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FUNCTIONAL DIVERSITY OF LIVING BENTHIC FORAMINIFERA OF THE SOUTHEASTERN PACIFIC OCEAN AND THEIR RELATIONSHIP WITH ENVIRONMENTAL VARIABLES

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STATEMENTS

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RESUMEN

Los foraminíferos bentónicos son indicadores clave que proporcionan información sobre el funcionamiento de los ecosistemas a través de sus adaptaciones a los gradientes ambientales. En el presente estudio se evalúa la diversidad taxonómica y funcional de las comunidades de foraminíferos bentónicos vivos a lo largo del margen continental occidental de América del Sur (1°-50°S) y a profundidades de entre 79 y 4500 m. Se identificaron un total de 365 especies, siendo Rotalida, Lituolida y Astrorhizida los órdenes más frecuentes.

La riqueza y diversidad de especies mostraron una pronunciada variabilidad espacial estructurada no por un gradiente latitudinal continuo, sino por umbrales ambientales discretos, asociados principalmente a la disponibilidad de oxígeno. Los análisis de diversidad funcional revelaron que las comunidades más ricas desde el punto de vista taxonómico ocupaban un espacio de rasgos funcionales más amplio, aunque de forma desigual en toda la zona de estudio, lo que indica una redundancia funcional considerable. Este patrón se asocia a un fuerte proceso de selección ambiental de especies (filtrado ambiental), junto con asociaciones de alta diversidad taxonómica en los que se observó una saturación parcial del espacio funcional.

Por el contrario, los sectores heterogéneos promovieron una mayor diferenciación de nichos y diversificación funcional. Los rasgos medios ponderados por la comunidad respaldaron cambios latitudinales consistentes en la morfología, las estrategias tróficas y la tolerancia al oxígeno. Los modelos aditivos generalizados identificaron la temperatura, la salinidad, el oxígeno, las concentraciones de fosfato y silicato y las características de los sedimentos como factores determinantes de la diversidad taxonómica y funcional, siendo el oxígeno el factor estructurante dominante. Los análisis de nicho confirmaron un fuerte efecto de este filtrado ambiental en condiciones de bajo oxígeno, donde las comunidades estuvieron dominadas por especialistas que ocupaban nichos marginales.

Nuestros resultados demuestran que la disponibilidad de oxígeno regula la distribución de las especies, la configuración de los nichos y la organización funcional, modulando el equilibrio entre la redundancia y la diferenciación en los ecosistemas bentónicos del Pacífico sudoriental. Este estudio establece una base de referencia regional para evaluar las consecuencias ecológicas de la continua expansión de la OMZ en el Pacífico sudoriental.

Palabras clave: Foraminíferos bentónicos, diversidad funcional, rasgos funcionales, nicho, Pacífico Sur Oriental.

ABSTRACT

Benthic foraminifera are key indicators that provide insights into ecosystem functioning through their adaptations to environmental gradients. This study assesses the taxonomic and functional diversity of living benthic foraminiferal communities along the western South American continental margin (1°–50°S) and water depths from 79 to 4500 m. A total of 365 species were identified, with Rotalida, Lituolida, and Astrorhizida as the most frequent orders.

Species richness and diversity exhibited pronounced spatial variability structured not by a continuous latitudinal gradient, but by discrete environmental thresholds, primarily associated with oxygen availability. Functional diversity analyses revealed that taxonomically richer communities occupied broader functional trait space, though unevenly across the study area, indicating substantial functional redundancy. This pattern emerged under environmental filtering, particularly in highly diverse assemblages where partial saturation of trait space occurred.

In contrast, heterogeneous sectors promoted greater niche differentiation and functional diversification. Community-weighted mean traits revealed consistent latitudinal shifts in morphology, trophic strategies, and oxygen tolerance. Generalized additive models identified temperature, salinity, oxygen, phosphate, silicate concentrations, and sediment characteristics as drivers of taxonomic and functional diversity, with oxygen emerging as the dominant structuring factor. Niche analyses were consistent with environmental filtering under oxygen-depleted conditions, where communities were dominated by specialists occupying marginal niches.

Our results demonstrate that oxygen availability regulates species distributions, niche configuration, and functional organization, modulating the balance between redundancy and differentiation in benthic ecosystems of the Southeastern Pacific. This study establishes a regional baseline to assess ecological consequences of continued OMZ expansion in the Southeastern Pacific.

Keywords: Benthic foraminifera, functional diversity, functional traits, niche, Southeastern Pacific

1. INTRODUCTION

1.1. Marine biodiversity

Marine ecosystems exhibit unique characteristics compared to terrestrial ones, as organisms have evolved under distinct physical and chemical constraints to ensure survival in the marine environment (Grassle *et al.*, 1991). The marine realm hosts approximately 35 Phyla, of which 14 are exclusive to this environment (Briggs, 1974; Gray, 1997). Over the past decades, research has advanced our understanding of marine biodiversity, including its composition, distribution and the processes that regulate community structure (Cardinale *et al.*, 2006; Costello *et al.*, 2010). In recent decades, the Southern Hemisphere has been shown to harbor several biodiversity "hotspots," largely associated with major current systems. Notably, the Benguela Current System (35°S - 15°S) (Kirkman *et al.*, 2013; Sakko, 1998; Zettler *et al.*, 2013) and the Humboldt Current System, which extends from 45°S off southern Chile to 4°S near the Peru–Ecuador border, stand out as key regions of high marine diversity (Montecino & Lange, 2009; Ramírez *et al.*, 2017; Wagner *et al.*, 2020).

In South America, extensive coastlines, heterogeneous habitats, and diverse oceanographic conditions strongly influence the richness and composition of marine invertebrate and fish assemblages across the Pacific and Atlantic coasts (Miloslavich *et al.*, 2011). The Pacific Ocean, in particular, is characterized by a high diversity of benthic macroinvertebrates groups, including Arthropoda, Crustacea, Decapoda, Echinodermata, Mollusca, Polychaeta, Bryozoa among others (Häussermann & Försterra, 2005; Hooker *et al.*, 2013; Lancellotti &

Vásquez, 1999; Mutschke *et al.*, 2017; Tasso *et al.*, 2018) as well as diverse seaweed species (Cárdenas-Calle *et al.*, 2020). This diversity reflects the wide range of habitats present, from rocky coasts to sandy substrates, spanning both intertidal and subtidal zones, and underscores the importance of environmental heterogeneity in shaping marine biodiversity patterns (Tarazona *et al.*, 2003)(Miloslavich *et al.,* 2016)

1.2. Southeastern Pacific Ocean (SEP)

The Southeastern Pacific Ocean (SEP) is strongly influenced by the Humboldt Current System (HCS), one of the most productive eastern boundary current systems in the world. The HCS originates from the northern branch of the Antarctic Circumpolar Current (ACC), driven by westerly wind drift (WWD, ~42°S–48°S), and transports cold Subantarctic Surface Waters (SAAW) northward toward the Equator (Silva *et al.*, 2009; Strub *et al.*, 1998). As it flows along the coast of Peru and Chile, it divides into two currents, the Peru Ocean Current (POC) and the Peru-Chile Current (PCC) (Figure 1). On the other hand, from the tropical zone, the Equatorial Subsurface Current (EUC) flows southeastward, reaching the Peruvian coast at 5°S, influencing the formation of southward-flowing currents: the Peru-Chile Countercurrent (PCCC) and the Peru-Chile Undercurrent (PCUC) (Figure 1a, b). The PCCC divides the PCC and POC (Chaigneau *et al.*, 2013; Montes *et al.*, 2010; Morales *et al.*, 1996; Strub *et al.*, 1998). While the PCUC transports Equatorial Subsurface Waters (ESSW), which are mainly characterized by being masses of water with high salinity, rich in nutrients and poor in oxygen, properties that are diluted along their path due to the northward advection of Antarctic Intermediate Waters (AAIW) (Figueroa & Moffat, 2000; Fuenzalida *et al.*, 2009; S & Neshyba, 1979).

A defining characteristic of the HCS is the occurrence of wind-driven coastal upwelling, which brings nutrient-rich ESSW to the euphotic zone. This process sustains extremely high primary productivity rates, estimated at approximately 1.2 kg C m^{-2} y^{-1} (Gutiérrez *et al.*, 2016; Montecino & Lange, 2009). Consequently, the region supports highly productive marine ecosystems and diverse benthic communities. Another feature of the SEP is the presence of an extensive Oxygen Minimum Zone (OMZ), which is closely associated with the PCUC and characterized by very low dissolved oxygen concentrations (Chavez *et al.*, 2008; Montecino & Lange, 2009; Thiel *et al.*, 2007). Upwelling intensity varies along the latitudinal gradient of the HCS. Permanent upwelling occurs north of ~32°S, where high nutrient availability sustains large phytoplankton populations dominated by diatoms (Abrantes *et al.*, 2007). While between ~33°S and 40°S, coastal upwelling becomes seasonal, occurring mainly during austral spring and summer and often interacting with riverine inputs that further enhance coastal productivity (Rosales Quintana *et al.*, 2021; Strub *et al.*, 1998)

These strong gradients in oxygen availability, nutrient concentration, and productivity create heterogeneous environmental conditions that significantly influence the composition and diversity of benthic communities in the Southeastern Pacific.

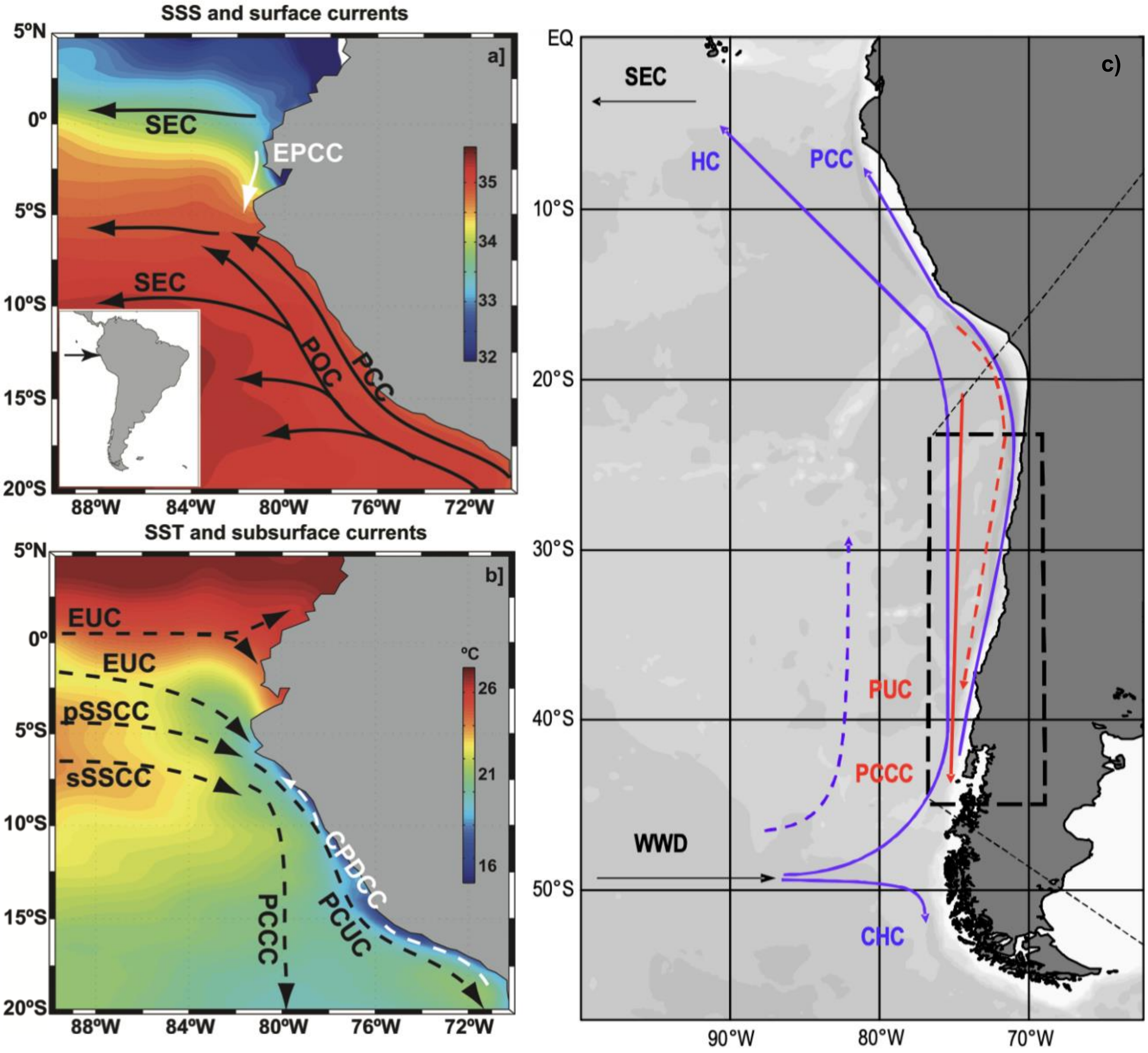


Figure 1. Main ocean currents and water masses in the Southeastern Pacific. a) Sea-surface salinity and surface circulation. b) Sea-surface temperature and subsurface circulation. Surface currents. SEC: South Equatorial Current; EPCC: Ecuador-Peru Coastal Current; POC: Peru Oceanic Current; PCC: Peru Coastal Current. Subsurface currents. EUC: Equatorial Undercurrent; pSSCC: primary (northern branch) Southern Subsurface Countercurrent; sSSCC: secondary (southern branch) Southern Subsurface Countercurrent; PCCC: Peru-Chile Countercurrent; PCUC: Peru-Chile Undercurrent. c) Map of the eastern South Pacific with schematic arrows indicative of the patterns of motion of the dominant water masses. The lines sketch the dominant currents (HC: Humboldt Current, PCCC: Peru-Chile Counter Current, PUC: Poleward Undercurrent, PCC: Peru-Chile Coastal Current, CHC: Cape Horn Current, SEC: South Equatorial Current, and WWD: West Wind Drift), the red/purple lines indicating waters of tropical/subpolar origin. The dashed lines correspond to intermediate waters. The solid and dashed lines are suggestive of the main direction of propagation of the upper and intermediate waters. Figures a) and b) were taken from Chaigneau *et al.* (2013). Figure c) was taken from Llanillo *et al.* (2013).

