Otaegui and Zaixso, 1974; Zaixso and Pastor, 1977; López Gappa et al., 1990, 1993; Zaixso et al., 1994; Scelzo et al., 1996; Vallarino, 2002; Adami et al., 2004 and Bertness et al., 2006). Nobody identified to date, in Buenos Aires Province rocky shores, a key benthic predator able to regulate distribution and abundance of the intertidal mussel *B. rodriguezii*. Previous studies carried out in the same area (López Gappa et al., 1993; Adami et al., 2004, Adami, 2005) has revealed that the success in the development of these populations and their assemblage species could be affected by the primary substrate available and by conditions of environmental stress such as desiccation and high temperatures.

Although temporal and spatial variations in the abundance of individuals in the mussel bed of the Buenos Aires rocky shore have been documented, the information available is still fragmentary (Penchaszadeh, 1973; Brankevich et al., 1984; Nugent, 1989; Scelzo et al., 1996; Vallarino, 2002; Adami, 2005). Mussel beds of *B. rodriguezii* display a great proportion of small individuals (1 to 5 mm shell length) during the whole year (Nugent, 1989; Penchaszadeh, 1973; Vallarino, 2002; Adami, 2005). In addition, fouling experiments, with artificial substrata within Quequén Harbour, have been shown that maximum frequencies of the recruits of *B. rodriguezii* and *Mytilus edulis platensis* d’Orbigny, 1846 were between August and January, over several years (Brankevich et al., 1986).

The aim of this paper was to study the temporal and spatial dynamics of a population of *Brachidontes rodriguezii*, by analysing variations in production, and recruits density. Two localities (Quequén and Necochea) and two slopes of the substrate (Vertical and Horizontal) were compared throughout the four seasons of the year.

### MATERIALS AND METHODS

#### Study zone

The study was performed in two intertidal rocky shores of Buenos Aires province (Argentina), composed of loess platforms and were exposed to wave action. The first site was located 4 km towards the east of Quequén Harbour (38º 34’ 11”S, 58º 39’ 17”W) (Fig. 1), and hereafter called Quequén. Since the Quequén Grande estuary influences this site, it shows salinity changes induced by the direction of the wind. Although values between 26.8 and 34.4 psu were reported in the course of this research, in previous studies in the same area (López Gappa et al., 1990) salinity was recorded to be between 24.1 and 24.4 psu. Horizontal loess platforms in this area step down towards the sea, with 40 to 60 cm differences in surface level, which can be observed during the low tide. The width of the intertidal zone in this locality ranges between 40 and 70 m during the low tide (López Gappa et al., 1990).

![Location of the study area](image)
The other site, hereafter called Necochea, is located ca. 8 km towards the west of the city of Necochea, (38° 37’ 10”S, 58° 49’ 22”W). This area is away from the influence of the Quequén Grande estuary, and displays normal values of salinity for a seawater area (33 psu). The intertidal rocky shore in this locality consists of a practically horizontal platform of loess without steps.

**Sampling and data analysis**

Samples were collected at random in the middle intertidal level during low tide in August 1999 (winter), November 1999 (spring), February 2000 (summer), and June 2000 (autumn). A total of 12 samples were taken on each date: four horizontal replicates at both Necochea and Quequén, and four vertical replicates only at Quequén. Substrate slopes could only be compared in Quequén because there were no vertical surfaces available in Necochea.

Corer samples of 10.7 cm² were taken to estimate density (ind.m⁻²), biomass (g.m⁻²), and length (mm). Taken in account *Brachidontes rodriguezii* densities known for this area (López Gappa *et al*., 1990; Adami *et al*., 2004), the expected number of individuals on each sample might be between 50 and 250. All mussels were fixed in 10% formalin and later transferred to 70% ethanol.

In order to integrate density and biomass in only one value, the production (g.m⁻².year⁻¹) of *B. rodriguezii* was estimated using the allometric equation derived by Brey (1990):

\[ P = D \times \left( \frac{B}{D} \right)^{0.72} \]

where B is biomass (g.m⁻²), D is density (ind.m⁻²), B/D is the mean body size, and 0.72 is the average exponent for the regression of annual production on body size for molluscs.

