Rev. Mus. Argentino Cienc. Nat., n.s.
27(1): 19-31, 2025
ISSN 1514-5158 (impresa)
ISSN 1853-0400 (en línea)

Intertidal occurrence of the sea urchin *Pseudechinus magellanicus* (Temnopleuridae) along the coasts of Argentina and southern Chile

Damián Gaspar GIL [1,2,*] & Héctor Eliseo ZAIXSO †[1]

[1] Laboratorio de Bentos Costero Patagónico. Instituto de Desarrollo Costero (LBCP – IDC). Universidad Nacional de la Patagonia San Juan Bosco (UNPSJB). Ciudad Universitaria, Ruta Provincial 1 s/n. Comodoro Rivadavia (CP 9000), Chubut, Argentina. [2] Departamento de Biología y Ambiente. Facultad de Ciencias Naturales y Ciencias de la Salud. UNPSJB. † The author passed away on 29/04/2015.
* Corresponding author: Damián Gaspar Gil, Email: gil_damian@hotmail.com
Orcid ID: https://orcid.org/0000-0002-8084-2181

Abstract: The study aimed to assess the coastal distribution of the widespread sea urchin *Pseudechinus magellanicus* along the southwestern Atlantic coast, focusing on its occurrence in the intertidal zone and explore its relationship with environmental factors. Data was collected in intertidal rocky shores across 36 sites along the Argentine and Chilean coasts during 2007 and 2010. The presence of *P. magellanicus* was verified in the intertidal zone on rocky coasts of Argentina between latitudes 45°S and 55°S, most frequently in the central area of the San Jorge Gulf, the Strait of Magellan, and the Beagle Channel. A fragmented coastal distribution is observed with the absence of the species in the intertidal zone between latitudes 47.2°S (Cape Blanco) and 54°S (Cape San Pablo). Logistic regression analysis and regression and classification trees (CART) suggest that higher water transparency and lower levels of dissolved chromatic organic matter in nearshore waters could explain its presence on intertidal platforms. Furthermore, in sites with high wave exposure, the likelihood of finding *P. magellanicus* increases rapidly only in sites with higher water transparency, while this increase is slower in sites with low transparency values. Establishing baseline data on the coastal distribution of these species is crucial for monitoring and evaluating the impacts of environmental shifts in the context of climate change and increasing human activity in coastal habitats.

Key words: Echinodermata, intertidal, distribution, Echinoidea

Resumen: Presencia intermareal del erizo de mar *Pseudechinus magellanicus* (Temnopleuridae) a lo largo de las costas de Argentina y sur de Chile. El presente estudio examina la distribución costera del erizo de mar *Pseudechinus magellanicus* a lo largo de la costa del Atlántico Sudoccidental, centrándose en su presencia en la región intermareal y explorando su relación con algunos factores ambientales. Se recolectaron datos sobre su presencia en intermareales rocosos de 36 sitios a lo largo de las costas de Argentina y Chile durante 2007 y 2010. Se verificó la ocurrencia de *P. magellanicus* en la zona intermareal en las costas rocosas de Argentina entre las latitudes 45°S y 55°S, con mayor frecuencia en el área central del Golfo San Jorge, el Estrecho de Magallanes y el Canal Beagle. Se observa una distribución costera fragmentada con ausencia de la especie en la zona intermareal entre las latitudes 47,2°S (Cabo Blanco) y 54°S (Cabo San Pablo). Los análisis de regresión logística y los árboles de regresión y clasificación (CART) sugieren que una mayor transparencia del agua y menores niveles de materia orgánica cromática disuelta en aguas cercanas a la costa podrían explicar su presencia en las plataformas intermareales. Además, en sitios con alta exposición al oleaje, la probabilidad de encontrar *P. magellanicus* aumenta considerablemente solo en sitios con mayor transparencia del agua, mientras que este aumento es menor en sitios con valores de transparencia bajos. La información de base sobre la distribución costera de esta especie es importante para monitorear cambios a lo largo del tiempo y evaluar los impactos de las variaciones ambientales en el contexto del cambio climático y el aumento de la actividad antrópica en la franja costera.

Palabras clave: Echinodermata, intermareal, distribución, Echinoidea

INTRODUCTION

The knowledge on spatial distribution in marine invertebrate populations is essential for understanding community organization, as well as the most relevant ecological processes affecting them (Underwood & Chapman, 1996; Krebs, 1999; Underwood, 2000). Significant environmental gradients can lead to variations in population distribution and abundance, driven by the diverse physiological tolerances exhibited by individuals, both within and between populations (Gaines & Lubchenco, 1982). Such segregation typically occurs on larger spatial scales, while on smaller spatial scales, physical factors influencing environmental heterogeneity play an important role in modulating the intensity of biological interactions (Benedetti-Cechi & Cinelli, 1995; Hawkins *et al*., 2019).

The sea urchin *Pseudechinus magellanicus* has a broad distribution and is one of the most abundant echinoid species in the Argentine Sea (Bernasconi, 1953, 1966; Brogger *et al*., 2013). Research on the distribution or population dynamics of the species has been conducted in the northern Patagonian gulfs (e.g., San Matías and San José gulfs: Zaixso & Lizarralde, 2000; Arribas *et al*., 2016; Lazari *et al*., 2022; Nuevo Gulf: Marzinelli *et al*., 2006; Rechimont *et al*., 2013), as well as in the San Jorge Gulf (Gil, 2015; Kaminsky *et al*., 2017; Gil *et al*., 2020, 2021), also in relation to shrimp fishery by-catch (Roux *et al*., 1995; Roux, 2000; Roux & Piñero, 2001). Its presence is also commonly recorded in the Beagle Channel and Malvinas Islands (Orler, 1992; Beaton *et al*., 2020; Friedlander, 2020,2021; Bravo *et al*., 2023) and on fishing grounds of the Continental shelf and slope area (Penchaszadeh *et al*., 2004; Schejter, 2005; Botto *et al*., 2006; Escolar, 2010), although there are no specific studies on its global distribution and population regulating factors in these areas. In the Magellan Strait and southern Chile, it is considered one of the dominant species within the benthos inhabiting the holdfasts of the kelp *Macrocystis pyrifera* (Ríos *et al*., 2003; Mutschke & Ríos, 2006; Ríos *et al*., 2007; Betti *et al*., 2017; Mutschke *et al*., 2017; Ojeda *et al*., 2017). In the San Jorge Gulf, Fernández (2006) reports high abundances of this species with maximum densities of 41.8 ind.m^{-2}. In coastal areas, the species is particularly abundant (Gil, 2025) and shows high trophic plasticity, enabling occupation of contrasting coastal and depth habitats (Penchaszadeh *et al*., 2004; Gil *et al*., 2021). Despite its wide distribution and significance as one of the dominant echinoid species in the Argentine Sea, its presence in coastal areas at an extended latitudinal range, including shallow waters such as the intertidal zone, has been poorly studied.

Latitudinal patterns in the distribution of invertebrates on rocky shores are known to be shaped by environmental factors, including substrate complexity and type and physicochemical profiles (e.g., sea water temperature, suspended matter), which may influence invertebrate distribution both directly and indirectly through changes in macroalgal abundance (Meager *et al*., 2011; Hadiyanto *et al*., 2024). The shallow rocky intertidal and subtidal environments are also highly vulnerable to the impacts of climate change and human activity (Barry *et al*., 1995; Kunze *et al*., 2021). Thus, describing and understanding the distribution of their dominant species is crucial and can serve as an early warning system (Sagarin *et al*., 1999; Harley *et al*., 2006; Helmuth *et al*., 2006). Marine invertebrate populations exhibit diverse responses to climate change, ranging from gradual shifts in distribution to changes in abundance and migration patterns (Pinsky *et al*., 2020). In this context, our objective is to investigate the coastal (intertidal) distribution of *P. magellanicus* along the SW Atlantic coast and southern Chile in relation to environmental factors.