1.3. Environmental gradients shaping marine biodiversity

Biodiversity patterns are not randomly distributed but are shaped by a variety of environmental and ecological drivers operating across spatial and temporal scales. Factors such as temperature, productivity, oxygen availability, habitat heterogeneity and disturbance have been widely recognized as major determinants of species distribution and community structure (Gaston, 2000; Huston, 1999; Tittensor *et al.*, 2010). In addition, species richness in marine ecosystems appears to be shaped by the interaction between species' environmental tolerances and both seasonal and interannual variability in environmental conditions (Rombouts *et al.*, 2012; Valdés & Moral, 1998; Williams, 1993).

In marine ecosystems, biodiversity patterns often show substantial spatial variability and do not always follow simple or universal gradients. Classical macroecological paradigms, such as the latitudinal diversity gradient, have been widely documented across terrestrial ecosystems, yet marine systems frequently exhibit more complex and region-dependent patterns (Danovaro, 2024; Piacenza *et al.*, 2015). These deviations arise because marine biodiversity is influenced by the interaction of multiple environmental drivers, including temperature, food availability, habitat heterogeneity and oceanographic processes, which vary across spatial and temporal scales (Danovaro, 2024). Furthermore, because marine ecosystems operate in a three-dimensional environment, depth plays a fundamental role in shaping species distributions and biodiversity patterns, particularly for organisms inhabiting subsurface and benthic habitats (Owens & Rahbek, 2025).

In the Southeastern Pacific, environmental gradients associated with the Humboldt Current System strongly influence benthic community structure. One of the most prominent features of this region is the presence of an extensive Oxygen Minimum Zone (OMZ), which creates pronounced gradients in oxygen availability along the continental margin (Montecino & Lange, 2009; Thiel, 2007). Low oxygen conditions have been shown to negatively affect macrobenthic diversity and species richness on the continental shelf and slope off Chile, often leading to simplified communities dominated by tolerant taxa (Palma *et al.*, 2005). Studies conducted along bathymetric gradients have also demonstrated that benthic diversity patterns vary with depth and oxygen availability, with lower diversity typically observed within the OMZ and higher diversity below it (Gómez *et al.*, 2024). In addition to oxygen, food supply derived from high primary productivity and the physical characteristics of sediments, such as grain size and organic matter content, have been identified as important drivers shaping macrobenthic biodiversity and distribution in this region (Soto *et al.*, 2017).

1.4. Foraminifera as a study model

Foraminifera are predominantly single-celled microorganisms with tests that inhabit mainly marine environments (Murray, 2006; Sen Gupta, 2002). Globally, more than 1000 species of benthic foraminifera have been described (Debennay, 2012; Loeblich & Tappan, 1988). The classification of this group is largely based on the composition and structure of the test wall (Blackmon & Todd, 1959). Three main types are recognized: 1) **Tectinaceous species**, characterized by an organic or proteinaceous wall, lacking a hard test. 2) **Agglutinated species**, with a proteinaceous or mineralized wall; they construct their tests by binding sediment particles together. 3) **Calcareous species**, with mono- or bilamellar walls, forming their tests from precipitated calcite, either with high or low Mg content (Kaminski, 2014; Lipps, 1973; Murray, 2007).

Benthic foraminifera constitute approximately 50% of the meiofauna in marine sediments (Zarghami *et al.,* 2019). They exhibit high microhabitats specificity and are widely recognized as potential environmental bioindicators (Jima *et al.*, 2022; Murray, 2001; Sen Gupta, 2002), as their tests can record evidence of environmental stress. Their short reproductive cycles and rapid growth make their community structure sensitive to environmental fluctuations (Scott *et al.*, 2005; Yanko *et al.*, 1994). Due to their sensitivity to environmental change and their excellent preservation in marine sediments, benthic foraminifera have become one of the most widely used biological indicators in environmental and paleoceanographic studies (Mackensen, 2008). Furthermore, benthic foraminifera play a key role in biogeochemical cycles, since they are capable of absorbing algal carbon, removing nitrogen through respiration and contributing to denitrification processes (Koho & Piña-Ochoa, 2012; Moodley *et al.*, 2000). Consequently, benthic foraminifera represent an important functional component of carbon and nitrogen cycling in marine ecosystems.

In the Southeastern Pacific, the taxonomic diversity of benthic foraminifera has been extensively investigated over the past decades (Diz *et al.*, 2023; Fernández & Zapata, 2010; Figueroa *et al.*, 2005; Figueroa *et al.*, 2006; Mayor Pastor, 1998). These organisms have been widely used in paleoceanography studies to infer temporal variations in sediment redox conditions (Cardich *et al.*, 2019; Erdem *et al.*, 2020); as environmental bioindicators (Tavera Martínez *et al.*, 2023; Tavera Martínez *et al.*, 2022), and for their potential role in biogeochemical processes (Cardich *et al.*, 2012; Glock *et al.*, 2013; Merma-Mora, 2016). Oxygen availability is considered one of the most important environmental factors controlling the distribution and diversity of benthic foraminiferal communities, as variations in oxygen concentration can strongly influence species composition, abundance and microhabitat distribution within marine sediments (Gooday, 2003; Jorissen *et al.*, 2007). Several species exhibit physiological adaptations that allow them to tolerate hypoxic or even anoxic conditions, including the ability to store and respire nitrate when oxygen availability is limited (Glock *et al.*, 2013; Piña-Ochoa *et al.*, 2010). The latter aspect is particularly relevant in the Southeastern Pacific since its extensive Oxygen Minimum Zone (OMZ). In such environments, benthic communities commonly exhibit reduced diversity and are dominated by taxa capable of tolerating hypoxic conditions (Gooday, 2003; Levin *et al.*, 2002). Benthic foraminifera displays both community-level and physiological responses to varying hypoxic gradients (Cardich, 2012; Cardich *et al.*, 2012). At approximately 12°S, species such as *Bolivina costata*, *Nonionella auris* and *Virgulinella fragilis* are characteristics of anoxic, organic-rich coastal sediments

(Cardich, 2012). Similarly, at 13°S, hypoxic conditions are associated with low diversity in benthic foraminiferal assemblages, which are strongly dominated by hyaline calcareous species such as *Buliminella elegantissima* and *B. costata*. These species are considered indicators of environmental stress because they exhibit high tolerance to low interstitial pH and tend to dominate under conditions that promote carbonate dissolution within the sediment (Merma-Mora, 2016).

Morphological characteristics, such as pore size and density, have been widely employed as paleoceanographic proxies to reconstruct past oxygenation and redox conditions (S Garrido *et al.*, 2025). These features are often associated with physiological adaptations to low-oxygen environments. Pore characteristics have been linked to the capacity of some benthic foraminifera to store and respire nitrate, allowing them to perform denitrification under hypoxic conditions (Glock *et al.*, 2012; Rathburn *et al.*, 2018; Richirt *et al.*, 2019). Evidence from the Oxygen Minimum Zone off Peru indicates that foraminiferal denitrification can account for up to ~38–50% of the total benthic nitrate loss between 79 and 248 m depth (Glock *et al.*, 2013; Piña-Ochoa *et al.*, 2010). Additionally, test morphology has been linked to the microhabitat of benthic foraminifera. Asymmetrical tests with pores concentrated on one side are typically associated with epifaunal species attached to hard substrates, whereas symmetrical tests with bilateral pore distribution are more characteristic of infaunal taxa living within the sediment (Dubicka *et al.*, 2015).

1.5. Functional Diversity

Community diversity studies have been extensively conducted to evaluate the impact of biodiversity loss on ecosystem functioning. The decline in biodiversity has been shown to negatively affect key ecosystem processes, including productivity, trophic interactions, and biogeochemical cycles (Loreau *et al.*, 2001). However, evidence of a consistent and universal relationship between species richness and ecosystem functioning remains elusive, as similar levels of ecosystem performance can be maintained by communities with different taxonomic compositions (Cadotte *et al.*, 2011; Cardinale *et al.*, 2000).

In this context, functional diversity has emerged as a key framework to better understand how biodiversity influences ecosystem processes. Functional diversity focuses on the characteristics of species that influence their ecological roles rather than solely on the number of species present (Cadotte *et al.*, 2011; Díaz *et al.*, 2007; Tilman *et al.*, 1997). By incorporating species' functional traits, this approach provides a more mechanistic understanding of how communities contribute to ecosystem functioning.

The concept of functional diversity has evolved over time and has undergone several conceptual refinements (Figure 2), integrating both the effects of species on ecosystem functioning and their responses to environmental change (Hooper *et al.*, 2005; Laureto *et al.*, 2015; Loreau *et al.*, 2001). In this study, we follow the framework proposed by Loreau et al. (2001), where ecosystem functioning is influenced by the diversity and distribution of functional traits within communities. This framework is commonly quantified using complementary indices that capture different aspects of functional structure, such as the volume of functional space occupied by species (FRic) and the regularity of species distribution within that space (FEve) (Laliberte & Legendre, 2010; Villeger *et al.*, 2008). A crucial step in this framework is the selection and assessment of functional traits. Functional traits are defined as morphological, physiological, or ecological characteristics that determine how organisms interact with their environment and influence ecosystem processes (Francisco & de la Cueva, 2017; Kaminsky *et al.*, 2018; Violle *et al.*, 2007). By quantifying these traits, functional diversity approaches provide insights into community assembly processes, species responses to environmental gradients, and the mechanisms underlying ecosystem functioning. Functional diversity therefore provides a mechanistic framework linking species traits, environmental gradients, and ecosystem functioning. Applying this framework to benthic ecosystems allows the evaluation of how environmental variability shapes functional trait distributions and ecological strategies within benthic communities.

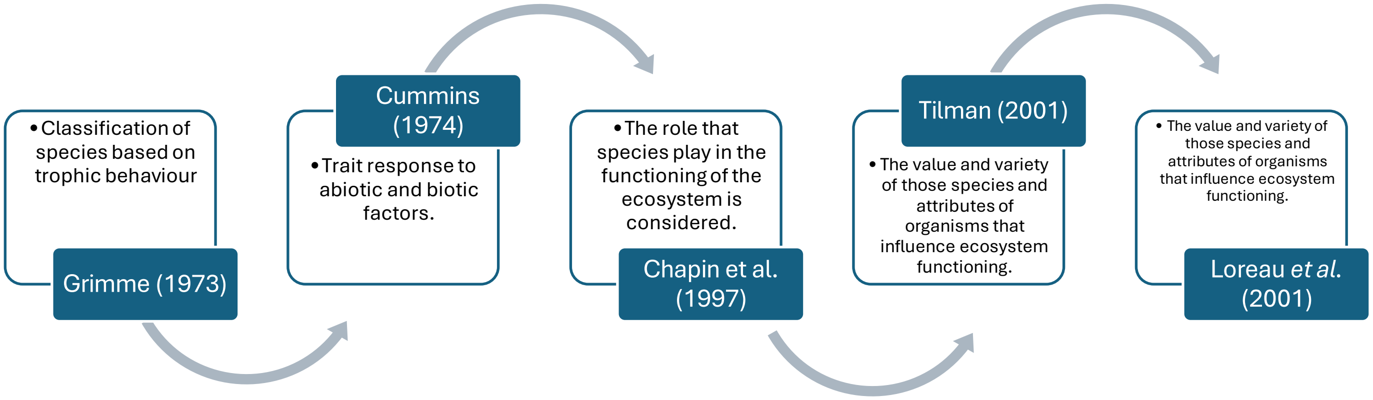


Figure 2. Concepts and definitions in the last decades of functional diversity.

1.6. Functional Diversity in the Benthic Ecosystem

The study of functional diversity in benthic ecosystems is essential for understanding how the distribution of functional traits relates to environmental variables, thereby providing insights into biodiversity-ecosystem functioning relationships (Bremner *et al.*, 2006; Kaminsky *et al.*, 2018). Functional traits commonly assessed in benthic organisms include morphological characteristics (*e.g.* body size, mobility), habitat preferences, feeding strategies (*e.g*. feeding mode or prey type), and life-history traits such as larval development or longevity (Brandt *et al.*, 2024; Ghodrati Shojaei *et al.*, 2015; Weigel *et al.*, 2016).

Species distribution in benthic ecosystems is strongly influenced by ecological niche differentiation along environmental gradients, which ultimately shapes the distribution of functional traits within communities (D'Andrea & Ostling, 2016; Kearney *et al.*, 2010). The ecological niche describes the range of environmental conditions that allow a species to persist in each habitat (Kearney, 2006). Differences in niche position and niche breadth can determine patterns of species occurrence, specialization, and tolerance to environmental variability (Qi *et al.*, 2025). Functional traits therefore reflect the ecological strategies through which species occupy and respond to these environmental conditions (Kearney *et al.*, 2010; Włodarska-Kowalczuk *et al.*, 2019).

In the case of foraminifera, several morphological traits have been linked to ecological functions. For example, motility has been suggested to influence sediment mixing and small-scale bioturbation (Deldicq *et al.*, 2020). However, the contribution of foraminifera to sediment reworking and bioturbation has often been underestimated in benthic ecosystem studies.

In addition to individual morphological traits, broader functional classifications have been proposed for foraminifera. One widely used approach is the classification of species into “morphogroups”, based on similarities in test morphology, which has been applied to evaluate stratigraphic and paleoenvironmental variations (Reolid & Martínez-Ruiz, 2013; Reolid *et al.*, 2008). Morphogroups integrate several biological characteristics, including test shape, inferred feeding strategies, and microhabitat preferences, under the assumption that test morphology reflects ecological strategies (Caratelli & Archuby, 2023; Corliss & Chen, 1988; Murray *et al.*, 2011). Although this assumption is not universally accepted (Linke & Lutze, 1993), morphogroup approaches have been successfully used to reconstruct environmental conditions in the geological record, including variations in oxygen availability and nutrient supply (Khare *et al.*, 2017; Reolid & Martínez-Ruiz, 2013; Saalim *et al.*, 2019).

