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Size overlap in intertidal decapod communities along the chilean coast

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Summary: The intertidal crustaceans on the Chilean coast are characterized by high diversity and niche specialization. The present study applied a size overlap null model for intertidal decapod communities at four different sites on the Chilean coast. The results revealed that there is a size overlap for the four sites, though body size is significantly different for each location. This means that the reported species would share their ecological niches. The results agree with the first classic environmental descriptions for Chilean intertidal decapods at a local scale and support the observations for similar species on the southern Pacific and southern Atlantic coasts.

Keywords: intertidal decapods; rocky shore; null models; size overlap.

Superposición de tamaño en comunidades de decápodos a lo largo de la costa chilena

Resumen: Los crustáceos intermareales en la costa chilena se caracterizan por su gran diversidad y especialización de nicho. El presente estudio tiene como objetivo aplicar un modelo nulo de superposición de tamaño para comunidades de decápodos intermareales en cuatro sitios diferentes de la costa chilena. Los resultados obtenidos revelaron que existe una superposición de tamaño para los cuatro sitios estudiados, a pesar de que el tamaño del cuerpo es significativamente diferente para cada ubicación. Esto significa que las especies reportadas tendrían una superposición de tamaño, lo que significa que las especies reportadas compartirían sus respectivos nichos ecológicos. En este contexto, los resultados estarían de acuerdo con las primeras descripciones ambientales clásicas para los decápodos intermareales chilenos a escala local, y apoyaría las observaciones de especies similares en el Pacífico sur y la costa sur del Atlántico.

Palabras clave: decápodos intermereales; costa rocosa; modelos nulos; superposición de tamaño.

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INTRODUCTION

The Chilean intertidal decapod fauna is characterized by the presence of a wide range of species along the whole continental territory and Peruvian coast and species reported only for the southern coast that can be shared with the southern Atlantic coast (Retamal 1981, Retamal and Moyano 2010, Vega-Aguayo et al. 2018). The ecological role of these decapods is detritivorous, and they inhabit mainly lower intertidal levels (Bahamonde and López 1969, Sanhueza et al. 1975, Vega-Aguayo et al. 2018).

The rocky shores between northern and southern central Chile (17-41°S) are characterized by the presence of coasts exposed to waves, with high productivity mainly in northern Chile because of the cold water of the Humboldt Stream that generates high species diversity (Santelices 1992). The rocky shores have high species richness because they provide environmental heterogeneity in term of microhabitats that can sustain high species diversity (Bahamonde and López 1969, Sanhueza et al. 1975, Santelices 1992).

To the south of 41° latitude there are many inner seas and estuaries characterized by low salinity and relatively low productivity and species richness in comparison with northern and central Chilean rocky shores (Retamal 1969, Santelices 1992, Vega-Aguayo et al. 2018). A similar situation has been reported for the southern Atlantic coast in Argentina (Boschi and Gavio 2005).

Community ecology proposes the use of null models to determine whether communities are structured or random (Gotelli and Graves 1996). One of the models proposed is called size overlap, which is based on the assumption that, in conditions of niche overlap, the ecological niche is shared by the involved species because of the absence of interspecific competence (Gotelli and Graves 1996, Gotelli and Entsminger 2009).

The present study aims to apply a size overlap null model to understand decapod community ecological patterns and structures and compare sizes within sites for decapod communities in four intertidal rocky environments in northern Chile (Antofagasta, 23°S and Caldera, 27°S) and southern Chile (Pargua, 41°S and San Juan 42°S) (Fig. 1) that are different types of rocky shores.

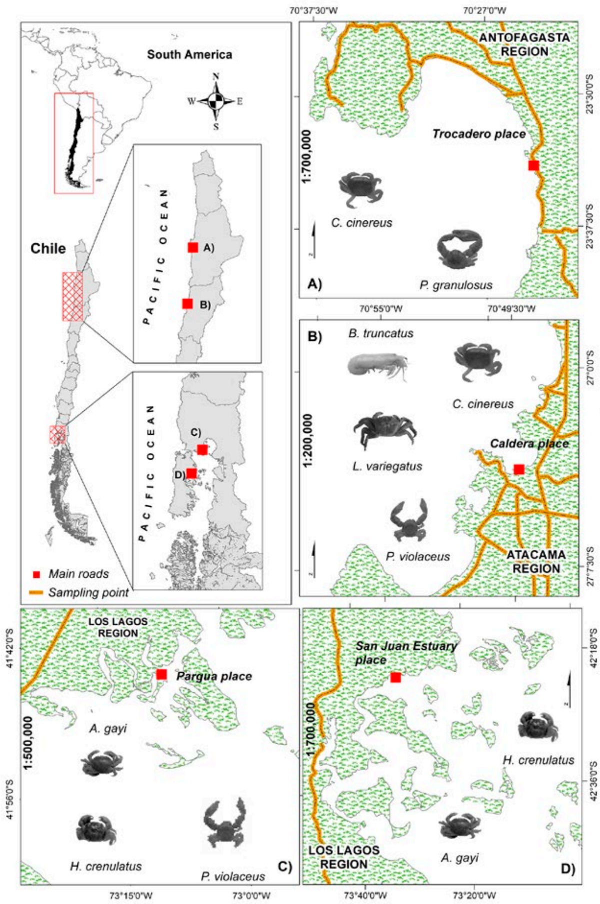

Fig. 1. – Map of sites included in the present study.