MATERIAL AND METHODS

The occurrence of the sea urchin *P. magellanicus* on intertidal rocky shores (exposed or within tidepool areas) was studied across 36 sites along the coast of Argentina and southern Chile during the years 2007 and 2010. The selected sites are listed in Figure 1 and Table 1. At each site, the presence or absence of the species was recorded during the lowest tides of the month, discriminating, where possible, between the low midlittoral shore zone (LwMd) and the upper infralittoral shore zone (InfraL). Surveys were conducted using equal exploration times per site (~ 2-3 hours), involving at least two to three experienced observers. Each site was thoroughly examined, including crevices, intertidal pools, rocks, channels, and spaces beneath macroalgae canopies. When sea urchins were observed, their occurrence was estimated using an ordinal variable derived from visual inspections of suitable intertidal habitats, with the aid of quadrats for reference when necessary. The occurrence of *P. magellanicus* was categorized into five levels:

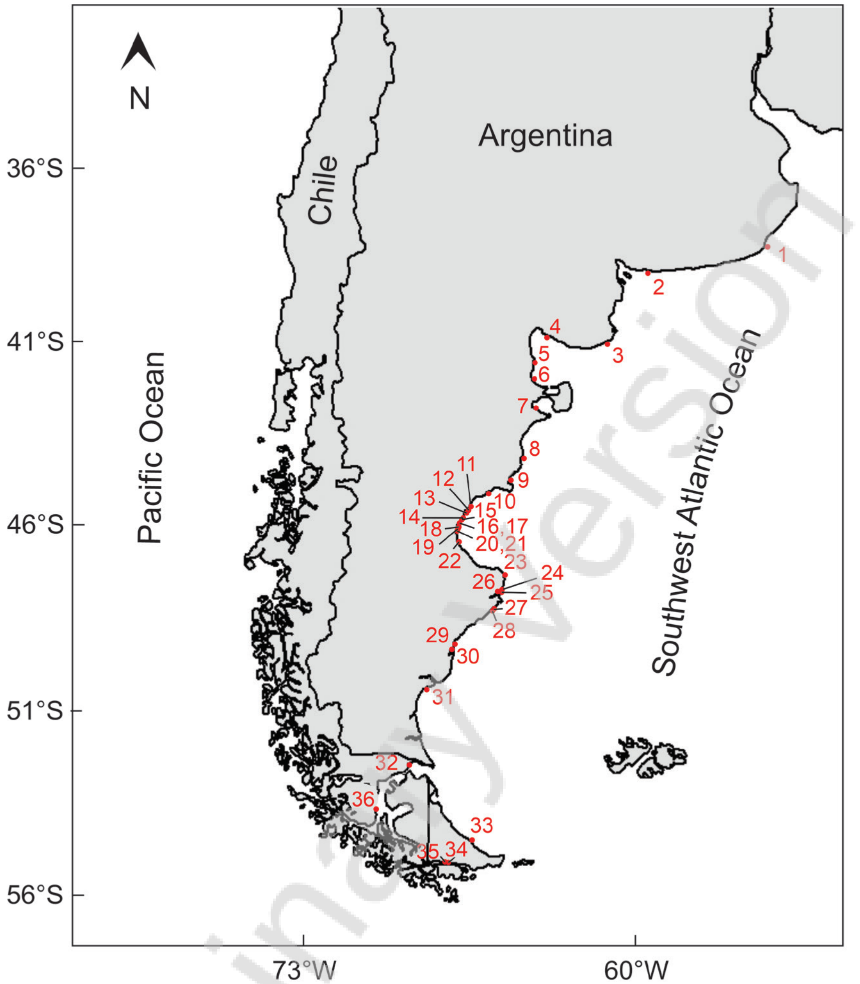

Fig. 1. Intertidal rocky shores examined in the study. The names of the sites are listed in Table1.

(1) absent, when no individuals were found, (2) rare, when only a single specimen was found, (3) scarce, when more than one specimen was found but at low frequency (approximately 0.5-1 specimens per m^2), (4) frequent (approximately 2-4 specimens per m^2), and (5) very frequent (more than 5 specimens per m^2). Some occurrence data used were obtained within the framework of different research projects (GEF/BIRF. UNDP ARG 02/018 Subprojects BB69 and BB70) or from personal communications from other researchers (Table 1). Although quantitative density measurements using quadrats were not performed, this approach provided a standardized, semi-quantitative method to assess occurrence across sites. It also allowed for classification into a binary variable (presence/absence) by integrating information from both intertidal zones. Rare records, although indicated in results, were not considered as established populations within the intertidal region.

For each evaluated site, the following information was obtained for an adjacent coastal area to each site during the years 2007-2009, using the Giovanni database (NASA): (1) annual mean sea surface water temperature (MODIS-Aqua satellite, resolution 4 km; unit: °C); (2) annual mean chromophoric dissolved organic matter (CDOM) concentration (MODIS-Aqua satellite, resolution 4 km; unit: dimensionless); and (3) annual mean diffuse attenuation coefficient at 490 nm (k490) (MODIS-Aqua satellite, resolution 4 km; unit: 1/m). High CDOM values constitutes a proxy for higher amount of suspended organic matter, while the coefficient k490 is an indicator of the clarity or transparency of seawater, representing the rate at which light with a wavelength of 490 nm (blue-green spectrum) is attenuated by depth

Table 1. Records and relative abundance of *P. magellanicus* in low midlittoral (LwMd) and upper infralittoral (InfraL) rocky shores along the coast of Argentina and southern Chile. A: This study.; B: Brogger, Rubilar and Tolosano, com. pers.; C: Zaixso, com. pers. - absent; • rare, + scarce, ++ frequent; +++: very frequent