Environmental factors such as oxygen concentration, organic matter availability, salinity, and depth strongly influence both the taxonomic composition and morphological traits of foraminiferal communities (Bouchet *et al.*, 2012; Bouchet *et al.*, 2018). For example, oxygen availability can be reflected in morphological attributes such as test porosity, wall thickness, and mineral composition (Kaiho, 1994). Habitat preferences of benthic foraminifera have also been conceptualized through the TROX model (Jorissen *et al.*, 1995), which proposes that the vertical distribution of foraminifera between epifaunal (surface dwelling) and infaunal (subsurface dwelling) microhabitats is regulated by the interaction between food availability and oxygen concentration.

2. STATEMENT OF THE PROBLEM

Climate change is expected to adversely affect marine ecosystems through multiple stressors including ocean acidification, increased eutrophication, and expansion of the Oxygen Minimum Zone (Allen *et al.*, 2023; Popova *et al.*, 2016).

Foraminifera, which constitute over 50% of the meiobenthos, are particularly sensitive to environmental factors such as organic matter availability, oxygen concentration, and sediment type (Castillo *et al.*, 2021; Kranner *et al.*, 2022; Miljutin *et al.*, 2012). Their sensitivity, combined with their fossilization potential, makes them indispensable for reconstructions past marine environment (Manasa *et al.*, 2016; S. dos S. de Jesus *et al.*, 2020) and for biomonitoring of potentially toxic elements such as heavy metals (Tavera Martínez *et al.*, 2023; Tavera Martínez *et al.*, 2022).

Although the distribution and taxonomic diversity of benthic foraminifera in the Pacific have been studied in specific regions (Mayor Pastor, 1998; Tavera Martínez *et al.*, 2022; Zapata *et al.*, 1995), comprehensive studies covering multiple surface sediment stations across a latitudinal broad latitudinal gradient remain scarce (Diz *et al.,* 2023). In particular, studies evaluating the functional diversity of benthic foraminiferal communities in the Southeastern Pacific are scarce. Most previous research in this region has focused primarily on taxonomic diversity or paleoenvironmental applications (Cardich *et al.*, 2012; Erdem *et al.*, 2020; Mallon *et al.*, 2011).

Functional diversity analyses integrate information on species occurrence and abundance with their functional traits, providing insights into how communities respond to environmental gradients and how ecosystem functioning may vary across space (Laureto *et al.*, 2015; Legras *et al.*, 2020). Because benthic foraminiferal species exhibit distinct ecological strategies and physiological adaptations, the analysis of their functional traits provides a valuable framework to understand how environmental variability shapes community structure and ecosystem functioning in marine environments.

Assessing the functional diversity of benthic foraminifera in the Southeastern Pacific will provide novel insights into ecosystem functioning and reveal whether patterns of functional diversity differ from those inferred from taxonomic diversity alone. This study represents one of the first attempts to characterize the functional diversity of benthic foraminiferal communities across this region using ecological and biological traits such as test wall-type, morphology, feeding strategies, and habitat preferences. In addition, the study examines the environmental variables that influence these traits, contributing to a better understanding of how benthic ecosystems respond to environmental variability.

3. RESEARCH QUESTION

What environmental variables modulate functional and taxonomic diversity in the Southeastern Pacific?

4. HYPOTHESIS

H1: In the Southeastern Pacific Ocean, zones with the highest diversity of living benthic foraminiferal species have a high number of morphological and ecological traits, resulting in the most functional diversity.

H2: The main environmental factors influencing the distribution of functional traits are sediment geochemistry and bottom water oxygen levels.

5. GENERAL OBJECTIVE

To evaluate the functional and taxonomic diversity of living benthic foraminifera, and analyze their relationship with environmental variables in the Southeastern Pacific Ocean

5.1. Specific Objectives

1) To characterize the functional traits of benthic foraminifera to identify their ecological roles at the spatial scale.

2) To determine the environmental variables that modulate the functional and taxonomic diversity of benthic foraminifera in the Southeastern Pacific.

6. MATERIALS AND METHODS

6.1. Data collection

6.1.1. Study area

This study focusses on the western South American continental margin extending from Ecuador (1ºS) to the South off Chile (50ºS) and spanning water depths from 79 to 4500 m across the shelf and slope, which are influenced by different water masses (Figure 1). For the purposes of this study, the South Pacific is split between the Southeastern Pacific (SEP) and the Equatorial Southeastern Pacific (ESEP) regions. In the case of the ESEP, the analysis is based on three sampling stations located off the coast of Ecuador, and this region is treated as being representative of the equatorial sector of the Southeastern Pacific, rather than as a comprehensive characterization of the province.

6.1.2. Environmental variables

Bottom-water environmental data corresponding to each the sampling stations were utilized compiled from Krahmann (2012), Krahmann (2018) and Reyes-Macaya *et al.* (2022) The environmental variables from the compiled dataset (Susaya-Vicente *et al.*, 2025) considered here include temperature, salinity, dissolved oxygen, phosphate, nitrate, nitrite, and silicate. Original hydrological data were interpolated using DIVA (Data-Interpolated Variational Analysis) and the non-outlier Weighted Average Interpolation gridding method implemented in Ocean Data View (ODV, R. Schlitzer, 2021) View, https://odv.awi.de/, 2021), applying maximum grid scales of 30:X and 20:Y nautical per mile.

To match environmental data with sampling locations, a custom Python script was developed to compute the nearest distance neighbour in latitude, longitude, and water depth ensuring site-specific (Python code is available in Reyes-Macaya *et al.* (2024)).

In addition, a sediment geochemistry dataset was compiled, including biogenic opal, total organic carbon, total nitrogen, the C/N ratio and $CaCO_3$ conted, obtaines from previously published studies (Sebastián Garrido *et al.*, 2025; Mollier-Vogel *et al.*, 2012; Prahl *et al.*, 2006; Romero & Hebbeln, 2003; Sommer & Dale, 2019) (Appendix 1).

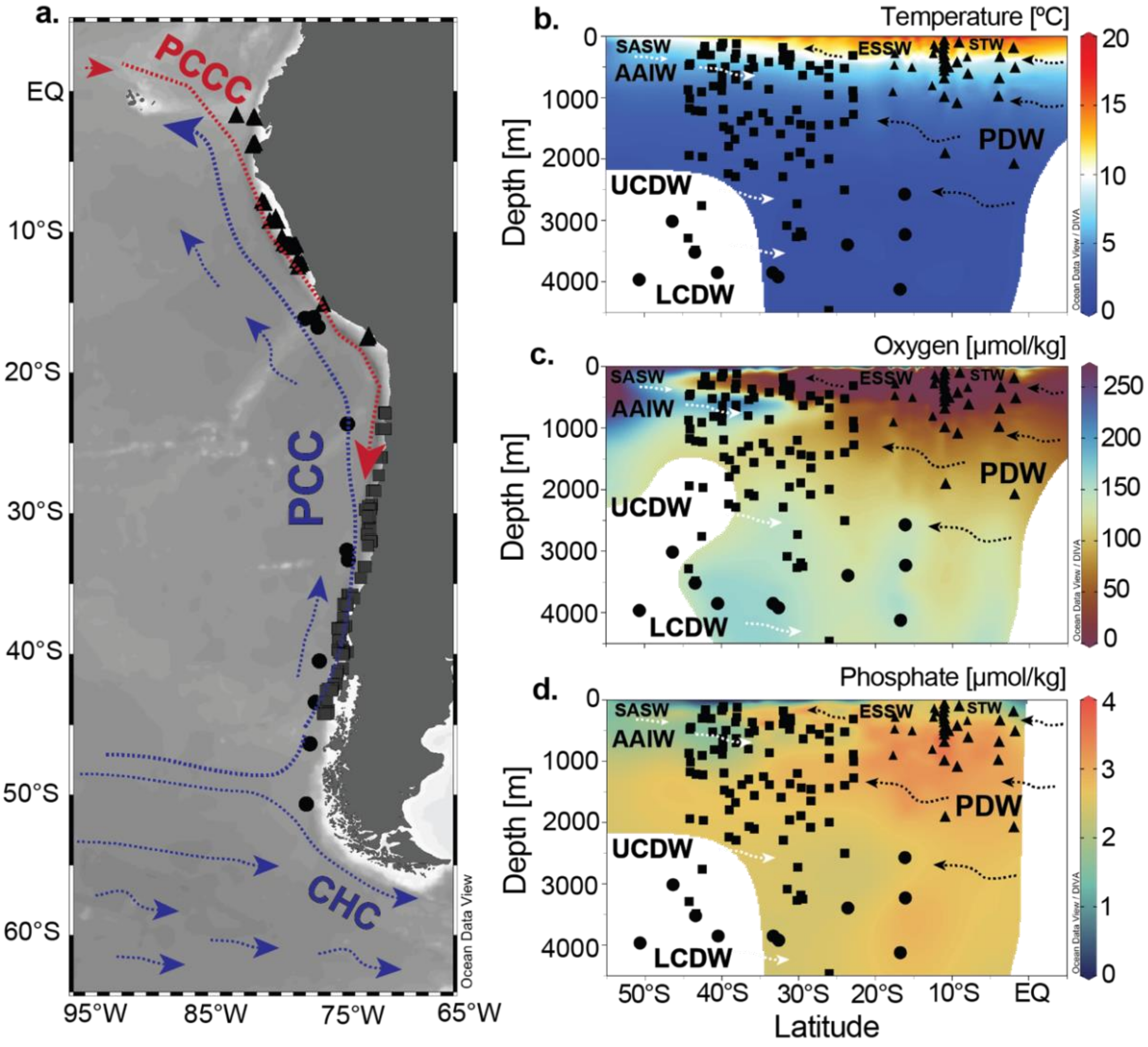


Figure 3. Sampling stations along the western South American margin. (a) Sampling locations: triangles = coasts of Ecuador and Peru (expedition M77 of the R/V Meteor, Mallon (2011)); grey squares = north and south-central Chile margin (PUCK expedition, Hebbeln *et al.* (2001)); dots = Nazca Ridge and Chile Rise (R/V Roger Revelle RR9702A). (b-d) Depth distribution of (b) temperature, (c) oxygen, and (d) phosphate concentrations of the main water masses influencing the sampling stations in the Southeastern Pacific. Currents: PCCC: Peru-Chile Countercurrent, PCC: Peru-Chile Current, CHC: Cape Horn Current. Water masses: ESSW: Equatorial Subsurface Water, STW: Subtropical Water, SAAW: Subantarctic Surface Water, AAIW: Antarctic Intermedia Water, PDW: Pacific Deep Water, UCDW: Upper Circumpolar Deep Water, LCDW: Lower Circumpolar Deep Water.

6.1.3. Surface sediments

Benthic foraminiferal data were obtained from 35 surface sediment samples collected during legs 1 and 2 of the R/V Meteor cruise M77, conducted between October 22 and December 22, 2008 (Pfannkuche, 2011). Samples were retrieved using a video-guide along the margin between 1°S (Ecuador) and 17°S (Peru), at depths ranging from 79 to 2092 m. The multicorer tubes had an inner diameter of 10 cm, and one tube with an even surface was selected from each deployment for analysis. Sampling was carried out along the continental margin between 1°S (Ecuador) and 17°S (Peru) at water depths ranging from 79 to 2,092 m. Sediments were retrieved using a video-guided multicorer with a 10 cm inner diameter. From each deployment, the core with the most undisturbed sediment surface was selected for analysis. Surface sediments were sliced into intervals of 2, 3, 5, or 10 mm intervals following standard procedures. Benthic foraminiferal assemblages, from the 63-2000 µm size fraction, following of (Mallon, 2011).

Additionally, 132 sediment samples were collected during leg 2 of the R/V Sonne cruise SO156 (PUCK expedition), conducted between April 24 and May 14, 2001, from 22°S (Iquique) to 44°S (Guaitecas Islands), at depths between 110 to 4470 m. As with R/V Meteor, the samples were collected, with a multicorer (10 cm inner diameter), and the selected cores were sliced into 1 cm-thick intervals (Hebbeln *et al.*, 2001). Benthic foraminiferal assemblages were analyzed. from >150 µm size fraction

Finally, 10 surface sediment samples were obtained during the R/V Roger Revelle cruise RR9702A (GENE03RR), conducted between February 25 and March 16, 1997, along Chilean continental margin between 16°S and 50°S, at depths ranging from 2575 to 4124 m. Data from this expedition are available at (https://www.pangaea.de/expeditions/events/RR9702A).

6.1.4. Sample processing

Sediment subsamples were preserved in a solution of 2 g L^{-1} Rose Bengal prepared in 96% ethanol and stored at 4°C in dark conditions until laboratory processing. This procedure is commonly used to distinguish living foraminifera at the time of collection

Foraminifera Specimens showing bright pink staining in 50% of their chambers were classified as living individuals (Fontanier *et al.*, 2016; McCorkle *et al.*, 1990; Murray & Bowser, 2000; Rathburn & Corliss, 1994). The faunal analysis was performed on the >150 µm. Size fractions to ensure comparability among sampling sites.

6.2. Taxonomic Diversity

After sieving and drying, a comprehensive taxonomic analysis of all samples was conducted. Separation, census, and identification of living benthic foraminifera were performed under a stereomicroscope. Samples from cruise RR9702A (16°S - 50°S) were analyzed at the Woods Hole Oceanographic Institution (WHOI, USA), whereas those from cruise M77 (1°S - 17°S) were analyzed at GEOMAR, Helmholtz Centre for Ocean Research, Kiel, Germany (Mallon, 2011), and the samples from the PUCK cruise (22°S and 44°S) were processed at the Paleoceanography Laboratory of the Lyell Centre, Heriot-Watt University, Edinburgh, Scotland.

Species determination was performed using standard taxonomic references and identifications keys including Cushman & Wickenden (1929), Bandy & Rodolfo (1968), Brady (1884), Ellis & Messina catalogue (1942-2006), Figueroa et al. (2005, 2006), Ingle et al. (1980), Loeblich & Tappan (1988), Resig (1981, 1990), Smith (1963), Uchio (1960), Whittaker (1988), Zapata et al. (1995,1999).