To compare production values and densities of the recruits between sites/slopes (Horizontal Quequén vs. Necochea, Horizontal Quequén vs. Vertical Quequén) at different times, two-way ANOVA was used. Homogeneity of variances was verified using Cochran’s C test. As regards the recruit densities, the ANOVA was made after an arcsin transformation, in order to verify the ANOVA statistical assumptions. Significant results were then analysed with the Fisher’s LSD (Least Significant Difference) Test, (Sokal and Rohlf, 1981) and Bonferroni’s correction was taken into account to ensure that the type-one error for all tests remained 0.05.

Small mussels (<10 mm) were counted below a micrometric eyeglass, and individuals smaller than 3 mm were considered recruits.

**RESULTS**

The estimation of production for *Brachidontes rodriguezii* showed significant spatial and temporal differences. Two-way ANOVA analysis did not show differences neither among all seasons nor sites, but interaction was significant because production was significantly higher in Necochea than in Quequén only in summer. On the other hand, mussel production showed differences between seasons and between slopes when it was analysed in Quequén: production values were significantly lower on vertical surfaces.
than on horizontal ones and in spring than in winter. Furthermore, production values showed significant differences between seasons in Necochea too, but the LSD tests did not allow to know which season was significantly different (Table 1, Fig. 2).

Recruit density showed significant seasonal and spatial differences. It was higher in summer and autumn (64.4% and 58.6% of individuals in the population, respectively) than in spring (only 35.3% of individuals in the population). The horizontal surfaces reported recruit density values which were five times higher than vertical ones, but recruit density differences between sites were not significant (Tables 2 and 3).

**DISCUSSION**

*Brachidontes rodriguezii* is the dominant species in the intertidal rocky shore of Quequén and Necochea both because its high production and it monopolizes the primary substrate (López Gappa *et al.*, 1990, 1993). Populations of this small mussel form a complex matrix that consists of recruits, juveniles and adults, which, just as other mytilid species, are arranged in a stratified way forming several layers of individuals (Alvarado and Castilla, 1996; Guiñez and Castilla, 1999; Commito and Rusignuolo, 2000).

Due to the fact that vertical surfaces are less exposed to direct solar irradiation than horizontal ones, they might operate as a shelter from desiccation stress for *M. edulis platensis* (Adami *et al.*, 2004). Nevertheless, Penchaszadeh (1973) observed that beds of *B. rodriguezii* developed on vertical substrates, but wave action protected (on metamorphic rock in Mar del Plata), showed a major stratification and, therefore, greater abundance and biomass per area unit than the values found on horizontal surfaces. However, it must be taken into account that intertidal hard substrates of Quequén and Necochea are made of softer and brittler rock than Mar del Plata ones (Amor *et al.*, 1991).

The phenomenon of continuous recruitment on the intertidal rocky shore of *Brachidontes rodriguezii*
Population Dynamics of the Intertidal Mytilid “Brachidontes Rodriguezii” (Bivalvia) on a Rocky Shore throughout the whole year has also been described by Penchazsadeh (1973), Brankevich et al. (1986), López Gappa et al. (1993), Scelzo et al. (1996) and Vallarino (2002). In the present study, a high proportion of recruits of over 64% was observed, although there were significant differences depending on the season and the slope of the rock surface (Tables 2 and 3). The maximum recruitment rates (Table 3) agree with those of Brankevich et al. (1986), who determined a period of maximum recruitment, on experimental panels inside Quequén harbour, between August and January. Maximum recruitment values have also been previously recorded in clear areas in Quequén during January (Adami, 2005). Nevertheless, Vallarino (2002) showed maximum recruitment densities in autumn and spring in Mar del Plata, whereas Nugent (1989) observed an increase in the number of recruits starting in spring and extending throughout the summer, with another peak at the beginning of winter in the same area. On the other hand, populations of PeruMytilus purpuratus (Lamarck, 1819) in Central Chile have shown an annual peak of recruitment during mid- and late summer (Alvarado and Castilla, 1996). Therefore, the information available seems to show that although B. rodriquezii individuals are recruited during the whole year, recruitment rates among localities change from year to year.