Sites	Abrev	Prov.	Latitude, Longitude	LwMd	InfraL	Ref
1- Mar del Plata	MdP	Bs. As.	38°02'21''S 57°30'31''O	-	-	A
2- Pehuencó	Peh	Bs. As.	39°00'11''S 61°36'56''O	-	-	A
3- Balneario El Cóndor	Cond	R. Negro	41°03'33''S 62°49'23''O	-	-	B
4- San Antonio Este	SAE	R. Negro	40°50'33''S 64°40'01''O	-	-	B
5- Playas Doradas	Dor	R. Negro	41°34'48''S 64°59'23''O	-	-	B
6- Puerto Lobos	Lob	Chubut	42°00'02''S 65°04'01''O	-	-	B, C
7- Punta Este (GN)	GN	Chubut	42°47'07''S 64°57'05''O	-	-	A, C
8- Santa Elena	StE	Chubut	44°09'32''S 65°15'18''O	-	-	A, C
9- Playa Elola	Elo	Chubut	44°50'26''S 65°43'05''O	-	+	A, C
10- Bahía Bustamante	Bust	Chubut	45°08'35''S 66°29'32''O	-	-	A, C
11- Quinta Rossi	QR	Chubut	45°40'41''S 67°20'51''O	-	+	A
12- Punta Novales	PN	Chubut	45°43'28''S 67°20'06''O	-	++	A
13- Caleta Córdova Norte	CCN	Chubut	45°43'28''S 67°21'59''O	-	+	A, C
14- Restinga Km 5	Km5	Chubut	45°49'09''S 67°25'42''O	-	+	A
15- Restinga Km 3	Km3	Chubut	45°50'09''S 67°27'30''O	-	++	A
16- Rada Tilly PN	RTn	Chubut	45°54'46''S 67°31'23''O	-	•	A
17- Rada Tilly PM	RTs	Chubut	45°57'22''S 67°31'42''O	-	++	A
18- Punta Maqueda	PM	Sta. Cruz	46°01'28''S 67°35'18''O	+	+++	A, C
19- La Tranquera	LT	Sta. Cruz	46°02'29''S 67°35'50''O	++	+++	A, C
20- Pasto Amarillo	PA	Sta. Cruz	46°03'49''S 67°36'41''O	++	+++	A
21- La Lobería	LL	Sta. Cruz	46°06'23''S 67°37'16''O	-	++	A
22- P. Agüero, Cal. Olivia	CO	Sta. Cruz	46°29'32''S 67°28'32''O	-	++	A
23- Cabo Blanco	Blco	Sta. Cruz	47°12'32''S 65°44'31''O	-	-	A, C
24- Península Foca	PF	Sta. Cruz	47°44'37''S 65°50'18''O	-	-	A
25- Punta Cavendish	PC	Sta. Cruz	47°44'59''S 65°51'10''O	-	-	A
26- P. Cascajo, R. Deseado	RD	Sta. Cruz	47°45'29''S 65°53'50''O	-	-	A, C
27- Punta Buque	Buq	Sta. Cruz	48°06'08''S 65°54'49''O	-	-	A, C
28- Punta Buque Sur	BqS	Sta. Cruz	48°06'59''S 65°55'49''O	-	-	A, C
29- La Mina, San Julián	Min	Sta. Cruz	49°09'20''S 67°37'44''O	-	-	A, C
30- B. Justicia, San Julián	SJ	Sta. Cruz	49°17'32''S 67°42'02''O	-	-	A, C
31- Monte León	MtL	Sta. Cruz	50°20'23''S 68°52'36''O	-	•	A, C
32- Buque Quemado	Mag	Chile	52°23'11''S 69°28'56''O	-	•	A, C
33- Cabo San Pablo	SnP	T. Fuego	54°15'41''S 66°44'00''O	-	-	A, C
34- Playa Larga, Ushuaia	PL	T. Fuego	54°48'25''S 68°13'02''O	-	-	A, C
35- B. Ensenada, Ushuaia	BE	T. Fuego	54°50'50''S 68°28'57''O	-	++	A, C
36- Fuerte Bulnes	Bul	Chile	53°37'36''S 70°55'08''O	+	++	A, C

(Acker & Leptoukh, 2007). Although these variables are not directly associated with intertidal areas, they were utilized as a robust proxy (annual mean) for the adjacent nearshore system.

The degree of wave exposure at each site was assigned at each site according to an ordinal scale of five categories by examining the coastal configuration, including the shape and orientation of the rocky shore platform, as well as nearby headlands, bays, and inlets. The extension and slope of each rocky shore within its central area were categorized using an ordinal scale (3 levels) on three broad groups: (1) very extended intertidal platforms exceeding >200 m with a very gentle slope; (2) moderate slope and moderate extension ranging from 50 to 200 m; and (3) high slope defined by narrow steep platforms less than 50 m in width. This assessment was done *in situ* during low tide and complemented using remote imagery tools (e.g., Google Earth).

The environmental data for each site were organized into a matrix categorizing sites by environmental factors. Exploratory graphs were conducted between latitude and different environmental variables used as potential predictors of the presence of *P. magellanicus*. The relation between oceanographic and topographic factors and the presence of the species in the intertidal zone (LwMd + InfraL) was examined through two distinct and complementary methods: a predictive model employing multiple logistic regression and a classification predictive model (CART) (D'eath & Fabricius, 2000).

In the first approach, the presence of the sea urchin in the intertidal zone was modeled through multiple logistic regression, using variable selection techniques. The response variable (binary) was the presence/absence of *P. mag-*

ellanicus, and the explanatory variables were: mean sea surface water temperature, mean chromophoric dissolved organic matter (CDOM), water transparency (k490), degree of wave exposure (ordinal), and extension/slope of the rocky reef in degrees (ordinal). First-order interaction terms were also included in the full model. The variables and interaction terms retained in the regression analysis were selected using a stepwise forward selection procedure, where variables entered the model at a value of $p < 0.05$ and exited the model at a value of $p > 0.10$. Prior to this, the absence of collinearity among the environmental variables used was verified, accepting a maximum value of 10.0 in the variance inflation factors (VIF) (Quinn & Keough, 2002).

A second approach involved classifying sites with presence and absence of *P. magellanicus* through classification and regression trees (CART) (Breiman *et al*., 1984). CART regression is a non-parametric binary partitioning method that builds a decision tree by iteratively dividing the data, resulting in a tree structure representing decision sets and partitioning rules to form homogeneous groups based on the variable to be discriminated (Breiman *et al*., 1984). To choose the best variable, a measure of purity is used in the assessment of the two possible child nodes. The Gini index was used as the partitioning criterion and measure of impurity, which is the most commonly used and tends to separate the largest category into a separate group by ensuring that purity in the child nodes is maximized (De'ath & Fabricius, 2000). No pruning operations were performed due to the presence of few explanatory variables and low complexity of the initial tree. Once the classification tree was obtained, indicators of importance for each explanatory variable were obtained. The advantages of using these classification tools as a complement to logistic regressions or linear models have been described by De'ath and Fabricius (2000).

A significance level of 5% was assumed throughout the study, and statistical analyses were conducted using STATISTICA 13.

RESULTS

The presence of *P. magellanicus* in the intertidal zone (LwMd + InfraL) in the Argentine Sea and southern Chile was observed on rocky shores south of Dos Bahías cape in the Chubut province, with higher frequencies noted in the central area of the San Jorge Gulf, the Magellan Strait, and the Beagle Channel (Table 1).

Figure 2 explores the relation between the presence-absence of *P. magellanicus* in the intertidal zone and latitude, mean sea water temperature, mean chromatic dissolved organic matter index (CDOM), and water transparency (coefficient k490). The sea urchin *P. magellanicus* was found at low levels on intertidal rocky shores, between latitudes 45 °S and 55 °S, with mean annual temperatures ranging from 6.6 °C to 12.2 °C (Fig. 2). Sea urchins were absent from intertidal sites where mean annual temperatures exceeded 12.2 °C, which corresponded to latitudes below 45 °S. Taking into account the specified latitudinal range, a fragmented coastal distribution of *P. magellanicus* was observed, characterized by its intertidal absence between latitudes 47.2 °S (Cabo Blanco) and 54 °S (Cabo San Pablo).

Sites where nearshore CDOM values exceeded 6.0 lacked *P. magellanicus* in the intertidal zone. Moreover, at sites south of 45 °S, the intertidal presence of the sea urchin was observed in sites with low CDOM values (2.8 - 6.0), contrasting with sites without sea urchins, which exhibited higher CDOM values (6.1 - 8.6) (Fig. 2)

When analyzing the coefficient of diffuse attenuation (k490), which reflects water column transparency, it was observed that sites with the presence of the sea urchin (*P. magellanicus*) from 45 °S onwards exhibited higher values (0.15 - 0.71 1/m) compared to those where was absent (0.13 - 0.30 1/m) (see Fig. 2c). Specifically, the site corresponding to Golfo Nuevo (Punta Este) demonstrated elevated k490 values (refer to Fig. 2c, 3), despite having a mean annual temperature close to 14.7 °C (refer to Fig. 2a).