To ensure taxonomic consistency and avoid overestimating species richness due to synonyms, the current generic classification, valid species names, and potential synonymies were verified using the World Register of Marine Species (WoRMS database https://www.marinespecies.org/ foraminifera/).

6.3. Estimation of the taxonomic diversity of benthic foraminifera

After taxonomic identification, approximately 100 individuals per sample were, counted to ensure statistical significance (Murray, 2007; Patterson & Fishbein 1989; Schönfeld *et al.,* 2012). Samples containing fewer than five individuals were excluded from subsequent analyses.

Given the heterogeneous sampling techniques and faunal census procedures along the western South American Margin, the population density of living foraminifera was standardized to the number of individuals per 50cm^3 of near-surface sediment, acknowledging that the top 1 cm was not consistently sampled across all sites (Schönfeld *et al.*, 2012).

Relative abundances were calculated to determine the percentage of contribution of each species to the total assemblage. Species present in more than 20% of the total samples were classified as dominant taxa.

Finally, community diversity indexes (species richness, Shannon–Wiener diversity index, and Pielou's evenness) were calculated using the PASTv4 software (Hammer *et al.*, 2001). Consequently, the iNEXT (iNterpolation/EXTrapolation) package using R v4.5 (Chao & Hsieh, 2016) was used to calculate the rarefaction curves. This technique allows direct comparison of species richness across samples with unequal abundances, thus enabling the evaluation of whether sampling effort was sufficient. When the rarefaction curve approaches an asymptote, it will indicate that the sampling effort adequately captured the diversity (Gotelli & Colwell, 2011).

6.4. Estimation of the functional diversity of benthic foraminifera

6.4.1. Functional traits matrix

A total of five functional traits, subdivided into 25 categories, were selected to characterize the ecological roles of benthic foraminifera within the ecosystem (Table 1). According to (Palacio *et al.*, 2022), a minimum of three traits is recommended for a reliable assessment of functional diversity without substantial loss. The selected traits included: 1) Test wall type, referring to the composition of the shell. 2) Morphology, corresponding to the overall shape or coiling pattern of the test. 3) Microhabitat, describing the lifestyle position of the species within the benthic environment. 4) Oxygen condition, reflecting the tolerance or requirement of species to different oxygenation levels.

5) Trophic behavior, indicating the feeding strategy of the species.

(Kaiho, 1994; Linke & Lutze, 1993; Lipps & Valentine, 1970; Murray *et al.,* 2011).

Table 1. Functional traits and associated categories of benthic foraminifera considered in this study, adapted from Guy-Haim and Bouchet (2025).

Traits	**Category**	**Function and processes in the ecosystem**
Wall Type	Agglutinated	Related to the sediment grain size, carbonate production, gas exchange
	Porcelanceous	
	Hyaline	
Morphology	Planispiral	Foraging mode, migration in the sediment.
	Trochospiral	
	Uniserial	
	Biserial	
	Triserial	
	Miliolide	
	Spheric	
Microhabitat	Epifaunal, 0 cm	Role in vertical sediment flow, i.e. bioturbation, biogeochemistry, fluxes and the benthic boundary
	Shallow infaunal, 0 – 0.5 cm	
	Intermedia infaunal, 0.5 – 1.5 cm	
Oxygen preference	Oxic, >50 µmol/l	Respiration, denitrification ability, contribution to the nitrogen cycle
	Hypoxic, < 50 – 5 µmol/l	
	Anoxic, < 5 µmol/l	
Trophic behavior	Phytodetritivore	Food acquisition, metabolism, endobionts, growth requirements
	Detritivore	
	Bacterivore	
	Herbivore	
	Omnivore	
	Carnivore	

Traits of information were compiled from published literature, preferentially at the species level. When species-specific data were unavailable, trait values were assigned from the closest relative within the same taxonomic group. Classification criteria followed: test wall type and chamber arrangement after Loeblich & Tappan (1988); microhabitat depth ranges as proposed by Corliss and van Weering (1993) and Fontanier *et al.* (2002); and oxygenation requirements according to Kranner *et al.* (2022) and Mallon *et al.* (2011).

After compiling the traits data, a fuzzy coding approach was applied to assign affinity value ranging from 0 (no affinity) to 1 (high affinity) for each species within each trait category (Chevene *et al.*, 1994). This method allows species to exhibit partial membership across multiple trait modalities, thereby capturing ecological plasticity. To ensure comparability across traits and species, the scores assigned to each species were subsequently standardized so that the sum of affinities equaled one

6.5. Functional diversity analysis

Functional diversity indexes (FRic, FDiv, FEve, FDis, Rao's Q) and community-weighted means (CWM) were calculated using the fuzzy coded functional traits matrix together with the relative abundance matrix of benthic foraminifera, employing the *dbFD* function in the "FD" R package (Laliberté *et al.*, 2014).

- **Functional richness (FRic)** quantifies the proportion of the functional space filled by the species within community, regardless of abundance, and is computed as the volume of the minimum convex hull that encloses all species in a multidimensional traits space (Villeger *et al.*, 2008).
- **Functional divergence (FDiv)** describes how abundance is distributed within the occupied functional space, with higher values indicating greater divergence from the community centroid (Mason *et al.*, 2005; Villeger *et al.*, 2008).
- **Functional evenness (FEve)** measures the regularity of species' abundance across the traitspace, with highervalues indicating greater divergence from the community (Villeger *et al.*, 2008).
- **Functional dispersion (FDis)** corresponds to the abundance-weighted mean distance of species from the community in centroid in trait space ((Laliberte & Legendre, 2010).
- **Rao's quadratic entropy (Rao's Q)** integrates both species abundances with functional distances (or dissimilarities) between all pairs of species (Botta-Dukát, 2005).

Before computing these indices, the density matrix (ind/50 cm^3) was transformed into relative abundances. This step avoids overrepresentation of stations with high densities and ensures that functional indices reflect proportional contributions rather than absolute abundances (Mouillot, Graham*, et al.*, 2013).

6.6. Statistical analysis

6.6.1. Correlation between indices

To examine the relationship between functional and taxonomic diversity, a Spearman correlation analysis was conducted. Taxonomic diversity was quantified using Shannon index, Fisher's α, Simpson's dominance, Pielou's evenness, abundance, and species richness, while functional diversity was represented by Rao's Q, FRic, FEve, FDis, and FDiv. This approach tests whether higher taxonomic diversity correlates with increased functional diversity, or if functional redundancy is present.

6.6.2. Effect of the environmental variables in the diversity indexes

Environmental variables 6.6.1 were standardized using the 'z-score' method (scale function in R), which normalizes values by subtracting the mean and dividing the standard deviation (Becker *et al.*, 1988). To reduce multicollinearity, pairwise Spearman correlations and variance inflation factors (VIF) were evaluated. Variables with $|\rho| > 0.7$ or $VIF > 10$ were excluded from further analyses, ensuring model parsimony and minimizing overfitting.

The influence of the selected environmental predictors on taxonomic and functional diversity indices was assessed using Generalized Additive Models (GAMs), fitted with the mgcv R package (Wood & Wood, 2015). Distributions for each index were chosen according to their statistical properties and best model fit (Table 2). To account for spatial structure, two-dimensional smoothers of latitude and longitude were included using a Gaussian Process base function (bs = "gp").

Additionally, the same environmental variables were tested against the functional traits of benthic foraminifera to evaluate how environmental gradients modulate specific ecological roles within communities. The final dataset used for the GAM and OMI analyses is provided in Appendix 2.

Table 2. Generalized Additive Models (GAMs) applied, including distribution of families, basis functions, and smoothing parameters.

Response Variable	**Predictor Variables**	**Family**
Shannon	s(Temp) + s(Salinity) + s(Depth) + s(Oxygen) + s(Phosphate) + s(Nitrite) + s(Silicate) + s(TOC) + s(TN) + s(Opal) + s($CaCO_3$) + s(C/N) + s(δ15N) + s(Longitude, Latitude, bs = "gp")	Gaussian
Taxa		Tweedie
Simpson		Quasibinomial
Pielou		Gaussian
Abundance		Gaussian
FRic		Tweedie
FDis		Gaussian
FDiv		Beta
FEve		Beta
RaoQ		Gaussian

6.6.3. OMI analysis

The influence of environmental variables on the functional traits of benthic foraminifera was assessed using an Outlying Mean Index (OMI) analysis (Dolédec *et al.*, 2000), implemented with the “niche” function in the ‘ade4’ package (Dray & Dufour, 2007). The analysis was based on a compiled dataset consisting of 1) the standardized abundance of the benthic foraminifera per station, 2) environmental variables at each station, and 3) the functional traits for each species.

It is important to note that $CaCO_3$ concentration was excluded this analysis, as its inclusion would have reduced the dataset by more than half (n = 38) (Appendix 2). In OMI analysis, the realized niche of species is represented in a multidimensional space defined by their distribution and trait composition. Three key parameters are obtained:

1) OMI (marginality index): measured the distance between the mean environmental conditions of a species and the mean environmental conditions of the study area.

2) Tolerance (Tol): quantifies niche breadth, representing the ranges of environmental conditions under which a species occurs. High values indicate generalist species, while low values denote specialists restricted to narrow environmental ranges.

3) Residual tolerance (RTol): represents the proportion of variance not explained by the analysis (Dolédec *et al.*, 2000).

7. RESULTS

7.1. Taxonomic diversity of benthic foraminifera

A total of 365 benthic foraminiferal species were recorded along the western South American Margin (Appendix 3). These species belong to the Classes Globothalamea, Nodosariata, Tubothalamea and Monothalamea, encompassing 11 orders. The most frequent orders were Rotalida (47%), Lituolida (13%), Polimorphynida (8%), and Astrorhizida (8%) (Figure 4).

Additionally, several species recorded in this study represent new occurrences for the Southeastern Pacific (SEP), including *Astrorhizoides cornutus*, *Crithionina pisum*, *Galwayella trigonoornata*, and *Liebusella goesi* (Figure S2).

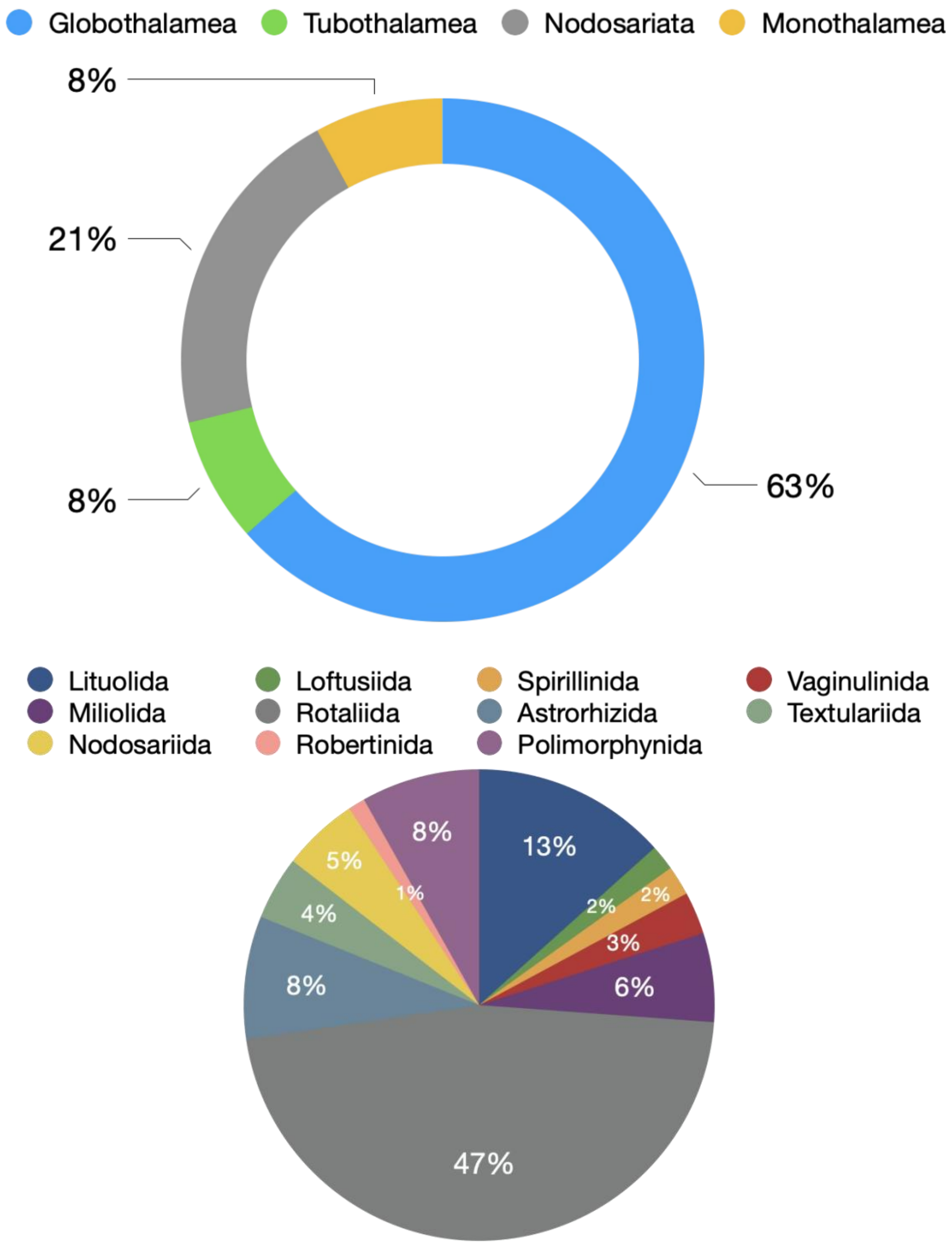


Figure 4. Percentage contribution of benthic foraminifera classes and orders recorded for the Southeastern Pacific Ocean.