MATERIALS AND METHODS

Specimens were collected manually from rocky intertidal shores at study sites during low tide in the austral autumn and spring of 2016 (Pargua and San Juan Estuary in May 2016, Trocadero, in September 2016, and Caldera in October 2016; Table 1). They were identified according to Retamal (1981). Total length of the collected samples was measured according to Bahamonde and López (1969) and Sanhueza et al. (1975).

Total length within reported species was compared for each site. A non-parametric Wilcoxon test was used for sites with two species, whereas a Kruskall-Wallis test was used for sites with more than two species. Successive non-parametric Wilcoxon tests within pairs were used for multiple comparison (Desu and Raghavarao 2004). All of these analyses were applied using the R software (R Development Core Team 2009).

The null model is size structure, was applied for total length collected specimens, and it was applied to determine the non-random patterns in size overlap of species. The data for this analysis consisted of a matrix in which each species was a row, and each site was a column (Gotelli and Graves 1996, Gotelli and Entsminger 2009). Entries in the matrix represented the mean size length of each species. The original matrix was then reshuffled to produce random patterns that would be expected in the absence of competitive interactions. The options minimum difference and size uniform were used. These null model analyses were performed using the EcosimR package (Gotelli and Ellison 2013) and the R software (R Development Core Team 2009).

RESULTS AND DISCUSSION

On the northern coast of Chile, the species *Cyclograpsus cinereus* Dana, 1851 and *Petrolisthes granulosus* (Guèrin, 1835) were observed at the Trocadero site, located within Antofagasta town, and the species *Betaeus truncatus* Dana, 1852, *C. cinereus*, *Leptograpsus variegatus*, (Fabricius, 1793) and *Petrolisthes violaceus* (Guerin, 1831) at the site near Caldera town. On

Table 1. – Geographical location, species reported and total length for species reported in sites included in the present study.

Site	Geographical location	Species reported	Total length (mm)
Trocadero	23°34′S 70°23′W	*Cyclograpsus cinereus* Dana, 1851	4.9±1.0 (n=5)
		Petrolisthes granulosus (Guerin, 1835)	6.6±0.9 (n=7)
Caldera	27°04′S 70°49′W	*Betaeus truncatus* Dana, 1852	29.2±4.9 (n=12)
		Cyclograpsus cinereus	6.2±1.1 (n=12)
		Leptograpsus variegatus (Fabricius, 1793)	53.2±3.2 (n=6)
		Petrolisthes violaceus (Guerin, 1831)	11.7±1.8 (n=12)
Pargua	41°46′S 73°08′W	*Acantocyclops gayi* (H. Milne Edwards and Lucas, 1844)	18.6±3.5 (n=20)
		Hemigrapsus crenulatus (H. Milne Edwards, 1837)	25.2±3.6 (n=5)
		Petrolisthes violaceus	11.2±2.9 (n=10)
San Juan estuary	42°19′S 73°29′W	*Acantocyclops gayi*	17.9±5.3 (n=15)
		Hemigrapsus crenulatus	17.0±3.5 (n=15)

the northern coast of Chile, the species *Acantocyclops gayi* (H Milne Edwards and Lucas, 1844), *Hemigrapsus crenulatus* (H Milne Edwards, 1837) and *P. violaceus* were observed at the Pargua site and *A. gayi*, and *H. crenulatus* at the San Juan estuary site (Table 1). The null model results for all the study sites revealed the presence of size overlap for all sites (Table 2, Fig. 2). The total length comparison denoted significant differences for all reported species within the study sites (Table 2).

The results of the size overlap null models indicate that the involved species have no niche segregation. The species richness of crustaceans on rocky shores is high at large scales (kilometres), with a marked niche segregation because of environmental heterogeneity (Lardies and Werthman 1996, Hernáez and Palma 2003, Díaz et al. 2013), but at a local scale there would be no niche segregation because two or more similar species may share microenvironments (Antezana et al. 1965, De los Ríos et al. 2018, Vega-Aguayo et al. 2018), such as intertidal pebbles, because of the absence of competence with other decapod species (Bahamonde and López 1969, Sanhueza et al. 1975, Hernáez and Palma 2003). The results obtained in the present study agree with similar observations for the south American Atlantic coast, including that of southern Argentina (Gerard et al. 1999, Boschi and Gavio 2005, Camiolo and Luppi 2016).