The planktonic larvae of Mytilids migrate to temporarily settlement on filamentous algae, and then from these to permanent places into adult mussel beds. Therefore, the first phase of settlement would then be a natural and necessary prelude to final settlement, and not a case of erroneous settlement on inadequate substrate (Bayne, 1964). Several species of Mytilus are attached to a wide variety of filamentous substrates, including bisal filaments of adult individuals of the same species (Petratis, 1978; Suchaneck, 1981; Hosomi, 1984) and filamentous algae (Paine, 1974; Suchaneck, 1978; Petersen, 1984a, b; King et al., 1990). For example, thicker algae like Corallina spp. or Gigartina spp. might satisfy the recruits for a longer period of time than other extremely thin filamentous ones. In the studied area, this primary substrate for the recruitment of planktonic larvae to the benthic environment might be Corallina cf. officinalis (Linneo, 1758). This red alga forms a dense coverage in low intertidal and infralitoral level and high numbers of B. rodriquezii recruits have been found among their turfs (Liuzzi and López Gappa, 2006).

The populations of B. rodriquezii previously studied do not tend to show seasonal variations in their coverage (López Gappa et al., 1993), density and biomass (Vallarino, 2002) or number of

<table>
<thead>
<tr>
<th>Season</th>
<th>Recruits (Density (ind. m$^{-2}$)</th>
<th>%</th>
<th>Juveniles and Adults (Density (ind. m$^{-2}$)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autumn</td>
<td>83016</td>
<td>58.6</td>
<td>58619</td>
<td>41.4</td>
</tr>
<tr>
<td>Winter</td>
<td>62303</td>
<td>44.5</td>
<td>77858</td>
<td>55.5</td>
</tr>
<tr>
<td>Spring</td>
<td>28081</td>
<td>35.3</td>
<td>51414</td>
<td>64.7</td>
</tr>
<tr>
<td>Summer</td>
<td>151132</td>
<td>64.4</td>
<td>83671</td>
<td>35.6</td>
</tr>
</tbody>
</table>

Table 2: Mean density (ind.m$^{-2}$), percentage of recruits (<3 mm), and juveniles and adults (>3 mm) for each season and sites/slopes.
individuals in the whole community (Scelzo et al., 1996). However, the significantly larger production of *B. rodriguezii* observed in Necochea during the summer (Table 1) may be a direct consequence of the highest recruitment that took place in that season. On the other hand, Quequén locality showed the minimum production value during the spring due to the lowest recruitments. Seasonal production changes observed in this study appear to be consequence of the seasonal recruitment changes (Table 1, 2 and 3).

*Brachidontes rodriguezii* is the dominant species on the intertidal rocky shores in Buenos Aires Province, so its role as habitat-forming to the benthic community must be assessed in space and time. In our study, the mussel beds showed spatial and temporal heterogeneity in the production patterns. This could be the consequence of the time when recruits settle, the influence of the oceanographic process through to larval transport and dispersion, and the micro-environmental factors such as the substrate slope, desiccation stress, etc. A better understanding of these patterns would help to know which are the key processes that regulate them.

**ACKNOWLEDGEMENTS**

This paper was carried out by reanalysing part of Mariana Adami doctoral thesis data, so we are grateful to Juan José López Gappa, who directed her, and to the National Council for Scientific Research (CONICET) in Argentina for financial support to her doctoral studies. We wish to thank to Javier Calcegno for statistical analyses review, Maria José Petinaroli for grammatical review, Guido Pastorino and Lobo Orensanz for general review on the manuscript, the authorities and staff at Puerto Quequén Hydrobiological Station for technical assistance in the field works.

**REFERENCES**


with varying wave forces in central Chile. Marine Ecology Progress Series, 133: 135-141.


(Received:February, 2, 2008; Accepted: May, 05, 2008)