The species richness and indices of Shannon-Wiener diversity, Simpson’s Dominance, Fisher’s-ɑ̣ and Pielou’s evenness were estimated (Figure 5), along with the percentage abundance of benthic foraminifera species (Figure 6). Species richness exhibited marked variability, ranging from 1 to 54 species per sample (Appendix 4). Notably conspicuous peaks in species richness (>40 species) were recorded, at stations located between latitudes 1°–3°S, 29°–32°S, and 39°–42°S, corresponding to depths greater than 900 m, 400–1600 m, and 300–1100 m, respectively (Figure 5a).

Simpson’s Dominance value ranged from 0.1–0.96, excluding stations with very low counts (1–3 specimens; Appendix 4), where the index could not be reliably calculated. The values ranged between 0.50 and 0.95 with most of the samples (75%) exhibiting values greater than 0.70 (Appendix 4).

The Shannon index varied from 0 and 3.30 (Appendix 4), with only four stations (Site_1_2092, Site_3_995, Site_29_1432, and Site_31_481) recording values above 3. In contrast, stations with index values below 1 were primarily located between latitudes 7° and 12°S and at depths of 100 -250 meters. These stations were directly influenced by the ESSW, characterized by low oxygen concentrations (1 - 2 µmol/kg) (Figure 5c). The Fisher-□ index ranged between 10 and 20 across the Southeastern Pacific (Figure 5d), with higher values typically observed at depths greater than 900 m.

Pielou's equitability was generally high (>0.7) at sites off the coast of Ecuador and at depths >500 m off Peru, with the highest values observed along the Chilean margin (Figure 4e). In contrast, low equitability (0.4–0.1) was recorded between latitudes 3°–

12°S at sites shallower than 400 m (Figure 5e). An exception was the site observed at 3°S and 700 m, where the value was 0.39 (Appendix 4). Along the Chilean coast, between latitudes 31° and 41°S, most stations shallower than 550 m exhibited average equitability values 0.5, except for one station (Site_31_183) which recorded a lower value of 0.3.

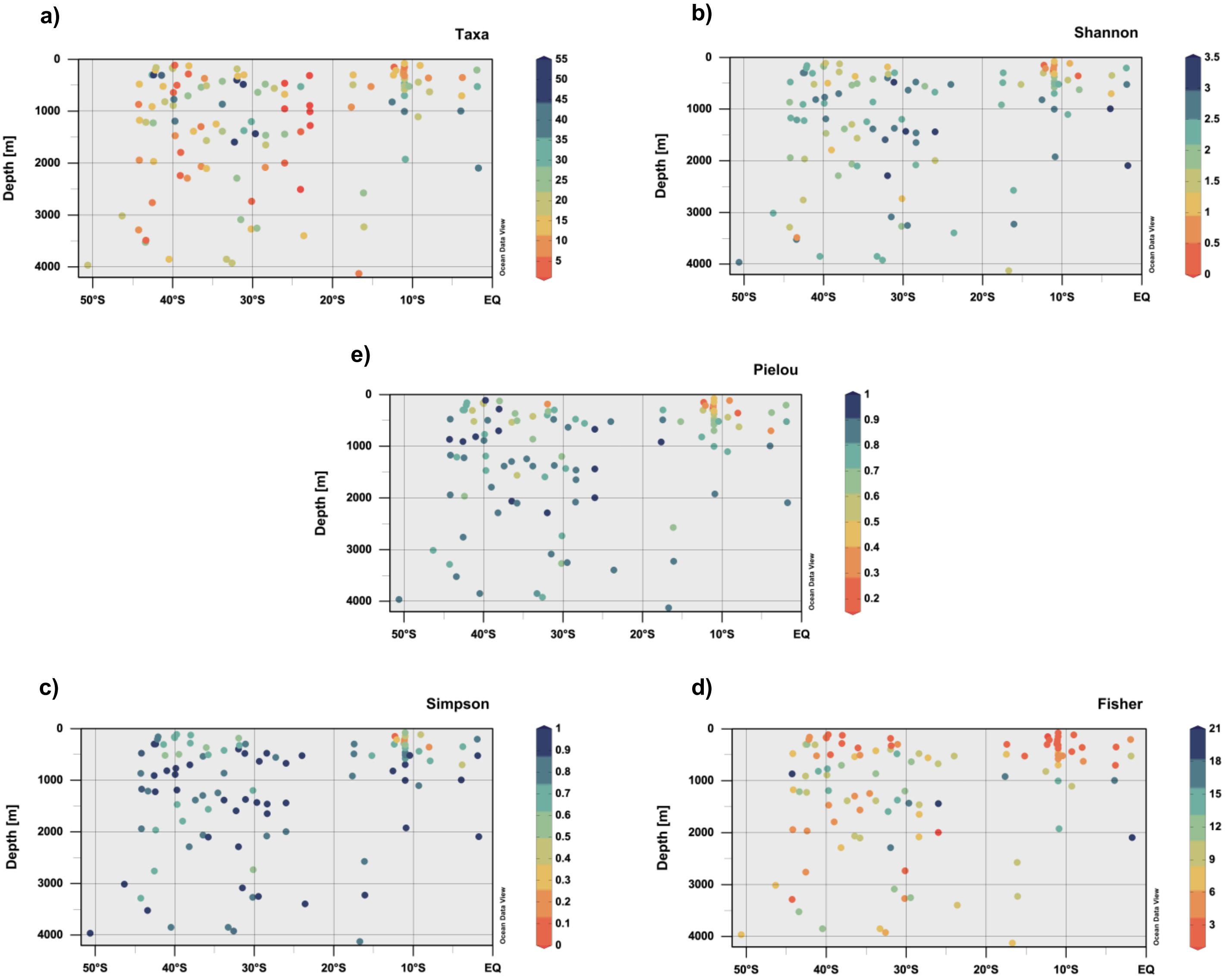


Figure 5. Variation of taxonomic richness along the Southeastern Pacific (SEP). (a) Species richness. (b) Shannon-Wiener Index. (c) Simpson Dominance Index. (d) Fisher´s-□ Index. (e) Pielou Evenness.

Benthic foraminifera abundance (ind/50 cm^3) showed a pronounced increase between 1°S and 17°S (Figure 6). Within this latitudinal range, however, the species' richness and diversity were markedly lower at 9°S and 12°S, coinciding with the low-oxygen conditions characteristic of this region. These sites recorded the highest abundances across the study area (>10,000 ind/50 cm^3), with values ranging from 15,370 to 105,558 ind/50 cm^3. In contrast, abundances south of 23°S generally did not exceed 1000 ind/50 cm^3, except at two sites (Site_31_183 and Site_31_398), which yielded 5580 and 1010 ind/50 cm^3, respectively (Figure 6; Appendix 5). Of the 77 sites situated between 23°S and 50°S, most (n = 55) contained between 10 and 100 ind/50 cm^3.

The most abundant taxa across all sites belonged to the genus *Bolivina*, which accounted for 79.54% along the Southeastern Pacific (Table 3). Species present in more than 20% of the samples included: *Bolivina costata, B. interjuncta, B. plicata, B. seminuda, B. spissa, Cassidulina carinata, Cyclammina cancellata, Glaphyrammina americana, Globobulimina pacifica, Hansenisca soldanii, Haplophragmoides pussillus, Hoeglundina elegans, Lobatula wuellestorfi, Melonis affinis, Nodulina dentaliniformis, Nonionoides grateloupii, Pullenia bulloides, Reophax scorpiurus, Stainforthia fusiformis, Trifarina angulosa, Uvigerina auberiana, U. peregrina and Valvulineria glabra* (Figure S3–S6). Notable changes were observed in the abundance and relative contribution of *Bolivina seminuda* and *Uvigerina peregrina* across Southeastern Pacific locations (Figure S3–S6). Between latitudes 1° and 17°S, abundances were overwhelmingly dominated by genus *Bolivina* (Figure S3). South of

23°S, although *Bolivina* persisted, its contribution declined markedly, particularly at depths greater than 500 m.

The most abundant taxa across all sites belonged to the genus *Bolivina*, which accounted for 79.54%, primarily driven by the contribution of *B. seminuda* (61.37%) along the SEP (Table 3). Species present in more than 20% of the samples included: *Bolivina costata, B. interjuncta, B. plicata, B. seminuda, B. spissa, Cassidulina carinata, Cyclammina cancellata, Glaphyrammina americana, Globobulimina pacifica, Hansenisca soldanii, Haplophragmoides pussillus, Hoeglundina elegans, Lobatula wuellestorfi, Melonis afinis, Nodulina dentaliniformis, Nonionoides grateloupii, Pullenia bulloides, Reophax scorpiurus, Stainforthia fusiformis, Trifarina angulosa, Uvigerina auberiana, U. peregrina* and *Valvulineria glabra* (Figure S2 – S5). The dominance of *Bolivina* was particularly pronounced within the oxygen-minimum zone (7°–17°S) at neritic and upper bathyal depths (Figure S2, S3). latitudes 7° and 17°S at neritic (0 – 250 m) and upper bathyal (>250 – 850 m) depths, abundances were overwhelmingly dominated by genus *Bolivina* (Figures S2 – S3). However, this pattern is not showed in lower bathyal (>850 – 2000 m) and abyssal samples (>2000 m), where their contributions are less than 10% and only reach until ~10ºS (S3 Figure), except for *B. spissa* (Figure S3 – S4). South of 23°S, although *Bolivina* persisted, its contribution declined markedly, and the genus *Uvigerina* and *T. angulosa* rise contributing ~10% or more per site and their contributions increased at sites > 250 m. The contribution of *C. carinata* is notably high mainly on sites at 250 – 850 m (Figure S3), as well, *H. elegans* and *M. affinis* contribute considerably at stations at the upper bathyal to abyssal zones. Finally, agglutinated species as *G. americana, R. scorpiurus* and *N.*

dentaliniformis have a contribution mainly in stations > 250 m. In neritic zones *G. americana* contribute ~2% at stations south of 37ºS, while *R. scorpiurus* contributions is only notable at stations of 1ºS (Figure S2). South of 23ºS G. americana contribution increases to 5% at upper bathyal zones (Figure S3) as well as *R. scorpiurus,* which contributes 50% at 39ºS while *N. dentaliniformis* only contributes 4% at a station at 31ºS (Figure S3). In lower bathyal zones, *G. americana* represent a contribution >15% in stations at 26ºS and 39ºS, as well as *N. dentaliniformis* (~12%) while *R. scorpiurus* is more representative (4 – 28%) in stations between 10º – 32ºS (Figure S4). Finally, station in the abyssal zone, *G. americana* has a contribution of 30% only at 36ºS, *N. dentaliniformis* shows representativity of 2 – 14% at stations between 1º - 30ºS and *R. scorpiurus* continue with a contribution of 1 – 34% along the sites (Figure S5) South of 23°S, a major shift in assemblage composition occurred. The relative contribution of *Bolivina* declined markedly, giving way to more diverse fauna. The genera *Uvigerina* and *Trifarina angulosa* became significant contributors (~10% or more per site) at depths >250 m (Figure S3, S4). Notably, agglutinated species such as *Glaphyrammina americana, Reophax scorpiurus,* and *Nodulina dentaliniformis* increased their contribution with depth, becoming dominant constituents in many lower bathyal and abyssal stations (Figs. S4, S5).

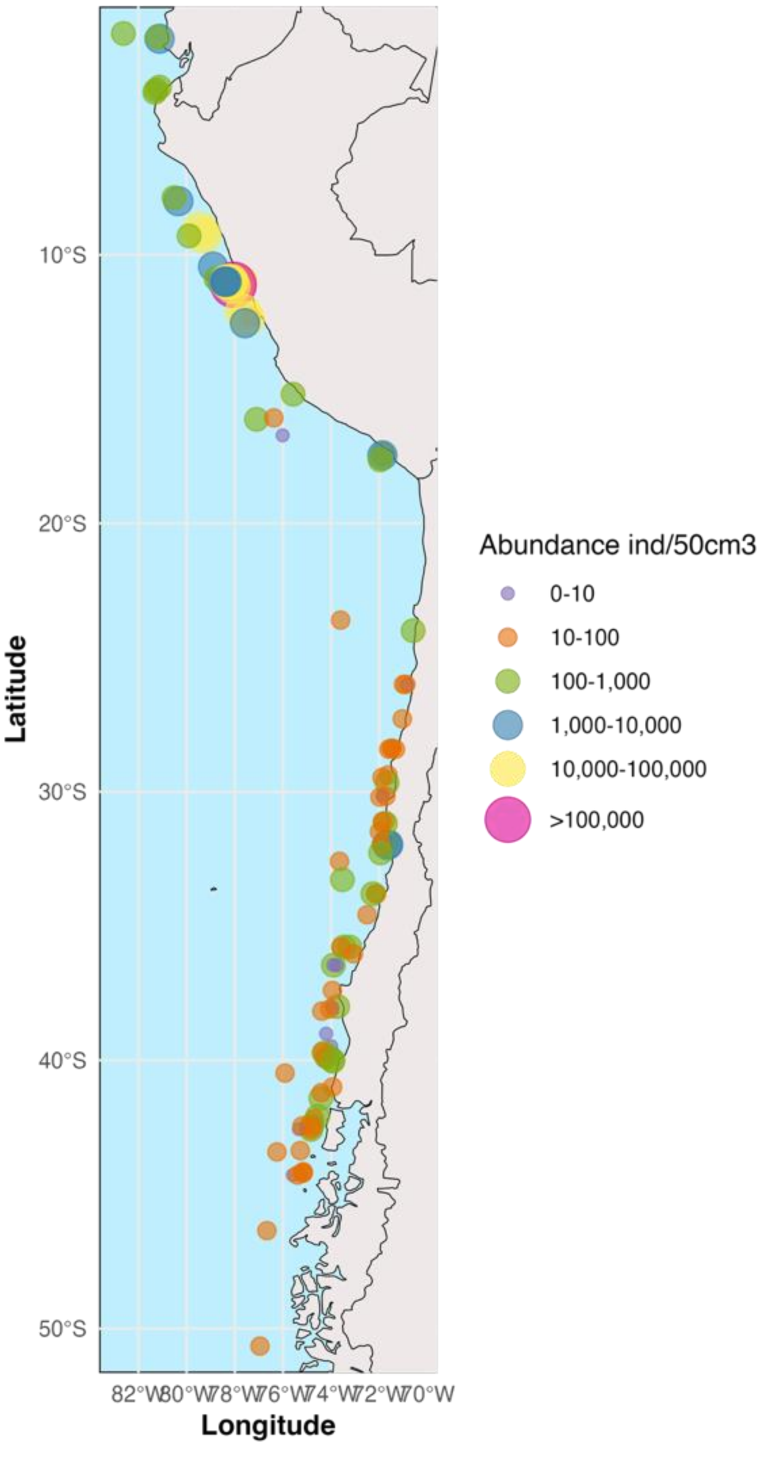


Figure 6. Spatial distribution of the total abundance of benthic foraminifera (ind/50cm ^{3}) of living benthic foraminifera along the western South American Margin.