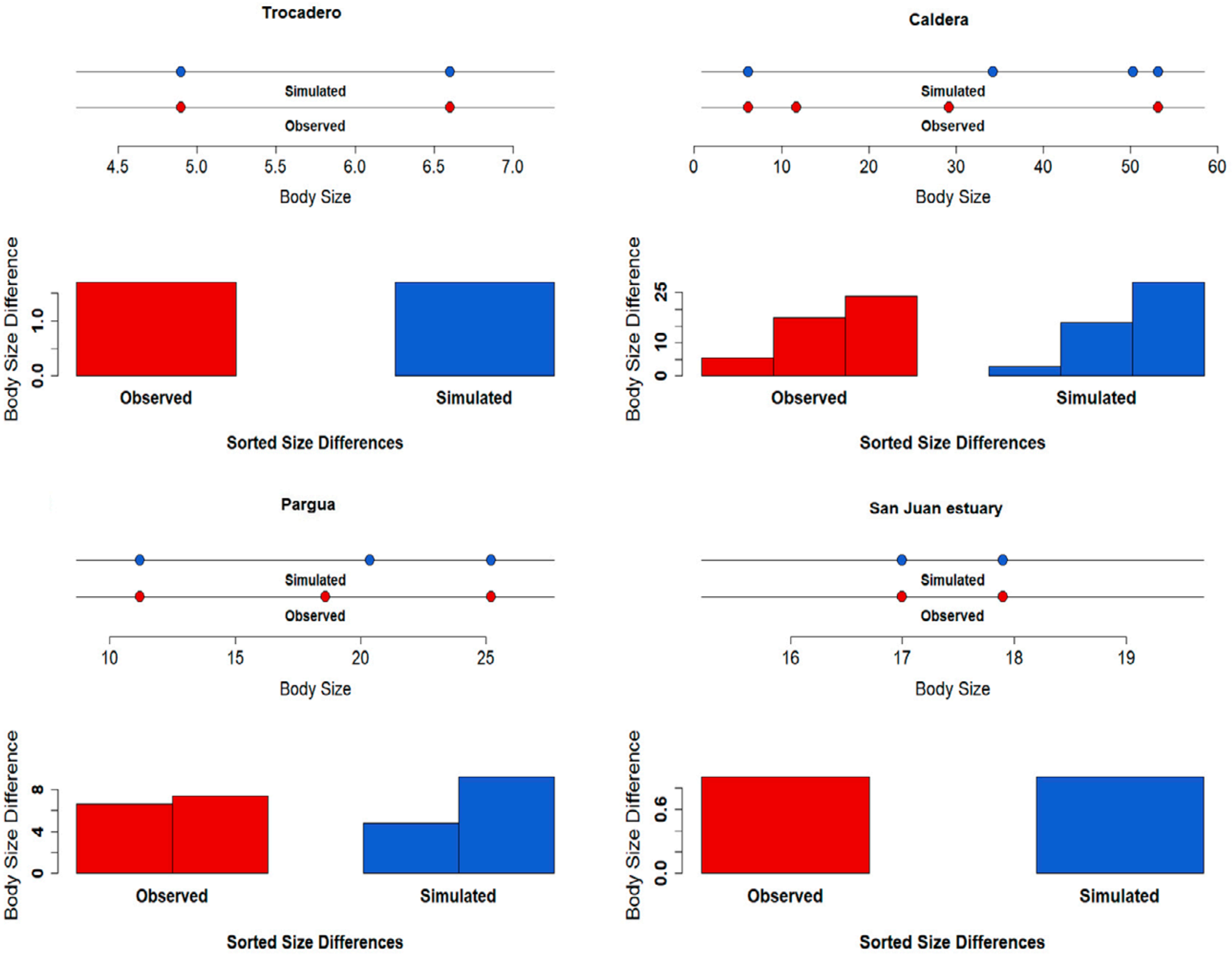

Fig. 2. – Graphs of results of the size overlap null model for the study sites.

Table 2. – Results of size overlap null models for decapod species and non-parametric comparisons reported for the sites in the present study; n.s., non-significant.

Site	Observed index	Mean index	Variance	P
Trocadero	1.700	1.700	0.001	0.999 n.s.
Caldera	5.500	5.387	14.247	0.445 n.s.
Pargua	6.600	3.416	4.176	0.058 n.s.
San Juan estuary	0.900	0.900	0.001	0.999 n.s.
	Non-parametric comparisons			
Trocadero	W=32.000 / P=0.017 *			
Caldera	c^2=39.875 (v=3) / P<0.001 *B. truncatus – C. cinereus*: W=144.000 / P<0.001* *B. truncatus – P. violaceus*: W=144.000 / P<0.001* *B. truncatus – L. variegatus*: W=0.000 / P<0.001* *C. cinereus – P. violaceus*: W=2.000 / P<0.001* *C. cinereus – L. variegatuss*: W=0.000 / P<0.001* *L. variegatus – P. violaceus*: W=0.000 / P<0.001*			
Pargua	c^2=22.284 (v=2) / P<0.001 *A. gayi – H. crenulatus*: W=8.500 / P=0.004* *A. gayi – P. violaceus*: W=190.500 / P<0.001* *H. crenulatus – P. violaceous* : W=0 / P=0.002*			
San Juan estuary	W=108 / P=0.896 n.s			

The results indicate the need for more ecological studies involving niche specialization of intertidal decapods species for each site, considering interspecific competence and niche segregation at different locations to explain biogeographical patterns.

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