Approach through a Multiple Logistic Regression Model

The explanatory variables exhibited no collinearity (VIF values < 1.8); hence, all variables and first-order interactions were included in the preliminary logistic model (full model). Upon conducting a selection for significant variables, a forward stepwise analysis revealed that only the mean chromatic dissolved organic matter index (CDOM) and the interaction between the mean diffuse attenuation coefficient (k490) and the degree of wave exposure were significant explanatory variables (Table 2). The reduced model achieved a classification accuracy of 88.9%. The final reduced model was:

$$P = e^{\frac{(2.82-1.24OM+4.62WxK)}{1+e^{(2.82-1.24OM+4.62WxK)}}}$$

where P represents the binary variable indicating the likelihood of finding *P. magellanicus* in the intertidal zone, while OM denotes the CDOM, and W×K the interaction between the wave exposure and sea water transparency (k490).

The dissolved organic matter index (CDOM) was found to negatively influence the likelihood of *P. magellanicus* occurrence in the intertidal zone. The interaction between wave exposure and seawater transparency (k490) emerged as the most significant term in the reduced model (Table 2). This interaction indicates that, at sites with high wave exposure, the likelihood of *P. magellanicus* occurrence increased rapidly only in areas with elevated k490 values, whereas the increase was more gradual at sites characterized by lower transparency values (Table 2; Fig. 3).

Regression and Classification Trees (CART) approach

The non-parametric CART analysis produced a tree-like structure comprising divisions, internal nodes, and terminal nodes ("leaves"). This analysis yielded a regression tree in which only the mean diffuse attenuation coefficient (k490) and the mean chromatic dissolved organic matter index (CDOM) were identified as significant variables for classifying sites with *P. magellanicus* occurrence in the low intertidal zone. The resulting regression tree consists of two divisions and three terminal nodes (Fig. 4).

The ranking of explanatory variables highlighted the significance of mean diffuse attenuation coefficient (k490) and mean chromatic dissolved organic matter (CDOM), while seawater temperature, wave exposure, and slope were found to be less important (Fig. 5). The most important variable, k490, accurately identified 88% of *P. magellanicus* occurrence sites with transparency values exceeding 0.23/m. In areas with lower k490 values (<0.23/m), CDOM emerged a significant determinant (Fig. 4). Sites lacking *P. magellanicus* were associated with reduced water transparency and elevated CDOM values (Fig. 4).

DISCUSSION AND CONCLUSIONS

The distribution of *P. magellanicus* along the SW Atlantic coast and southern Chile exhibits a discontinuous pattern, with its presence restricted to rocky shores within the low midlittoral and upper infralittoral zones. This intertidal distribution spans from the southern region of Cape Dos Bahías in Chubut Province to the southern

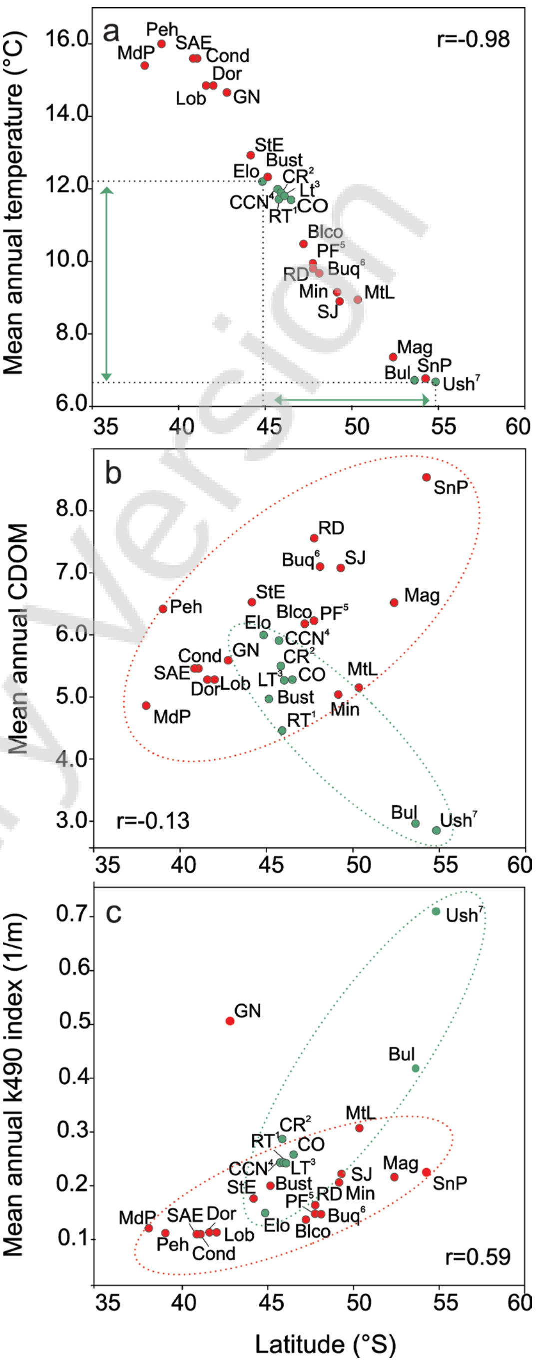

Fig. 2. Relation between latitude and a: sea surface temperature, b: CDOM, c: k490. Sites with absence of the sea urchin are indicated in red, while those with occurrence are in green. Ellipses indicate latitudinal trends. Abbreviations in Table 1. Aggregated sites: RT[1]: RTn and RTs; CR[2]: Km3 and Km5; LT[3]: LT, PM and LL; CCN[4]: CCN, PN and QR; PF[5]: PF and PC; Buq[6]: Buq y BqS; Ush[7]: PL and BE. Person Correlation analysis (r) are also included.

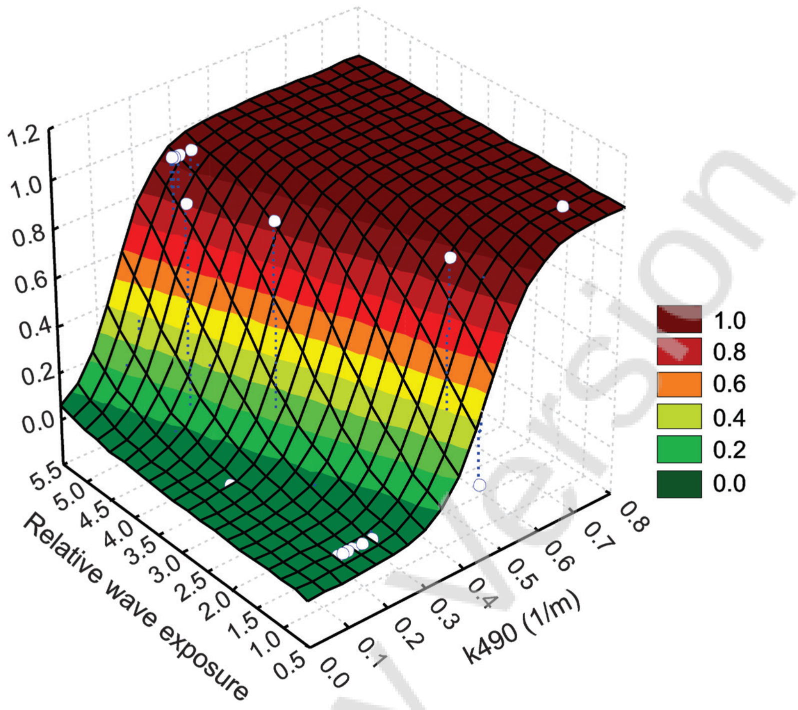

Fig. 3. Response surface showing the interaction between wave exposure and the coefficient k-490 on the likelihood of *P. magellanicus* occurrence (color scale), based on the reduced multiple logistic regression model.