Table 3. Species contributing most to the total number of sampling sites based on their abundance (ind/50cm^3) in the Southeastern Pacific. Ocean.

% Contribution	Species
10.27%	*Bolivina costata*
2.86%	*Bolivina interjuncta*
5.04%	*Bolivina plicata*
61.37%	*Bolivina seminuda*
1.13%	*Buliminella elegantissima tenuis*
1.48%	*Cancris carmenensis*
1.26%	*Epistominella obesa*
2.66%	*Nonionella stella*
1.33%	*Stainforthia fusiformis*
1.54%	*Uvigerina peregrina*
2.53%	*Valvulineria glabra*
8.51%	Others

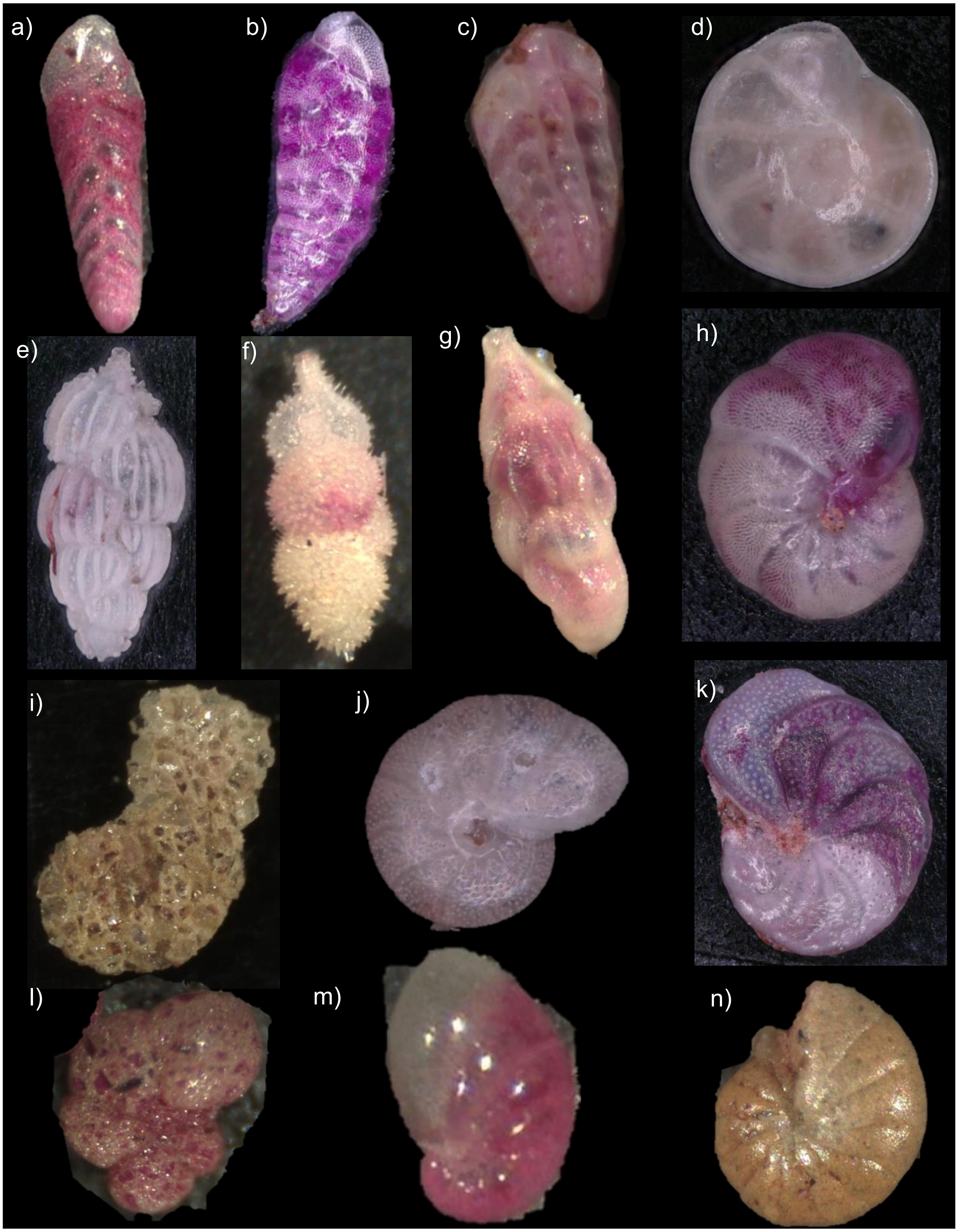


Figure 7. Most abundant taxa of living benthic foraminifera across the Southeastern Pacific. a) *Bolivina spissa.* b) *B. seminuda.* c) *B. plicata.* d) *Hoeglundina elegans.* e) *Uvigerina peregrina.* f) *U. auberiana.* g) *Trifarina*

angulosa. h) *Valvulineria glabra.* i) *Glaphyrammina americana.* j) *Melonis affinis.* k) *Lobatula wuellestorfii.* l) *Haplophragmoides pussillus.* m) *Nonionoides grateloupii.* n) *Cyclammina cancellata*.

Regarding the rarefaction curves (Figure S3), only a subset of sites reached the asymptote, indicating an optimal sampling effort. These included sites “1_207”, “3_350”, “7_559”, “9_115”, “9_437”, belonging to the group 1; “10_521”, “11_291”, “11_317”, “11_319”, “11_375”, “11_495”, “11_511”, (group 2); “11_697”, “12_214”, “12_302”, “12_823”, “17_298”, (group 3); all sites in Group 4 except for “17_918” and “26_1996”; “31_183”, (Group 5); all sites in Group 6; “37_124” and “39_174” (group 7); “39_190”, “40_165”, “41_308”,(group 8); “42_371”, “43_1212”, “43_3523”, “44_1771”, “44_1939”, (group 9), and , “46_3014” and “50_3964”. In contrast, sites where the curves did not stabilize suggest the potential presence of higher, unrecorded diversity.

7.2. Assessment of Functional Diversity

Functional richness (FRic) showed low values, with only 11.8% of sites exhibiting values >70 (Figure 7a). In contrast, functional divergence (FDiv) was generally high, (>0.7) at 80% of sites (Table S4), being noticeable at sites between 7°S – 12°S, where FDiv values approached 1 (Figure 7b). The RaoQ index, measuring functional dissimilarity, increased with depth (>500 m) across most samples (Figure 7c). Conversely, functional dispersion (FDis) revealed low values (<3) near 11°S (Figure 7d). Functional evenness (FEve) was relatively low to intermediate (0.4 – 0.65) across the study area (Figure 7e). The uniform distribution of traits (FEve > 0.7) was observed in a mere 14% of the sites, predominantly situated south of 26°S.

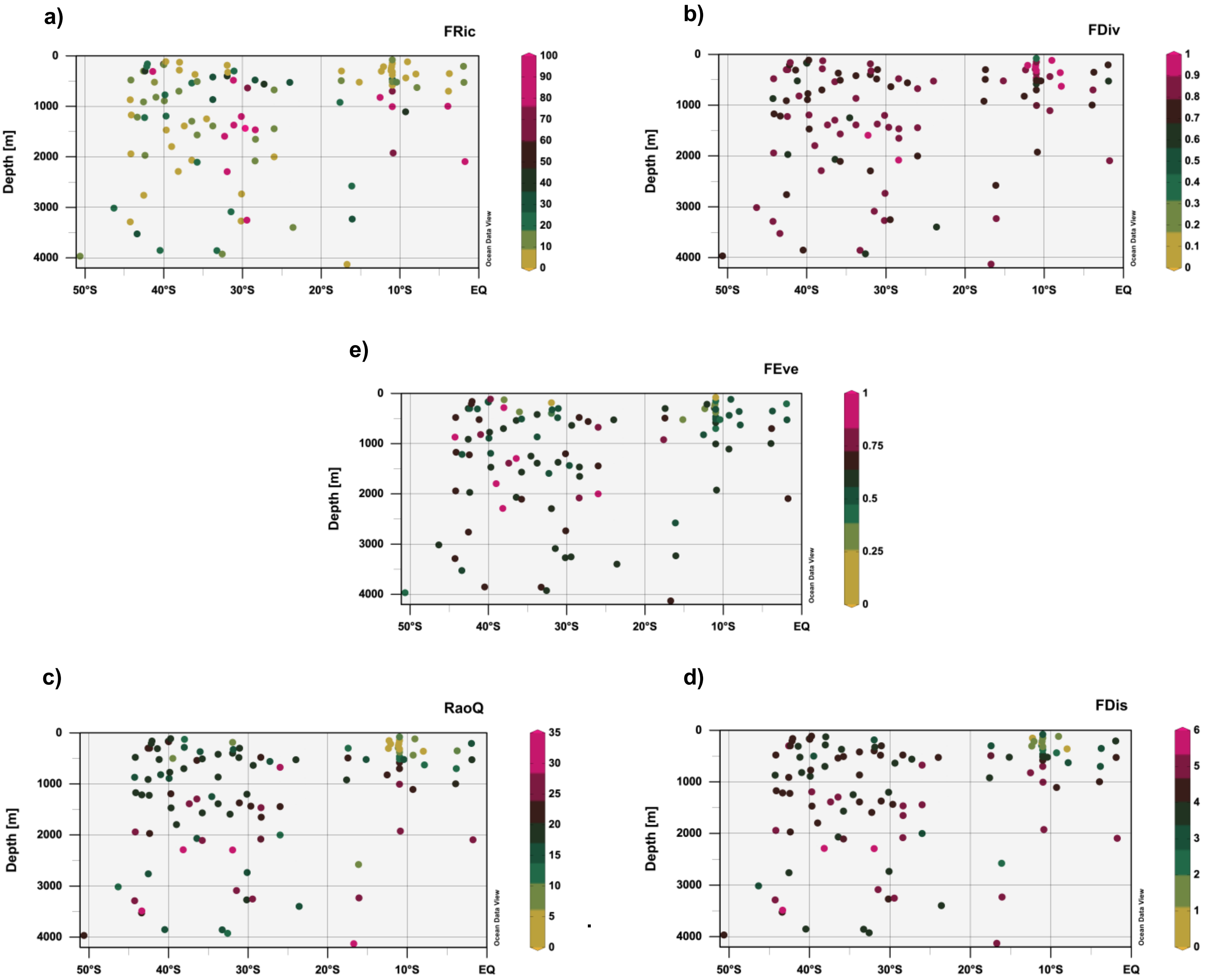


Figure 8. Functional diversity index of benthic foraminifera along the Southeastern Pacific. (a) Rao Quadratic Functional Diversity Index. (b) Functional Richness. (c) Functional Divergence. (d) Functional Dispersion. (e) Functional Evenness

7.3. Characterization of Functional Traits

Community-weighted means (CWM) of traits revealed clear spatial patterns along the Southeastern Pacific, particularly in morphology, oxygen preference, and trophic behavior. Morphological traits (Figure 9) exhibited more distinct spatial variation. Biserial forms, mainly composed by *Bolivina* (15 sp), were found to predominate (>80%) between 9° and 11°S, but in less percentage south of 17° (Figure 8), where the assemblages exhibited a transition towards a predominance of trochospiral and triserial morphologies (collectively 30% – 80%). This change is given by *Trifarina angulosa*, *Hoeglundina elegans*, *Cibicidoides* and *Uvigerina* (Table S6). Oxygen and trophic preferences also exhibited clear latitudinal shifts. Hypoxia-tolerant species consistently accounted for 40–60% of assemblages, with peaks (>60%) at bathyal depths south of 17°S. Detritivores were the dominant feeding strategy throughout, while phytodetritivores were particularly abundant between 1°–15°S and 23°–36°S. Conversely, omnivores gained prevalence south of 33°S, and bacterivores contributed substantially (35–60%) at specific bathyal sites (~1500 m, near 30°S). Finally, test wall type and microhabitat preference showed less pronounced spatial variation. Hyaline tests occur across the study area contributing mostly with >50% in the assemblages, as well, the less contribution (<25%) was at 1000–3000 m off 28º–32ºS and coincide with the highest values of agglutinated (>70%). Agglutinated test presented values <25% in most of the sites (73) exhibiting a minimum or zero contribution in neritic to upper-bathyal zones (79–700 m) between 3º–17ºS and some deepest sites off 42º, 43º, 46º and 50ºS, showing no strong latitudinal gradient. Despite the contribution of porcelaneous tests being small across the stations, its remarkable contribution is notable (8–28%) at some sites >900 m (Figure 9). Shallow infaunal taxa were ubiquitously dominant (50–100%) in all the sites, while epifaunal taxa showed highest contribution (>70%) between 3º–12ºS, and intermediate infaunal taxa showed dominance <30% at most of the sites.

Spearman's correlation analysis revealed that species richness (taxa) is the main driver of functional richness in the benthic foraminiferal community, given the positive and significant correlation (rho = 0.841, $p < 0.01$; Appendix 6). Similarly, species richness exhibited a positive correlation with various other taxonomic diversity indices, except for Pielou's evenness index (-0.04, $p \geq 0.05$), indicating that species richness is not dependent on abundance uniformity (Appendix 6). FEve and abundance (rho = -0.667, $p < 0.001$), indicating that sites with high individual's densities, are dominated by species with generalist traits. Unexpectedly, a negative correlation between the abundance and RaoQ (rho = -0.367, $p < 0.001$) was observed, reflecting that sites with many individuals are often dominated by a few species. Finally, FDiv showed no correlation with species richness (rho = -0.057, $p > 0.05$), therefore a greater number of species does not necessarily correspond to dominance of species with specialized traits.

