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Modelling large-scale occurrence and abundance of the sandy beach isopod *Excirolana armata* along the morphodynamic and salinity gradients of the Rio de la Plata Estuary, Uruguay

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Understanding the relationships between beach morphodynamics and macrofauna assemblages has been critical in theoretical evolution of sandy beach ecology (Defeo & McLachlan 2005). However, these relationships have been mainly analyzed in oceanic sandy beaches, being exceptional macroscale studies considering the concurrent effects of large-scale estuarine and morphodynamic gradients (Lercari & Defeo 2006, Celentano *et al*. 2010).

Excirolana armata constitutes one of the most widespread cirolanid isopod species in Atlantic sandy beaches of South America. In Uruguay, it is particularly abundant in exposed oceanic beaches (Defeo *et al*. 1997) and also occurs in beaches of the Rio de la Plata (RdlP) estuary (Lercari & Defeo, 2006). This work evaluates macroscale concurrent effects of estuarine and beach morphodynamic gradients on the spatial distribution and abundance of *E. armata*.

We developed a large-scale (400 km) and bi-annual study considering 16 sandy beaches with contrasting physical characteristics, along the full estuarine gradient of the RdlP estuary (Uruguay) (Table I, Fig. 1). A conditional two-step procedure was performed to model the spatial distribution of *E. armata* in relation to several environmental variables simultaneously. Considering that in both cases these relationships were likely to be nonlinear, a Generalized Additive Model (GAM) was used.

Table I: Environmental characterization based on variables registered in the 16 beaches along the Rio de la Plata estuary and the oceanic Uruguayan coast.

	Range				
	Median	Min.	Max.	Percentile 25	Percentile 75
Environmental variables					
Salinity	25.1	0.1	34.3	13.3	30.5
Water temperature (ºC)	18.5	7.4	32.0	13.4	21.7
Swash width (m)	8.0	0.0	20.0	4.0	10.0
Beach width (m)	48.0	16.0	120.0	38.0	57.0
Breaker height (m)	0.5	0.0	2.5	0.2	1.0
Beach slope (%)	4.8	0.7	13.9	3.4	6.9
Mean grain size (mm)	0.3	0.1	0.9	0.2	0.4
Sand compaction ($kg \cdot cm^{-2}$)	3.2	1.0	5.0	2.6	4.3
Sand moisture (%)	8.9	2.4	23.9	6.5	15.3
Wave period (s)	11.5	0.0	25.0	9.0	14.0
Organic matter (%)	0.22	0.05	0.89	0.15	0.32
Composite indices					
Dean's parameter	2.7	0.4	10.2	1.9	3.9
BDI	63.2	10.4	1037.5	36.3	154.6

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Main results were as follows: 1) the first-step GAM explained 65.3% of the deviance in isopod occurrence distribution and retained 6 physical descriptors in the model (decreasing order: mean grain size, sediment organic matter content, water salinity, beach width, sediment water content and water temperature); and 2) the second-step GAM explained 66.4% of the deviance in abundance and shows that mean grain size, water salinity, sediment water content, beach width, penetrability and sediment organic matter were the most important explanatory variables (decreasing order).

Beach morphodynamic and salinity gradients affected large scale distribution and abundance patterns of *E. armata*. However, mean grain size was the principal predictor in both GAMs, suggesting an important substrate specificity of this isopod. A global scale (Pan-American) review confirms that *E. armata* is more abundant in fine sands, supporting GAMs results and reinforcing its characterization as a high substrate-specific species. Salinity was also a key factor; confirming that *E. armata* is a marine species with relatively high tolerance to estuarine conditions. The analysis of other population aspects (e.g. reproduction, mortality) will give additional evidences into the differential effect of these gradients in sandy beach populations

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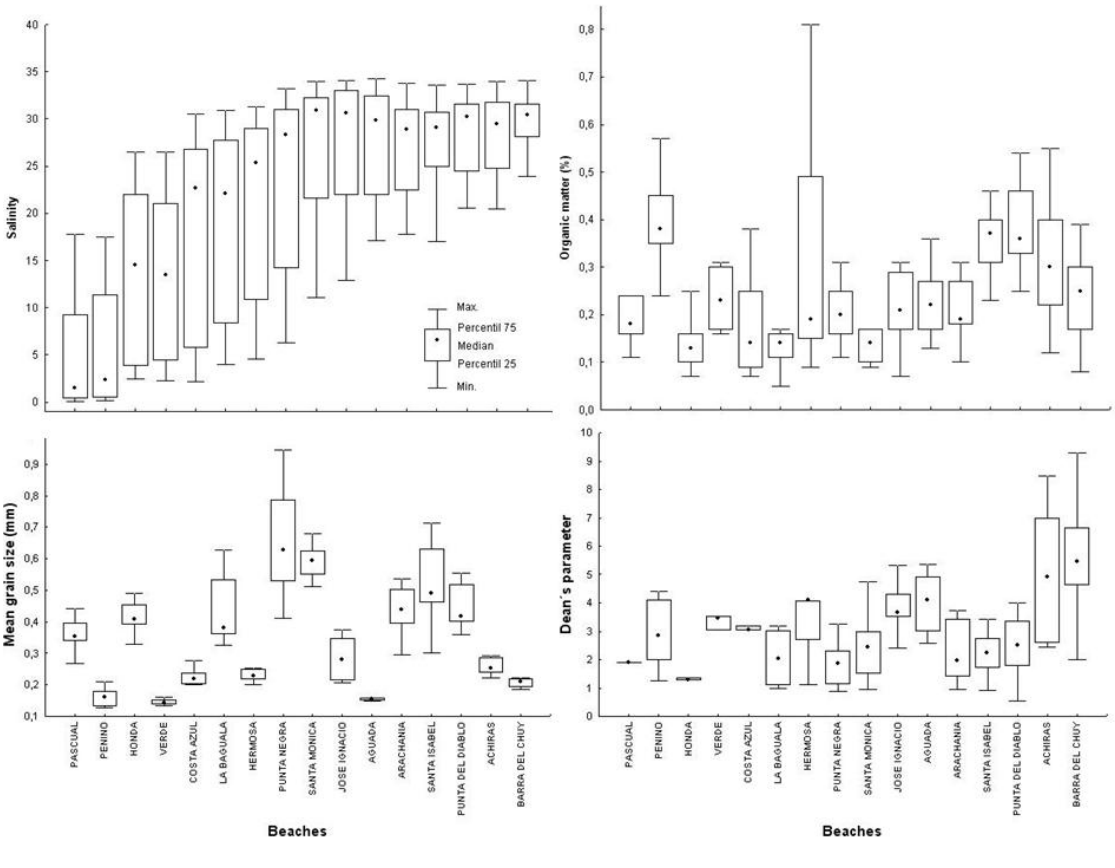

Figure 1: Box-and-whisker plots (median, 25 and 75 percentiles, minimum and maximum) for the 16 sandy beaches with respect to salinity, mean grain size, organic matter and Dean´s parameter along the Rio de la Plata estuary and the oceanic Uruguayan coast.