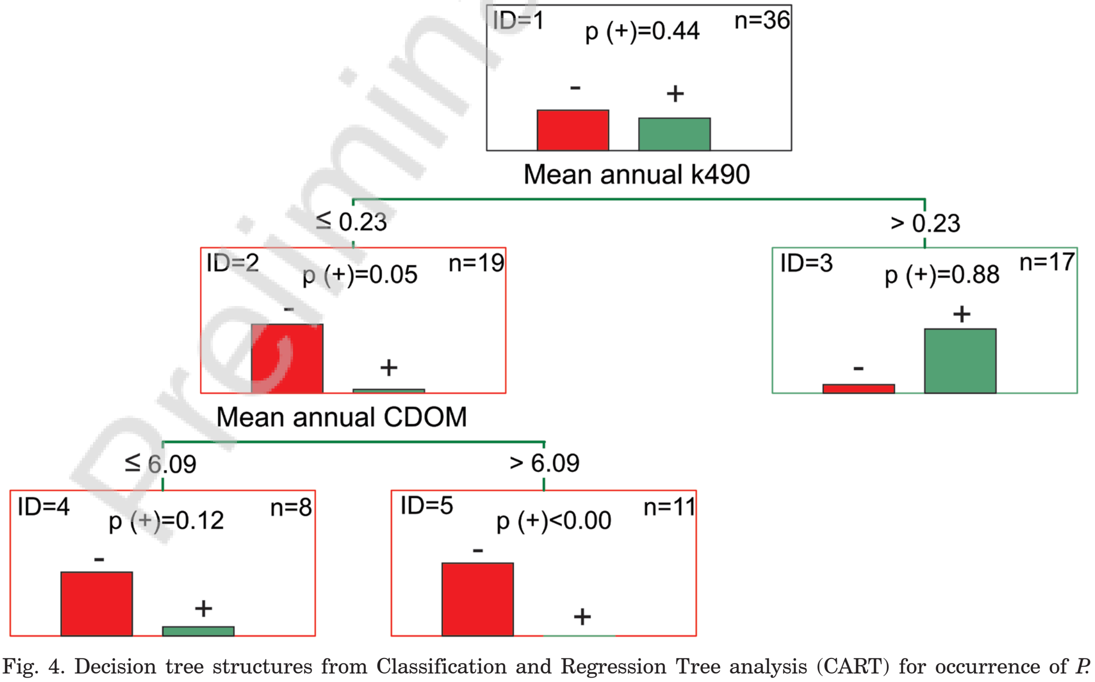

Fig. 4. Decision tree structures from Classification and Regression Tree analysis (CART) for occurrence of *P. magellanicus* on low intertidal rocky shores of the SW Atlantic coasts. +: presence of *P. magellanicus* (green), -: absence (red) of the species

extent of Caleta Olivia in Santa Cruz Province, encompassing the San Jorge Gulf. Additionally, the species is found in the Strait of Magellan and the Beagle Channel. Several non-exclusive factors may influence this discontinuous coastal distribution, including oceanographic variables (e.g., temperature, amount of dissolved organic matter, transparency of the water column nearby, currents), topographic factors (e.g., shoreline extension and slope; exposure to wave action, substrate type), biological factors (e.g., high densities of subtidal populations, larval availability, availability of food resources), and interactions between them.

Temperature plays an important role in determining the survival conditions of many species of marine invertebrates, including sea urchins (Sala *et al*., 2012). Some studies have shown that temperature influences physiological and biochemical rates at the individual level, which can, in turn, affect survival, growth, and reproductive capacity, thereby affecting population dynamics (Thomas *et al*., 2000; Kordas *et al*., 2011). Some species exhibit different responses including thermal habitat selection to avoid lethal temperatures, and selected temperatures often reflect recent thermal history or a state of thermal acclimatization (Díaz *et al*., 2011). The absence of sea urchins on intertidal platforms north of Cape Dos Bahías (~44.5°S; Chubut Province; Cuevas *et al.,* 2006) may be related to a higher environmental stress in the intertidal zone and to a lethal effect of high temperatures during the summer. In this regard, Díaz *et al*. (2011) have shown that sea urchins *Strongylocentrotus purpuratus* and *S. franciscanus* can exhibit thermo-regulated behavior when exposed to a thermal gradient. Similarly, Sewell and Young (1999) point out that the distribution of *Echinometra lucunter* may be limited by the thermal tolerance of adults. However, temperature alone does not explain the striking absence of *P. magellanicus* on intertidal platforms between latitudes 47 °S (Cabo Blanco, Santa Cruz) and 54 °S (Cabo San Pablo, Tierra del Fuego). The regional oceanic circulation in this area involves the mixing of subantarctic water from the Cape Horn Current with Atlantic water through the Strait of Magellan, diluted by freshwater inputs from the continent (Piola & Rivas, 1997). The resulting coastal current along Santa Cruz Province is influenced by prevailing westerly winds, creating a vertically homogeneous water plume due to tidal currents and wind action (Acha *et al*., 2004). Near Cape Tres Puntas, the flow splits into two branches: one enters the San Jorge Gulf, forming a significant thermohaline front (Akselman, 1996; Fernández *et al*., 2008), while the other moves north-northeastward, impacting the gulf's mouth (Fernández *et al*., 2005; Fernández, 2006). Within this oceanographic framework, logistic regression and CART analysis suggest that water transparency (k490) plays a more significant role, while the amount of dissolved chromatic organic matter (CDOM) has a lesser, yet notable, influence on the presence of *P. magellanicus* in the intertidal zone. The sites located south of Cabo Blanco and up to Tierra del Fuego over the Atlantic Ocean, characterized by the absence of the species, showed low k490 values and high CDOM values. On the other hand, sites with the presence of *P. magellanicus* have low CDOM values and high k490 values. Although the nature of this study is exploratory, water turbidity is known to affect the survival of the echinopluteus larva of some species (e.g., *Evechinus chloroticus*; Phillips & Shima 2006) and, therefore, could affect larval settlement and species distribution.

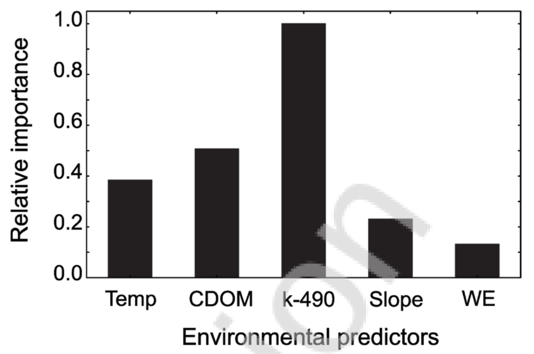

Fig. 5. Ranking of importance of predictor variables associated with CART analysis.

The discontinuous latitudinal distribution found along the intertidal zone could also be the result of alterations in the availability of *P. magellanicus* larvae and recruitment in adjacent subtidal areas. In this regard, coastal latitudinal gaps have been found in other species of marine invertebrates that have been identified as a failure or a decrease in recruitment rates (e.g., Ebert & Russell, 1988; Roughgarden *et al*., 1988; Menge *et al*., 2004). Recruitment, in turn, can be affected by hydrodynamic factors and topographic features because larvae have limited locomotion capacity and depend largely on the movement of water masses, which vary latitudinally and locally (Menge *et al*., 2004). Another potential causes for the absence of *P. magellanicus* between 47°- 54°S in the intertidal zone could be

Table 2. Results of multiple logistic regression with stepwise forward variable selection on the likelihood of *P. magellanicus* occurrence in the intertidal zone. Exp (b): odds ratio. WE: relative wave exposure. Hosmer-Lemeshow test: $p = 0.17$. Nagelkerke $r^2 = 0.68$.

Variable	**b**	**SE (b)**	**Wald** X^2	**d.f.**	***p***	**Exp (b)**	**CI -95% Exp (b)**	**CI +95% Exp (b)**
Constant	2.82	3.25	0.75	1	0.38	16.79	-	-
CDOM	-1.24	0.59	4.41	1	0.035	0.29	0.09	0.92
K490 × WE	4.62	1.56	8.7	1	0.003	101.56	4.72	2182.18
Model	X^2							
Reduced model	25,86			2	< 0.001			

Cases correctly classified by the reduced model: 88.9%

related to biological processes such as predation, competition, or variability in the predictability of food resources. However, in Patagonian ecosystems, there are no large specialized sea urchin predators known to exert significant regulatory pressure (Castilla, 1985; Vásquez & Buschmann, 1997), and this influence seems even more limited in intertidal platforms. Recently settled *P. magellanicus* in nearshore ecosystems are predominantly associated with the infralittoral fringe and subtidal zones, often occupying cryptic biogenic microhabitats such as beneath coralline algae or within macroalgal turfs (Gil, 2015). Mortality within these microhabitats may influence settlement in intertidal zones. These habitats are thought to provide refuge from fish and macroinvertebrate predators in other nearshore ecosystems (Scheibling, 1996), though further research is needed. Finally, food resources do not appear to be a clear limiting factor, as sea urchins exhibit considerable plasticity in their trophic sources (Penchaszadeh *et al.*, 2004; Gil *et al.*, 2021). However, reduced seawater transparency may lower photosynthetic activity, potentially affecting seaweed productivity (Babuder, 2020). Macroalgal production, derived from ocean conditions, could thus influence resource availability for shallow-water benthic grazers such as sea urchins, which feed directly on seaweeds and utilize detrital material as a nutritional subsidy (Ebert *et al.*, 2012; Kelly *et al.*, 2012). Such changes in resource availability may affect the establishment of intertidal and subtidal sea urchin populations. A pertinent hypothesis for future investigation could explore the relationship between subtidal sea urchin abundance and the development of *Macrocystis pyrifera* kelp, given its critical role in structuring the local ecosystem. Although *P. magellanicus* is one of the most abundant species in nearshore ecosystems, many aspects of its biology and ecology (e.g., competition, predation, and population regulation) remain poorly studied in this region.

A plausible explanation for the frequent presence of *P. magellanicus* on intertidal platforms in the central and southern San Jorge Gulf can be attributed to the oceanographic and biological conditions that may favor its abundance and settlement. The benthic community of the San Jorge Gulf is known to be sectorized, with *P. magellanicus* emerging as the predominant species, even inhabiting muddy substrates at the center of the gulf (Fernández, 2006). Prior to 1998, *P. magellanicus* was nearly absent from the central region of the gulf, but its distribution expanded thereafter, leading to its dominance throughout the entire gulf. Roux and Bertuche (1998) attribute this phenomenon to defaunation and subsequent recolonization, where disturbances reduced diversity and result in the establishment of "monospecific populations" with increased biomass. Fernández (2006) suggested that the San Jorge Gulf is currently in a recolonization phase, with *P. magellanicus* serving as the indicator species of this transition. Additionally, the topographic features of surveyed sites (e.g., extent and slope, wave exposure) may also influence the species' presence on intertidal platforms. However, the widespread occurrence of *P. magellanicus* across coastal strips with diverse topographic characteristics in the San Jorge Gulf suggests that these effects are minimal. In areas with higher wave exposure, the likelihood of finding *P. magellanicus* increases rapidly only in sites with higher seawater transparency, while the increase is more gradual in sites with lower transparency values. The predictive logistic model accounts for sites located in the Beagle Channel and Fuerte Bulnes, where wave exposure is lower than in the sampled sites of the San

Jorge Gulf, and excludes sites with high wave exposure but low seawater transparency. Although not fully understood, some species of coastal sea urchins are known to be affected by turbidity or increased sedimentation (Airoldi, 2003; Díaz-Martínez *et al*., 2015).

The complexity of factors influencing species distribution is substantial (Rivadeneira & Fernández, 2005). When comparing latitudinal variations in the abundance of marine invertebrates with limited mobility, caution is essential due to the intricate interactions between environmental variables and biological and ecological processes. Strong local microenvironmental factors are also at play, and interactions between abundance, lifespan, and body size may occur (Lewis, 1986). Given this complexity, interpretations should be made with care, as multiple, often unquantified, factors could influence the observed patterns. Hence, further surveys and/or experiments are required to elucidate the observed discontinuous pattern. Future investigations could examine the correlation between abundance on intertidal platforms and subtidal environments, as well as species/habitats associations, food supply, and larval settlement mechanisms under varying environmental conditions.

ACKNOWLEDGMENTS

We will like to express our gratitude to Estela Lopretto for her assistance and insights provided during the initial drafting phases of this research. We are also grateful to Martín Varisco, Javier Tolosano, and Julio Vinuesa for their assistance during the latitudinal field assessments. We also thank José Carlos Hernández and two anonymous reviewers for their helpful comments. This paper is a tribute the memory of our co-author, Dr. Héctor E. Zaixso, whose contributions were essential to this study.

REFERENCES

Acha, E.M., H.W. Mianzan, R.A. Guerrero, M. Favero & J. Bava. 2004. Marine fronts at the continental shelves of austral South America: physical and ecological processes. *Journal of Marine Systems* 44: 83-105.

Acker, J.G. & G. Leptoukh. 2007. Online Analysis Enhances Use of NASA Earth Science Data. *EOS Transactions American Geophysical Union* 88:14-17.

Airoldi, L. 2003. The effects of sedimentation on rocky coast assemblages. *Oceanography and Marine Biology* 41: 161-236.

Akselman, R. 1996. Estudios ecológicos en el Golfo San Jorge y adyacencias (Atlántico sudoccidental). Distribución, abundancia y variación estacional del fitoplancton en relación a factores físico-químicos y a la dinámica hidrográfica. Doctoral Thesis, Universidad de Buenos Aires, Argentina.

Arribas, L.P., M.I. Martinez & M.I. Brogger. 2016. Echinoderms in San Matías Gulf, Southwestern Atlantic Ocean. *Thalassas: An International Journal of Marine Sciences* 32: 11-18.

Babuder, M. 2020. Effects of turbidity on habitat-forming seaweeds in Southern New Zealand. PhD Dissertation. University of Canterbury, New Zealand.

Barry, J.P., C.H. Baxter, R.D. Sagarin & S.E. Gilman. 1995. Climate-related, long-term faunal changes in a California rocky intertidal community. *Science* 267: 672–675.

Beaton, E.C., F.C. Küpper, P. van West, P.E. Brewin & P. Brickle. 2020. The influence of depth and season on the benthic communities of a *Macrocystis pyrifera* forest in the Falkland Islands. *Polar Biology* 43: 573-586.

Benedetti-Cecchi, L. & F. Cinelli. 1995. Habitat heterogeneity, sea urchin grazing and the distribution of algae in littoral rock pools on the west coast of Italy (western Mediterranean). *Marine Ecology Progress Series* 126: 203–212.

Bernasconi, I. 1953. Monografía de los equinoideos argentinos. *Anales del Museo de Historia Natural* 6(2): 1-58

Bernasconi, I. 1966. Los equinoideos y asteroideos colectados por el buque oceanográfico R/V, frente a las costas argentinas, uruguayas y sur de Chile. *Revista del Museo de Ciencias Naturales Bernandino Rivadavia. Serie Zool* 9 (7): 1-15.

Betti, F., G. Bavestrello, M. Bo, F. Enrichetti, A. Loi, A. Wanderlingh, I. Pérez-Santos & G. Daneri. 2017. Benthic biodiversity and ecological gradients in the Seno Magdalena (Puyuhuapi Fjord, Chile). *Estuarine, Coastal and Shelf Science* 198: 269-278.

Botto, F., C. Bremec, A. Marecos, L. Schejter, M. Lasta & O. Iribarne. 2006. Identifying predators of the SW Atlantic Patagonian scallop *Zygochlamys patagonica* using stable isotopes. *Fisheries Research* 81: 45-50.

Bravo, G., J. Kaminsky, M. Bagur, C.P. Alonso, M. Rodríguez, C. Fraysse, G. Lovrich & G. Bigatti. 2023. Roving diver survey as a rapid and cost-effective methodology to register species richness in sub-Antarctic kelp forests. *Diversity* 15: 354.

Breiman, L., J.H. Friedman, R.A. Olshen & C.G. Stone. 1984. *Classification and Regression Trees*. Wadsworth International Group, Belmont, California, United States.

Brogger, M.I., D.G. Gil, T. Rubilar, M.I. Martínez, M.E. Diaz de Vivar, M. Escolar, L. Epherra, A.F. Pérez & A. Tablado. 2013. Echinoderms from Argentina: biodiversity, distribution and current state of knowledge. In: J.J. Alvarado & F.A Solis-Marin FA (eds.), *Echinoderm Research and Diversity in Latin America*, pp. 359–402. Springer, Berlin Heidelberg, Germany.

Castilla, J.C. 1985. Food webs and functional aspects of the kelp, *Macrocystis pyrifera*, community in the Beagle Channel, Chile. In: W.R. Siegfried, R.R. Condy & R.M. Laws (eds.) *Antarctic nutrient cycles and food webs*. Springer, Berlin Heidelberg.

Cuevas, J.M., J.P. Martin & R. Bastida. 2006. Benthic community changes in a Patagonian intertidal: a forty years later comparison. *Thalassas* 22: 31-39.

De'ath, G. & K.E. Fabricius. 2000. Classification and Regression Trees: a powerful yet simple technique for ecological data analysis. *Ecology* 81:3178–3192

Díaz, F., A. Salas, A.D. Re, M. González & I. Reyes. 2011. Thermal preference and tolerance of *Megastrea* (*Lithopoma*) *undosa* (Wood 1828). *Journal of Thermal Biology* 36: 34–37.

Díaz-Martínez, J.P., F. Benítez-Villalobos & A. López-Serrano. 2015. Density, spatial distribution and mortality rate of the sea urchin *Diadema mexicanum* (Diadematoida: Diadematidae) at two reefs of Bahías de Huatulco, Oaxaca, Mexico. *Revista de Biología Tropical* 63: 173-182.

Ebert, T.A. & M.P. Russell. 1988. Latitudinal variation in size structure of the west coast purple sea urchin: A correlation with headlands. *Limnology and Oceanography* 33: 286-294.

Ebert, T.A., J.C. Hernández & M.P. Russell. 2012. Ocean conditions and bottom-up modifications of gonad development in the sea urchin *Strongylocentrotus purpuratus* over space and time. *Marine Ecology Progress Series* 467: 147-166.

Escolar, M. 2010. Variaciones espacio-temporales en la comunidad de invertebrados bentónicos asociada al frente de talud. Equinodermos como caso de estudio. Doctoral Thesis. Universidad de Buenos Aires, Argentina.

Fernández, M. 2006. Características físico-químicas de los sedimentos del Golfo San Jorge y su relación con los organismos bentónicos del sector. Doctoral Thesis. Universidad Nacional de Mar del Plata, Argentina.

Fernández, M., J. Carreto, J. Mora & A. Roux. 2005. Physico-chemical characterization of the benthic ambient of Golfo San Jorge, Argentina. *Journal of the Marine Biological Association of the United Kingdom* 85: 1317-1328.

Fernández, M., J. Mora, A. Roux, D. Cucchi Colleoni & J. Gasparoni. 2008. A new contribution on spatial and seasonal variability of environmental conditions of the Golfo San Jorge, Argentina. *Journal of the Marine Biological Association of the United Kingdom* 88: 227-236.

Friedlander, A.M., E. Ballesteros, T.W. Bell, J.E. Caselle, C. Campagna, W. Goodell, M. Hüne, A. Muñoz, P. Salinas-de-León, E. Sala & Dayton, P. K. (2020). Kelp forests at the end of the earth: 45 years later. *Plos one* 15: e0229259.

Friedlander, A.M., E. Ballesteros, W. Goodell, M. Hüne, A. Muñoz, P. Salinas-de-León, P., C. Velasco-Charpentier & E. Sala. 2021. Marine communities of the newly created Kawésqar National Reserve, Chile: From glaciers to the Pacific Ocean. *PloS one* 16: e0249413.

Gaines, S.D. & J. Lubchenco. 1982. A unified approach to marine plant-herbivore interaction. I. Biogeography. *Annual Review of Ecology and Systematics* 13: 111-138.

Gil, D.G. 2015. Biología y ecología del erizo de mar *Pseudechinus magellanicus* (Echinoidea: Temnopleuridae) en Patagonia Central. Doctoral Thesis. Universidad Nacional de la Plata, Argentina.

Gil, D.G. & H.E. Zaixso. 2025. First insights into the vertical patterns of size distribution, abundance, and spatial aggregation of the sea urchin *Pseudechinus magellanicus* on a wave-exposed rocky shore in San Jorge Gulf, Argentina. *Zoological Studies* 64:08.

Gil, D.G., A.L. Boraso, E.C. Lopretto & H.E. Zaixso. 2021. Depth-related plasticity in the diet composition of *Pseudechinus magellanicus* (Echinoidea, Temnopleuridae) in nearshore environments off central Patagonia, Argentina. *Aquatic Ecology* 55: 589-606.

Gil, D.G., E.C. Lopretto & H.E. Zaixso. 2020. Reproductive timing and synchronized reproduction of the sea urchin *Pseudechinus magellanicus* (Echinoidea: Temnopleuridae) in central Patagonia, Argentina. *Marine Biology Research* 16: 311-326.

Hadiyanto, H., J. Prince & R.K. Hovey. 2024. Latitudinal biodiversity gradients of rocky intertidal assemblages: Spatial scales and complex associations with environmental factors. *Marine Ecology* 45: e12789.

Harley, C.D., A. Randall Hughes, K.M. Hultgren, B.G. Miner, C.J. Sorte, C.S. Thornber, L.F. Rodríguez, L. Tomanek & S.L. Williams. 2006. The impacts of climate change in coastal marine systems. *Ecology Letters* 9: 228-241.

Hawkins, S.J., K. Bohn K., L.B. Firth & G.A. Williams. 2019. *Interactions in the marine benthos* (No. 87). Cambridge University Press.

Helmuth, B., N. Mieszkowska, P. Moore & S.J. Hawkins. 2006. Living on the edge of two changing worlds: forecasting the responses of rocky intertidal ecosystems to climate change. *Annual Review of Ecology, Evolution, and Systematics* 37: 373-404.

Kaminsky, J., M. Varisco, M. Fernández, R. Sahade & P. Archambault. 2018. Spatial analysis of benthic functional biodiversity in San Jorge Gulf, Argentina. *Oceanography* 31:104-112.

Kelly, J.R., K.A. Krumhansl & R.E. Scheibling. 2012. Drift algal subsidies to sea urchins in low-productivity habitats. *Marine Ecology Progress Series* 452:145 – 157

Kordas, R.L., C.D.G. Harley & M.I. O´Connor. 2011. Community ecology in a warming world: The influence of temperature on interspecific interactions in marine systems. *Journal of Experimental Marine Biology and Ecology* 400: 218-26.

Kunze, C., M. Wölfelschneider & L. Rölfer. 2021. Multiple driver impacts on rocky intertidal systems: The need for an integrated approach. *Frontiers in Marine Science* 8: 667168.

Lazari, C., L. Epherra, E. Morsan & T. Rubilar. 2022. Macrobenthic subtidal communities of Northern

Patagonia: a focus on the changes in echinoderm populations. *Cahiers de Biologie Marine* 63: 199-211.

Lewis, J.R. 1986. Latitudinal trends in reproduction, recruitment and population characteristics of some rocky littoral molluscs and cirripedes. *Hydrobiology* 142: 1-13.

Marzinelli, E.M., G. Bigatti, J. Giménez & P. Penchaszadeh. 2006. Reproduction of the sea urchin *Pseudechinus magellanicus* (Echinoidea: Temnopleuridae) from Golfo Nuevo, Argentina. *Bulletin of Marine Science* 79: 127-136.

Menge, B.A., C. Blanchette, P. Raimondi, T. Freidenburg, S. Gaines, J. Lubchenco, D. Lohse, G. Hudson, M. Foley & J. Pamplin. 2004. Species interaction strength: Testing model predictions along an upwelling gradient. *Ecological Monographs* 74: 663-684.

Mutschke, E. & C. Ríos. 2006. Spatial distribution and relative abundance of echinoderms from the strait of Magellan, Chile. *Ciencia y Tecnología del Mar* 29: 91-102.

Mutschke, E., D. Gerdes & C. Ríos. 2017. Distribution and abundance patterns of echinoderms in the fjord and channel complex from a subantarctic north Patagonian Ice field, Magellan region. *Revista de Biología Tropical* 65: 60-72.

Ojeda, J., J.P. Rodríguez, S. Rosenfeld & N. Vega. 2017. Comparación de la estructura comunitaria entre plataformas y bolones del intermareal en isla Navarino, Reserva de Biósfera Cabo de Hornos. *Anales del Instituto de la Patagonia* 45: 33-43.

Orler, P.M. 1992. Biología reproductiva comparada de *Pseudechinus magellanicus* y *Loxechinus albus*, equinoideos del canal Beagle. Doctoral Thesis. Facultad de Ciencias Naturales y Museo, Universidad Nacional de la Plata, Argentina

Penchaszadeh, P. E., G. Bigatti & P. Miloslavich. 2004. Feeding of *Pseudechinus magellanicus* (Philippi, 1857)(Echinoidea: Temnopleuridae) in the SW Atlantic coast (Argentina). *Ophelia* 58: 91-99.

Phillips, N.E. & J.S. Shima. 2006. Differential effects of suspended sediments on larval survival and settlement of New Zealand urchins *Evechinus chloroticus* and abalone *Haliotis iris*. *Marine Ecology Progress Series* 314: 149-158.

Pinsky, M.L., R.L. Selden & Z.J. Kitchel. 2020. Climate-driven shifts in marine species ranges: scaling from organisms to communities. *Annual Review of Marine Science* 12: 153-179.

Piola, A.R. & A.L. Rivas. 1997. Corrientes en la plataforma continental. In: I. Boschi (ed.), *El Mar Argentino y sus recursos pesqueros* 1, pp. 119-132. Publicación especial del INIDEP, Mar del Plata, Argentina.

Quinn, G.P. & M.J. Keough. 2002. *Experimental design and data analysis for biologists*. Cambridge University Press, UK.

Rechimont, M.E., D.E. Galvan, M.C. Sueiro, G. Casas, M.L. Piriz, M.E. Diez, M.I. Brogger, J.E.F Alfaya & G. Bigatti. 2013. Benthic diversity and assemblage structure of a north Patagonian rocky shore: a monitoring legacy of the NaGISA project. *Journal of the Marine Biological Association of the United Kingdom* 93: 2049-2058.

Ríos, C., W.E. Arntz, D. Gerdes, E. Mutschke & A. Montiel. 2007. Spatial and temporal variability of the benthic assemblages associated to the holdfasts of the kelp *Macrocystis pyrifera* in the Straits of Magellan, Chile. *Polar Biology* 31: 89-100.

Ríos, C., E. Mutschke & Y. Cariceo. 2003. Estructura poblacional de *Pseudechinus magellanicus* (Philippi 1857) (Echinoidea: Temnopleuridae) en grampones de la macroalga sublitoral *Macrocystis pyrifera* (L.) C. Agardh en el Estrecho de Magallanes, Chile. *Anales del Instituto de la Patagonia* 31: 75-86.

Rivadeneira, M.M. & M. Fernández. 2005. Shifts in southern endpoints of distribution in rocky intertidal species along the south-eastern Pacific coast. *Journal of Biogeography* 32: 203-209.

Roughgarden, J., S. Gaines & H. Possingham. 1988. Recruitment dynamics in complex life cycles. *Science* 241: 1460-1466.

Roux, A. 2000. Evaluación del impacto pesquero a través del análisis de la fauna bentónica acompañante en la pesquería de langostino (*Pleoticus muelleri*) del Golfo San Jorge y litoral de Chubut, Argentina. *Frente Marítimo* 18: 143-149.

Roux, A. & D. Bertuche. 1998. Breve reseña de las evidencias de contaminación con petróleo detectadas en el Golfo San Jorge y de posibles efectos sobre el recurso langostino. Julio 1998. *Informe Técnico INIDEP* 97/98: 1-8.

Roux, A. & R. Piñero. 2001. Cambios en la estructura de la comunidad bentónica del Golfo San Jorge y áreas asociadas a los fondos de pesca del langostino patagónico. *Informe Técnico INIDEP* 107/01: 1-10.

Roux, A., M. Fernández & C. Bremec. 1995. Preliminary survey of the benthic communities of patagonian shrimp fishing grounds in San Jorge Gulf (Argentina). *Ciencias Marinas* 21: 295-310.

Sagarin, R.D., J.P. Barry, S.E. Gilman & C.H. Baxter. 1999. Climate related changes in an intertidal community over short and long time scales. *Ecological Monographs* 69: 465-90.

Sala, E., E. Ballesteros, P. Dendrinos, A. Di Franco, F. Ferretti, D. Foley, … & M. Zabala. 2012. The structure of Mediterranean rocky reef ecosystems across environmental and human gradients, and conservation implications. *PloS One* 7: e32742.

Scheibling, R.E. 1996. The role of predation in regulating sea urchin populations in eastern Canada. *Oceanologica Acta* 19: 421-430.

Schejter, L. 2005. Asociación bentónicas en bancos de vieira patagónica (*Zygochlamys patagonica*) en el Mar Argentino. Doctoral Thesis. Universidad Nacional de Mar del Plata, Argentina.

Sewell, M.A. & C.M. Young. 1999. Temperature limits to fertilization and early development in the tropical sea urchin *Echinometra lucunter*. *Journal of Experimental Marine Biology and Ecology* 236: 291–305.

Thomas, C.W., B.J. Crear & P.R. Hart. 2000. The effect of temperature on survival, growth, feeding and

metabolic activity of the southern rock lobster *Jasus edwardsii*. *Aquaculture* 185: 73–84.
Underwood, A.J. 2000. Experimental ecology of rocky intertidal habitats: what are we learning? *Journal of Experimental Marine Biology and Ecology* 250: 51–76.
Underwood, A.J. & M.G. Chapman. 1996. Scales of spatial patterns of distribution of intertidal invertebrates. *Oecologia* 107: 212–224.
Vásquez J.A. & A.H. Buschmann. 1997. Herbivore-kelp interactions in Chilean subtidal communities: a review. *Revista Chilena de Historia Natural* 70: 41–52.
Zaixso, H.E. & Z.I. Lizarralde. 2000. Distribución de equinodermos en el golfo San José y sur del golfo San Matías (Chubut, Argentina). *Revista de Biología Marina y Oceanografía* 35: 127–145.

Doi: 10.22179/REVMACN.27.853

Recibido: 3-VI-2024
Aceptado: 28-I-2025