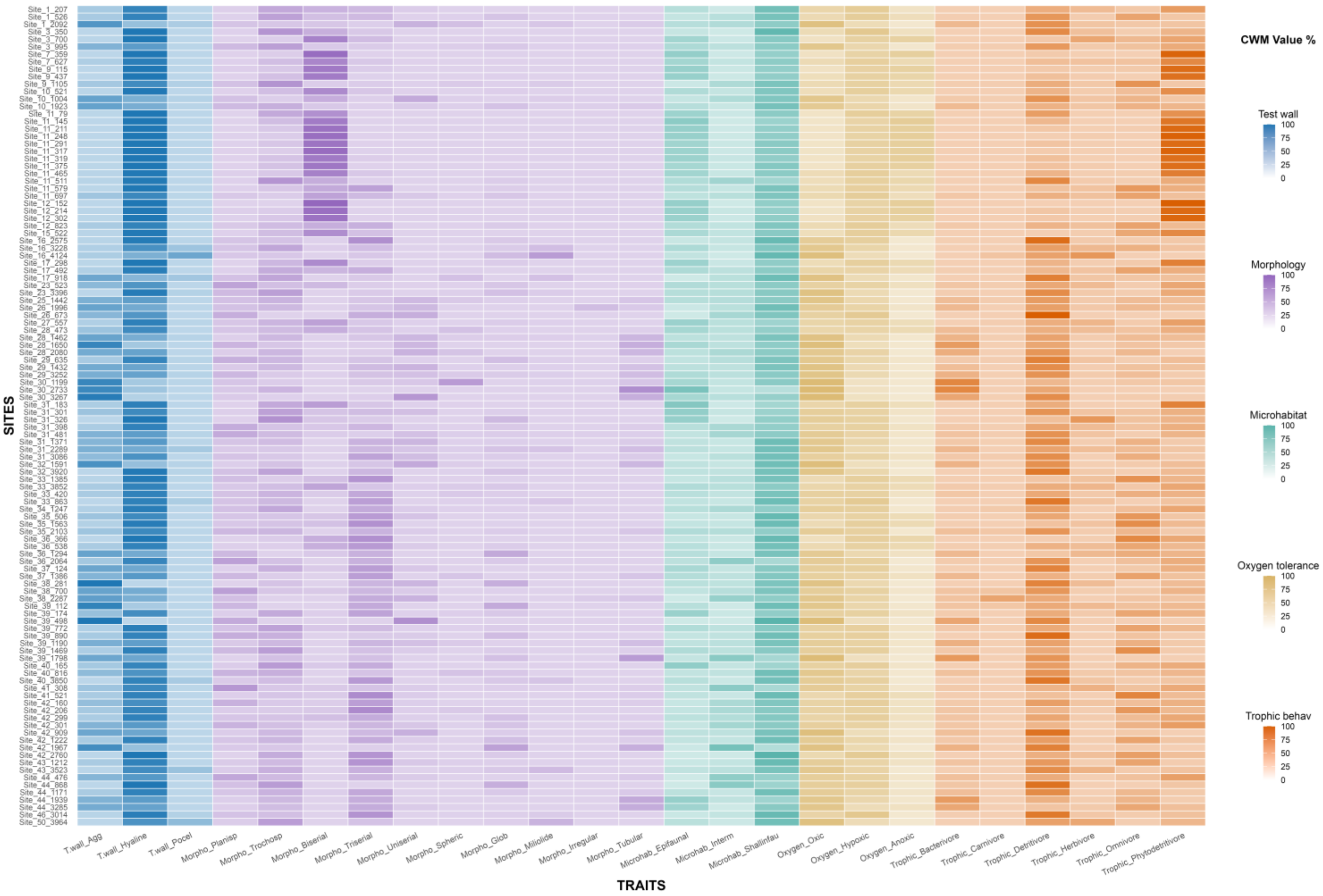


Figure 9. Community Weighted Means (CWM) of functional traits of living benthic foraminifera along the southeastern Pacific. Latitudinal order is shown from bottom to top. Colors indicate trait categories: blue = test wall type; purple = morphology; green = microhabitat preference; yellow = oxygen tolerance; orange = trophic behavior. T.wall = test wall type, Agg = agglutinated, Porcel = Porcelanaceous, Planisp = planispiral, Trochosp = trochospiral, Glob = Globose/subglobose/ovoid or streptospiral.

7.4. Environmental variables which modulate the taxonomic and functional indices

The GAM analyses identified temperature, salinity, oxygen, phosphate, and silicate as the primary environmental drivers affecting both the functional and taxonomic diversity indexes (Table 4). Abundance, species richness (taxa), and functional richness (FRic) of benthic foraminifera were also influenced by sediment properties, specifically the C/N ratio, opal, and $CaCO_3$, respectively (Table 5). Latitude, longitude, and d15N (δ15N) were significant predictors only for species richness and FRic. Oxygen was the sole variable affecting functional dispersion (FDis) and functional evenness (FEve). No significant relationships were detected between environmental variables and functional divergence (FDiv) or Rao's Q.

Table 4. GAM models for the taxonomic and functional indexes, including response variables, predictor variables, AIC, R^2, and deviance explained.

Response Variable	**Predictor Variables**	**AIC**	**R-sq**	**Deviance explained**
Shannon	Temperature, Salinity, Depth, Oxygen, Phosphate, Nitrite, Silicate, TOC, TN, Opal, CaCO3, C/N, d15N, Longitude, Latitude, bs = "gp"	42.195	0.787	89.3%
Taxa		337.142	0.828	97.3%
Simpson		NA	0.771	84.8%
Pielou		-90	0.648	81.3%
Abundance		164.231	0.806	90%
FRic		417.919	0.922	91.9%
FDis		-55.425	0.622	74.4%
FDiv		-55.983	0.227	64.3%
FEve		-26.442	0.091	55.7%
RaoQ		85.299	0.47	63.8%

Table 5. Summary of GAM results showing the effects of environmental variables on taxonomic and functional diversity indices ($p < 0.05$).

Index	**Significant variables**	**Degrees of Freedom**	***p*-value**
Shannon	Temp	3.75	$p<0.01$
	Salinity	1.00	$p<0.05$

	Oxygen	3.08	p<0.01
	Phosphate	1.00	p<0.01
	Silicate	1.00	p<0.01
Taxa	Temp	1.00	p<0.01
	Salinity	1.00	p<0.01
	Oxygen	1.00	p<0.01
	Phosphate	1.00	p<0.01
	Silicate	1.00	p<0.01
	Opal	7.19	p<0.01
	$CaCO_3$	3.36	p<0.05
	Long, Lat	12.64	p<0.01
Simpson	Temp	1.00	p<0.01
	Salinity	1.00	p<0.05
	Oxygen	2.83	p<0.01
	Phosphate	3.97	p<0.01
	Silicate	1.00	p<0.01
Pielou	Oxygen	1.00	p<0.05
	Phosphate	3.82	p<0.05
	Silicate	1.00	p<0.05
Abundance	Salinity	3.70	p<0.05
	C/N	1.00	p<0.05
FRic	Temp	1.00	p<0.01
	Salinity	1.00	p<0.05
	Oxygen	2.62	p<0.01
	Phosphate	1.00	p<0.01
	Silicate	1.00	p<0.01
	Opal	6.72	p<0.01
	$CaCO_3$	1.69	p<0.05
	δ15N	1.00	p<0.01
FDis	Oxygen	1.00	p<0.05
FDiv	N.A	-	-
FEve	Oxygen	3.13	p<0.05
RaoQ	N.A	-	-

7.5. Niche analysis

The realized niche analysis (OMI) revealed a strong structure of the benthic foraminiferal community along the environmental conditions (Figure 10a). The first and second axis of the OMI analysis encompassed 74.98% (OMI 1, 54.47% variance; OMI 2, 20.51% variance) characterizing two groups of stations. One group is formed by the Ecuador and Peru zones which are associated with low dissolved oxygen, high TOC, nitrite, opal and ratio C/N. While the second group, formed by Northern and Southern Chile, is characterized by greatest oxygen values, total nitrogen, $\delta^{15}N$ and depth. Additionally, OMI 2 clearly shows a bathymetric gradient from neritic to abyssal stations, with high to low temperature values, respectively. Similarly, Figure 10b exhibited a pattern of species grouping, which tends to organize themselves in relation to the same environmental variables as shown in Figure 10a.

Regarding to the distribution of the functional traits across the two OMI axes (Figure S8), we observed that species with hyaline test were strongly associated with Peru and Ecuador zone characterized by high TOC, and nitrite, at neritic and upper bathyal sites. Species with agglutinated test walls are related to sites with more oxygen and greater depth, mainly in Chile zone (Figure S8a). In this region, morphologies such planispiral, irregular, uniserial, and triserial shells dominate mainly at upper and lower bathyal zones (Figure S8b). On the other hand, the biserial morphology was more common at sites off Peru at neritic and upper bathyal depths, influenced mainly by the high temperature, C/N and NO_2^-. Finally, the microhabitat and trophic behavior traits (Figure S8c, S8d) did not show a grouping pattern.

In addition, marginality was assessed for 281 species (Table S7). The classification of niche strategies for species was based on the absolute values of OMI and TOL (Table 6). Both metrics were conducted using quartiles, which were calculated from the distribution of values for all species analyzed. *Vaginulina americana* (Vamer - abbreviations used in Table 6 and Fig. 9b), *Eubuliminella curta* (Ecurt), *Buliminella elegantissima limbosa* (Belim), and *Buliminella elegantissima tenuis* (Belte) had the highest Marginality values of the group (OMI

= 35.27, 31.67, 31.02, and 30.50, respectively), indicating marked specialization (Low Tolerance, Tol = 0.00, 0.03, 0.03, and 0.02, respectively). Agglutinated species *Bathysiphon capillare* (Bcapi), which is present in southern Chile at upper bathyal depth, also exhibited analogous values (OMI = 24.45, Tol = 0.00; Figure 9 a, b). Species as *Eggerelloides advena* (Eadve), *Hanzawaia mexicana* (Hamex), *Bolivina subadvena acuninata* (Bsubacu), *Bulimina pagoda* (Bpago), *Bolivina seminuda* (Bsemi) and *Protoglobobulimina pupoides* (Ppupo) exhibited moderate to high marginality (OMI = 23.27, 21.2, 19.77, 17.99, 15.28 and 13.40, respectively) and higher tolerance values than strict specialists (Tol = 2.7, 3.09, 1.01, 0.49, 5.22 and 4.35, respectively). Therefore, these species are interpreted as flexible specialists. Most of the species showed moderate marginality (OMI = <13.38–6.72) and variable tolerance values (Tol = 0.06–2.83), representing intermediate strategies. Finally, the most generalist species are *Hoeglundina elegans* (Heleg) and *Melonis affinis* (Maffi), which present the lowest marginality value (OMI = 1.65 and 2.25, respectively) with a high tolerance (Tol = 1.42 and 1.17, respectively).

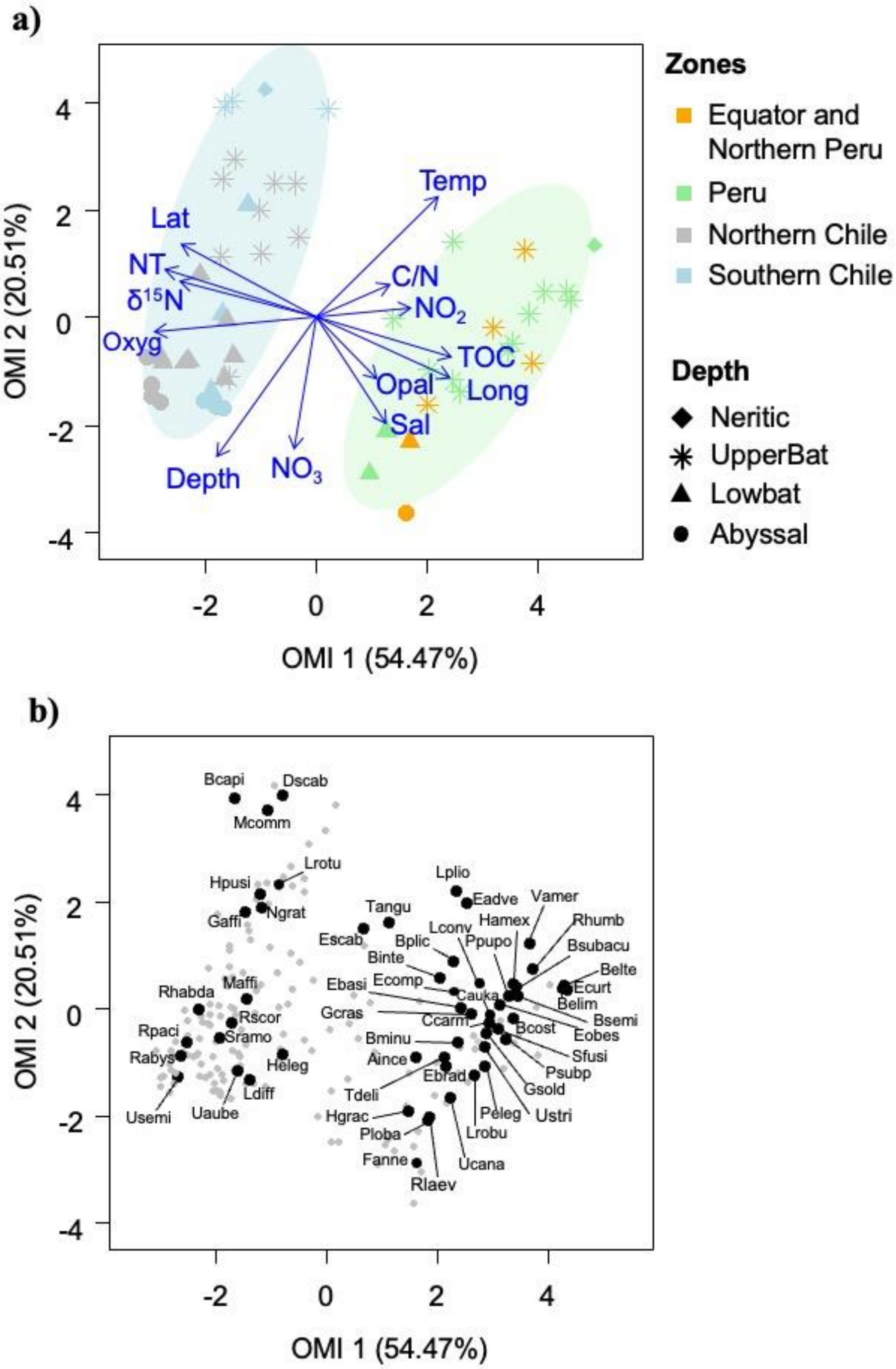


Figure 10. Outlying mean index (OMI) of the influence of the environmental variables on the functional traits of the benthic foraminifera species. a) Plot representing the environmental variables tested. The length of the blue vectors represents the importance of each variable. The zone refers to the area to which the sample sites belong. Ecuador and Northern Peru are the sites off 1ºS–3ºS, Peru: 7ºS–17ºS, North-Chile: 23ºS–39ºS, South-Chile: 39ºS–50ºS. Depth refers to the water depth the sample has been taken. Neritic: 0–250 m, UpperBat: >250–850 m, Lowbat: >850–2000 m, Abyssal: >2000 m. b) Realized

niches of benthic foraminifera species in the Southeastern Pacific. •□ Species that showed significant marginality ($p<0.05$)

Table 6. Niche parameters of the species of benthic foraminifera and their traits are estimated by the Outlying Mean Index (OMI). Niche parameters are given for each species as both absolute values and percentages of variability. Inertia = total variability, OMI = Outlying Mean Index (i.e., marginality), Tol = Tolerance, RTol = Residual Tolerance. Only species with a significant OMI index ($p<0.05$) are shown.

Code	**Specie**	**OMI**	**Tol**	**Rtol**	**Classification**
Vamer	*Vaginulina americana*	35.27	0	0	Strict Specialist
Ecurt	*Eubuliminella curta*	31.67	0.03	0.35	Strict Specialist
Belim	*B. elegantissima limbosa*	31.02	0.03	0.40	Strict Specialist
Belte	*B. elegantissima tenuis*	30.5	0.02	0.45	Strict Specialist
Rhumb	*Rhumblerella humboldti*	29.35	0.68	2.45	Strict Specialist
Bcapi	*Bathysiphon capillare*	24.45	0	0.16	Strict Specialist
Mcomm	*Martinottiella communis*	22.03	0.03	2.40	Strict Specialist
Dscab	*Dorothia scabra*	20.27	0.01	1.98	Strict Specialist
Eadve	*Eggerelloides advena*	23.27	2.7	5.93	Flexible Specialist
Lplio	*Lenticulina pliocaena*	21.77	1.25	7.76	Flexible Specialist
Hamex	*Hanzawaia mexicana*	21.2	3.09	5.56	Flexible Specialist
Bsubacu	*Bolivina subadvena acuminata*	19.77	1.01	5.79	Strict Specialist
Bpago	*Bulimina pagoda*	17.99	0.49	1.95	Strict Specialist
Bsemi	*Bolivina seminuda*	15.28	5.22	7.65	Flexible Specialist
Lconv	*Lenticulina convergens*	14.5	2.22	5.05	Flexible Specialist
Psubp	*Pseudoparrella subperuviana*	14.16	1.56	3.43	Flexible Specialist
Ppupo	*Protoglobobulimina pupoides*	13.4	4.35	5.48	Flexible Specialist
Ucana	*Uvigerina canariensis*	13.38	0.12	2.66	Intermediate Low Tol.
Ploba	*Pseudobrizalina lobata*	13.24	0.33	8.45	Intermediate
Bcost	*Bolivina costata*	12.67	2.5	9.24	Intermediate
Fanne	*Fissurina annectens*	12.05	0.34	3.58	Intermediate
Cauka	*Cassidulina auka*	11.19	1.51	6.96	Intermediate
Eobes	*Epistominella obesa*	11.02	0.54	7.97	Intermediate
Ustri	*Uvigerina striata*	10.96	0.55	4.84	Intermediate
Sfusi	*Stainforthia fusiformis*	10.91	0.84	7.94	Intermediate

Peleg	*Pullenia elegans*	10.67	0.31	7.54	Intermediate
Lrobu	*Labrospira robusta*	10.56	0.06	6.52	Intermediate Low Tol.
Rlaev	*Reussoolina laevis*	10.48	1.42	5.94	Intermediate
Ccarm	*Cancris carmenensis*	10.12	2.83	6.09	Intermediate High Tol.
Gsold	*G. soldanii multilocula*	10.11	0.54	6.93	Intermediate
Usemi	*Uvigerina semiornata*	9.84	0.12	0.89	Intermediate Low Tol.
Bminu	*Bolivinita minuta*	9	0.33	5.88	Intermediate
Rabys	*Rhabdammina abyssorum*	8.81	0.15	0.83	Intermediate Low Tol.
Ecom	*Ehrenbergina compressa*	8.68	0.17	4.34	Intermediate Low Tol.
Gcras	*Globocassidulina crassa*	8.65	1.7	7.04	Generalist
Hgrac	*Hyalinonetrion gracillimum*	8.28	3.87	5.08	Generalist
Rpaci	*Rhabdammina pacifica*	7.94	0.70	2.58	Generalist
Bplic	*Bolivina plicata*	7.7	4.94	8.16	Generalist
Lrotu	*Lenticulina rotulata*	7.23	2.58	4.67	Generalist
Tdeli	*Takayanagia delicata*	6.82	2.9	6.57	Generalist
Ebrad	*Eggerella bradyi*	6.72	0.31	9.28	Generalist
Hpusi	*Haplophragmoides pusillus*	6.44	3.16	5.60	Generalist
Gaffi	*Globobulimina affinis*	5.96	2.9	5.46	Generalist
Tangu	*Trifarina angulosa*	5.75	1.07	12.36	Generalist
Binte	*Bolivina interjuncta*	5.64	1.92	11.18	Generalist
Ngrat	*Nonionoides grateloupii*	5.63	4.26	6.13	Generalist
Escab	*Eggerelloides scabrum*	5.56	0.92	11.14	Generalist
Rhabda	*Rhabdammina* sp.	5.29	0.48	4.85	Generalist
Aince	*Ammodiscus incertus*	4.77	3.79	11.53	Generalist
Sramo	*Saccorhiza ramosa*	4.28	1.51	7.12	Generalist
Ldiff	*Lagenammina difflugiformis*	4.20	1.26	8.82	Generalist
Uaube	*Uvigerina auberiana*	3.9	0.96	4.56	Generalist
Rscor	*Reophax scorpiurus*	3.27	2.89	7.64	Generalist
Maffi	*Melonis affinis*	2.25	1.17	8.40	Generalist
Heleg	*Hoeglundina elegans*	1.65	1.42	8.76	Generalist

8. DISCUSSION

8.1. Taxonomic diversity patterns

This study recorded a total living benthic foraminifera richness of 365 species along the investigated latitudinal gradient (1°–50°S) in the SEP. This number is greater than previous studies (Bandy & Rodolfo, 1964; Mallon, 2011; Romero *et al.*, 2023; Tapia *et al.*, 2008). Furthermore, we recorded *Astrorhizoides cornutus, Crithionina pisum, Galwayella trigonoornata, Liebusella goesi* in the SEP. These species have been found mainly in the Northwest Atlantic, near fjords or in the Arctic Ocean (Gooday *et al.*, 2008; Hesemann, 2023; Jima *et al.*, 2022; Schönfeld, 2002). However, the genus *Galwayella* has been established a few decades ago (Patterson & Pettis, 1986) and has only been reported in a few instances (Hesemann, 2023; Patterson & Burbidge, 1995). *G. trigonoornata* is described here for the first time in the region. Interestingly, several species found during this study were previously denominated as being extinct (*Fissurina (Fissurina) ovata*, *Haplophragmoides bulloides*, *Lagena parvulipora, Reophax duplex, R. globosus*). These were reported from the Upper Cretaceous/Lower Tertiary (*H. bulloides*) in Europe (Bugge *et al.*, 1975; Neagu, 1968), Upper Cretaceous-Eocene (*R. duplex, R. globosus*) (Silva, 2011; Waśkowska, 2021), or rather vague in description (Seguenza, 1868). *L. parvulipora* was reported wrongly as *Pygmaeoseistron parvuliporum* for the Miocene in Chile (Finger, 2013). The author cites the original description of Bandy (1949a), which was corrected later (Bandy, 1949b).

The diversity indexes (Shannon, Fisher-α, Pielou's evenness) exhibited a strong latitudinal and bathymetric variation (Figure 5a). The highest values of diversity and species richness were observed at sites influenced by well-oxygenated water masses as Subantarctic (SAAW) and Antarctic intermediate Water (AAIW), where other authors have identified a similar pattern (Bandy & Rodolfo, 1964; Ingle *et al.*, 1980; Patarroyo & Martinez, 2021). In contrast, areas bathed by the ESSW, characterized by hypoxia and high nutrient concentrations (Figure 2c), showed a low overall diversity, in particular, between 7° and 12°S and at 100 – 50 m (Figure 5b), where severe hypoxia prevailed (1-2 µmol/kg). A Shannon index <1, Pielou evenness <0.05, and the Fisher-α <3 reflects an ecosystem with high abundances of a few species only (notably *Bolivina* spp.) as reported in previous studies (Cardich *et al.*, 2012; Glock *et al.*, 2013; Mallon *et al.*, 2012), demonstrating that OMZs are strong environmental filters, favoring the adaptation and development of opportunistic or hypoxia-tolerant species.

The abundance of benthic foraminifera exhibited a remarkable division of high abundances between 1º–17º S, and consistently lower abundances between 22º–50º S (Figure 4). This pattern overlaps with the year and seasonal round upwelling (~4º–35ºS), as well as with high biogenic opal content in surface sediments (Figure S1), which reflects primary productivity and export fluxes to the seafloor (Tarazona & Arntz, 2001; Zuta & Guillen, 1970). Within the northern productive sector, the highest abundances (>10,000 ind/50 cm^3) were recorded between 9°–12°S, mainly dominated by *Bolivina* species (Figure S3). Similar oxygen deficient environments, such as the Arabian Sea, have documented as dominant taxa to *Bolivina* and *Uvigerina* species (Kaithwar *et al.*, 2020; Schumacher *et al.*, 2007). The dominance of bolivinidae across the equatorial to central Peruvian margin suggests that opportunistic species that thrives well under low-oxygen conditions in bottom/pore waters associated with high organic matter preservation at shallow infaunal sediment depths. Conversely, more heterogeneous assemblages at southern latitudes indicated that moderate to high oxygen levels and variable sediment composition supported a higher taxonomic evenness and diversity (Castillo *et al.*, 2021; Tapia *et al.*, 2008).

8.2. Functional diversity, linking with taxonomic diversity

Functional richness (FRic) was low (<35). Only 14 sites showed high values (>70). In several of these sites, high FRic coincided with elevated species richness (~40) and low abundances (Figure 7a, 3a; Table S5). The overall positive correlation between species richness and FRic (rho = 0.841, $p < 0.01$) supports the expectation that the functional space increased with the number of species (Petchey & Gaston, 2002). Functional space represents the multidimensional space occupied by species' traits, and the volume or dispersion of this space reflects the functional strategies present in the community (Mason *et al.*, 2003). However, most stations displayed a low FRic regardless of species count, indicating that relationship was not consistent across the region. A decoupling can be explained by “functional redundancy” or “functional similarity”, where multiple species share similar trait combinations and therefore contribute similarly to ecosystem functioning (Eisenhauer *et al.*, 2023; Fischer & de Bello, 2023; Petchey & Gaston, 2006). Consequently, species-rich communities may occupy a relatively narrow functional space. This pattern is complemented by functional evenness (FEve), especially at sites where its negative correlation with total abundance (rho = -0.667, $p < 0.01$) reveals that these communities reflect a small set of strategies, mainly stress-tolerance (OMZ sites), resulting in an uneven distribution of functions within the functional space (Mason *et al.*, 2005; Villeger *et al.*, 2008). Functional divergence (FDiv) reinforced the interpretation, remaining high at most stations (>0.66 at 79% of sites). This pattern implies that the dominant species occupy the extremes of functional space in these communities and are well adapted to environmental stress (Villeger *et al.*, 2008).

The integration of these indices indicates that the benthic ecosystem does not represent a continuous gradient across the SEP. Only few sites exhibit moderate to high FEve (≥0.6) and RaoQ (≥17) high FRic (>66), and high FDiv (Figure 7b). This specific combination represents communities where numerous strategies coexist in equilibrium. The traits are supported by balanced abundances of high functional complementarity, species differ markedly in their traits, and by a low probability of functional similarity, which indicated an efficient resource utilization (Mason *et al.*, 2013; Xie *et al.*, 2025). These sites occur mainly in the deepest areas (>1000m) of Ecuador and northern Peru (1º–3ºS), outside the OMZ core but also between 27º–32ºS. This type of correlation (high species richness, high functional diversity) has been recorded in deep sea ecosystems where the functional similarity is low, and a high number of species has a direct effect on functional diversity (Danovaro *et al.*, 2008). These specific zones could also be influenced by local characteristics, for instance the change from permanent to seasonal upwelling and the topography (Figueroa & Moffat, 2000; Montecino & Lange, 2009).

Assemblages that present high FEve and RaoQ, moderate to high FDiv (~0.5–0.9) and low FRic (<23), are randomly distributed between 300 – 4000 m. This indicates a community where the small functional space maintains distinct roles with balanced coexistence (Mason *et al.*, 2013). Most sites were south of 16ºS and >900 m. Other taxonomic groups revealed that changes in functional diversity components with taxonomic diversity are due to the environmental characteristics of the zone or habitat heterogeneity (Buhl-Mortensen *et al.*, 2012; Carvalho & Barros, 2017; