



Density and spatial distribution of *Ocypode quadrata* (Decapoda, Ocypodidae) in an insular environment in the state of Rio de Janeiro, southeastern Brazil

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Abstract. *Ocypode quadrata* is a crab species distributed from United States of America to Brazil which is frequently found in supratidal zones of sandy beaches, where they built burrows. The counting of the number of burrows allows sample of both population densities and spatial distribution of individuals. To study these parameters of *O. quadrata* in Vila Dois Rios, southeastern Brazil, were delimited plots (3.14 m²) to distances from nearest backshore vegetation that varied from 1 to 10 m (60 plots = 188.4 m²). Burrows' density in Vila Dois Rios was 0.67 burrows/m² (126 burrows). The density of burrows of this species might vary influenced by local environmental factors (e.g. tides). The distances of the burrows from the vegetation and the diameter of its openings averaged 357.1 ± 272.7 cm (N = 83) and 15.1 ± 8.3 mm (N = 83), respectively. Larger burrow openings were built near the vegetation. It is possible that larger-sized individuals might exclude smaller ones from this region which may have more protection against energy of tides and flooding and a potential higher availability of food resources. Moreover, smaller-sized crabs might occupy areas near the sea due to lesser capacity of excavation than adults and/or to avoid the risk of desiccation due to their high surface/volume ratio. This study in Vila Dois Rios reinforces the occurrence of the construction of burrows near to the vegetation by larger *O. quadrata*.

Keywords: Burrow size, burrow diameter, Decapoda, Malacostraca, population densities.

Resumo: Densidade e distribuição espacial de *Ocypode quadrata* (Decapoda, Ocypodidae) em um ambiente insular no estado do Rio de Janeiro, sudeste do Brasil. *Ocypode quadrata* é uma espécie de caranguejo distribuída desde os Estados Unidos da América até o Brasil frequentemente encontrada em zonas supratidais de praias arenosas, onde constroem tocas. A contagem do número de tocas permite amostrar densidades populacionais e a distribuição espacial dos indivíduos. Para estudar estes parâmetros de *O. quadrata* em Vila Dois Rios, sudeste do Brasil, foram delimitadas parcelas (3.14 m²) a distâncias a partir da vegetação pós-praia que variaram de 1 a 10 m (60 plots = 188.4 m²). A densidade de tocas em Vila Dois Rios foi de 0.67 tocas/m² (126 tocas). A densidade de tocas desta espécie pode variar influenciada por fatores ambientais locais (e.g. marés). A distância dos abrigos a partir da vegetação pós-praia e a largura das aberturas dos abrigos mediram 357,1 ± 272,7 cm (N = 83) e 15,1 ± 8,3 mm (N = 83), respectivamente. Tocas com aberturas maiores foram construídas próximas à vegetação. É possível que indivíduos maiores possam excluir aqueles menores desta região que oferece maior proteção contra a energia das marés e inundações e uma

potencial maior disponibilidade de recursos alimentares. Além disso, caranguejos menores podem ocupar áreas mais próximas ao mar devido à sua menor capacidade de escavação do que a de adultos e/ou para evitar os riscos de dessecação devido à sua relativa maior relação superfície/volume. Este estudo em Vila Dois Rios reforça a ocorrência da construção de tocas próximas à vegetação por indivíduos maiores *O. quadrata*.

Palavras-chave: Decapoda, densidade populacional, diâmetro da toca, Malacostraca, tamanho da toca.

INTRODUCTION

Ocypode quadrata (Fabricius, 1787) is a crab species that lives in coastal areas with geographic distribution ranging from Rhode Island (United States of America) to Rio Grande do Sul (southern Brazil) (POWERS, 1977). This species lives mainly in supratidal zones, building in the sandy substrate burrows which they use for shelter (MILNE & MILNE, 1946; POWERS, 1977; ALBERTO & FONTOURA, 1999). Some authors showed the role of *O. quadrata* crabs as biological indicators of quality of environments exposed to anthropogenic pressures (ALBERTO & FONTOURA, 1999; BLANKENSTEYN, 2006; ARAUJO *et al.*, 2008; SOUZA *et al.*, 2008; MAGALHÃES *et al.*, 2009), which highlights its importance. The counting of the openings of the burrows that *O. quadrata* dig in the sand is a simple and fast strategy of obtaining population densities for this species (*e.g.* ALBERTO & FONTOURA, 1999; BLANKENSTEYN, 2006; ARAUJO *et al.*, 2008), and also can be used in studies concerning spatial distribution and habitat use.

There are reports of occurrence of larger burrows of *O. quadrata* in areas located farther from the water, *i.e.* near the backshore vegetation of sandy beaches (*e.g.* FISHER & TEVESZ, 1979; TURRA *et al.*, 2005; PEREZ & VIANNA, 2007; SOUZA *et al.*, 2008), which might confer advantages with regard to food resources availability (WOLCOTT, 1978; SOUZA *et al.*, 2008) and protection. Based on burrow openings built by individuals of this species, the goal of this study was (1) to estimate the population density of *O. quadrata*,

and (2) to analyze the spatial distribution of these crabs in an insular environment in Brazil.

MATERIAL AND METHODS

Field work was carried out throughout two days in Vila Dois Rios beach (23°11'S 44°12'W) in Ilha Grande, an island located in the municipality of Angra dos Reis, in the east of the state of Rio de Janeiro, southeastern Brazil, during November 2011. The beach is located in the south side of the island, which is facing the ocean. Its size along-shore is approximately 1 km, and the distances across-shore varies in different parts of the beach because of the topography of the terrains and of tide regimes. The beach in Vila Dois Rios is characterized by low waves, and is classified as dissipative. The beach is located in an area with relatively few human occupations shortly after the bare sand; however, there are some constructions in part of the beach. In more interior areas of the locality, there are some constructions, and the vegetation after the beach was modified. The majority of the beach in Vila Dois Rios has backshore vegetation, and there are no obstacles which disable the crabs to disperse to the coastal plain.

In the beach, the distances from the vegetation were raffled (1 to 10 m) at which 1 m-radius circular plots (3.14 m²) were established on the sand. This procedure was performed every 10 m, totaling approximately 188 m² of area sampled (60 plots). The number of opened burrows in each plot were counted and the density of *O. quadrata* was estimated

through the ratio between the total number of openings and the total area sampled (burrows/m²). The distance of each opening of burrow to the nearest backshore vegetation (measure tape precision of 1 mm) and the diameter of their openings (caliper precision of 0.05 mm) were measured, and interaction between these variables was evaluated through Spearman's nonparametric correlation analysis.

RESULTS

One hundred and twenty six burrows built by *O. quadrata* crabs were counted inside the circular plots delimited on the sand in the beach habitat in Vila Dois Rios, which ranged from zero to eight burrows per plot examined. The population density

estimation of *O. quadrata* in the study site, based on the number of burrows found inside the plots, was 0.67 ± 0.68 burrows/m² (range: 0 – 2.5 burrows/m²; 188 m² of area sampled).

With regard to the spatial distribution of individuals of this species, the distance of the burrows from the backshore vegetation and the width of openings of burrows dug by *O. quadrata* in Vila Dois Rios averaged 357.1 ± 272.7 cm (range: 0 – 1000.5 cm, N = 83) and 15.1 ± 8.3 mm (range: 6.1 – 46.3 mm, N = 83), respectively. The size of the burrows was negatively correlated to the distance from the backshore vegetation Spearman's nonparametric correlation, $R_s = -0.545$, $P < 0.0001$).

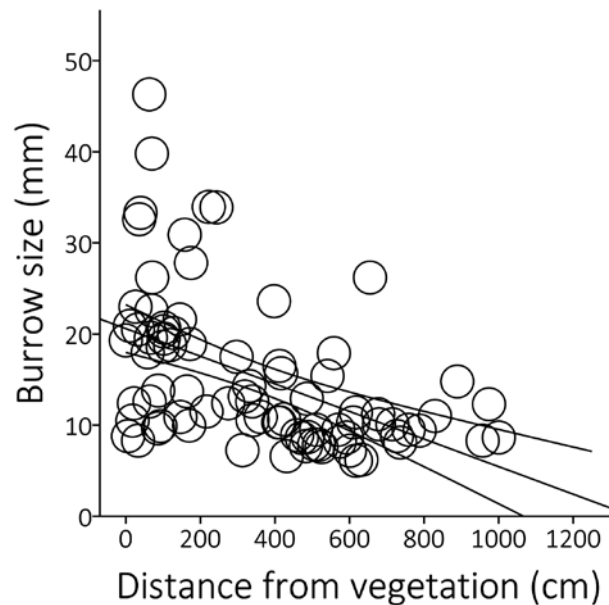


Figure 1. Correlation between the diameter (in mm, log) of the openings of burrows of *Ocypode quadrata* (N = 83) and the distance from the backshore vegetation (N = 83) in an insular habitat in Vila Dois Rios beach, municipality of Angra dos Reis, state of Rio de Janeiro, southeastern Brazil.

DISCUSSION

The density of *O. quadrata* found in Vila Dois Rios is an intermediate value for this species compared to other beach habitats in South America, Central

America, and North America (Table 1). The densities of *O. quadrata* might vary due to changes in characteristics of the beaches where it occurs. Local environmental factors, such as environmental

temperatures, tide levels, water salinity, sand grain size, and the direction and intensity of wind might cause fluctuations in density of burrows of this species, with individuals closing the burrows and burying themselves into the sand, or constructing their burrows in alternative sites, when affected by these factors (ALBERTO & FONTOURA, 1999; TURRA *et al.*, 2005; DA ROSA & BORZONE, 2008). Furthermore, exposure to anthropogenic pressures also might affect the density of their burrows in different habitats. For instance, BLANKENSTEYN (2006) suggested that beaches with a greater availability of food resources left by humans might have higher densities of *O. quadrata*, while areas exposed to traffic of vehicles (with the consequent destruction of sand dunes) and fisheries activities may have reduced densities of this crab species. In sandy beaches impacted by vehicle traffic, individuals of *O. quadrata* may display changes in movement rates and in behavior: in areas with tire

track marks the crabs travelled shorter distances in a more erratic way pattern (zigzag), and they also had smaller home ranges (SCHLACHER & LUCREZI, 2010). In the state of Pernambuco, it was reported that a higher number of *O. quadrata* burrows was found in non-urban beaches compared to urban ones (SOUZA *et al.*, 2008). Despite of the beach of Vila Dois Rios is relatively non-urban, there are daily fluxes of tourists which might affect density of burrows of this species, and may have contributed to the observed value of estimated density. Nevertheless, OCAÑA *et al.* (2012) did not find evidence of direct relationship between the level of human impact and the density of ghost crab burrows. They suggested that the variation in density may result from other factors that are acting in close contact, which must be evaluated simultaneously in a single model to elucidate the relative contribution of each factor to modulate the population dynamics of this species.

Table 1. Density of burrows of *Ocypode quadrata* (burrows/m²) in beaches in different localities in South America (Brazil), Central America (Cuba; 8 beaches), and North America [Mexico and United States of America (USA)], and the source of the data.

Locality	Range of density (burrows/m ²)	Reference
North America		
North Carolina, USA	0.005 – 0.014	WOLCOTT & WOLCOTT, 1984
Veracruz, Mexico	0.49 – 1.79	VALERO-PACHECO <i>et al.</i> , 2007
North Carolina, USA	0.02 – 0.13	HOBBS <i>et al.</i> , 2008
Central America		
Northeastern coast, Cuba	0.13 – 0.29	OCAÑA <i>et al.</i> , 2012
South America		
Rio Grande do Sul, Brazil	0.06 – 0.7	ALBERTO & FONTOURA, 1999
São Paulo, Brazil	0 – 2.85	TURRA <i>et al.</i> , 2005
Santa Catarina, Brazil	0.78 – 2.13	BLANKENSTEYN, 2006
Rio Grande do Sul, Brazil	0.3 – 5.0	NEVES & BENVENUTI, 2006
Espírito Santo, Brazil	0.08 – 0.33	ARAUJO <i>et al.</i> , 2008
Pernambuco, Brazil	0.3 – 0.57	SOUZA <i>et al.</i> , 2008
Paraná, Brazil	0 – 5.7	DA ROSA & BORZONI, 2009
Rio de Janeiro, Brazil	0.67	PRESENT STUDY

Evaluation of data obtained in Vila Dois Rios revealed that the size of the burrows of *O. quadrata* was negatively correlated to the distance from the backshore vegetation. In other words, there was a trend of construction of larger burrows near to the vegetation zone of the beach. A similar result was also found in previous studies with this species (MILNE & MILNE, 1946; FISHER & TEVESZ, 1979; DUNCAN, 1986; ALBERTO & FONTOURA, 1999; PEREZ & VIANNA, 2007; ARAUJO *et al.*, 2008; SOUZA *et al.*, 2008; BRANCO *et al.*, 2010; OCAÑA *et al.*, 2012). Burrows dug in regions near to the backshore vegetation tend to be more protected against both flooding (which might drown these crabs – see MILNE & MILNE, 1946) and structural damages caused by hydrodynamic energy of tides. An additional advantage of this proximity may result from the potential higher food availability in this region of the beach (WOLCOTT, 1978; SOUZA *et al.*, 2008). Smaller crabs might be excluded from these potential better quality areas by larger crabs. Moreover, smaller crabs might occupy areas near to the water due to their lesser capacity to dig deep burrows than adults (FISHER & TEVESZ, 1979) and/or to their higher susceptibility to dehydration related to high surface/volume ratio. MILNE & MILNE (1946) suggested that adult *O. quadrata* seems to be more resistant to higher environmental temperatures depending on moisture content of their gill chambers, and juvenile crabs appear to use less terrestrial habitats than do conspecific adults. Despite data limitation with regard to spatial and temporal samplings (considering that *O. quadrata* crabs have variability in abundance of juveniles and adults among localities and along the year), the findings in Vila Dois Rios reinforces the importance of construction of burrows near vegetation by larger *O. quadrata*, which could gain advantages of protection from threats to the burrows' galleries and to

themselves and of greater supply of food resources near the vegetation.

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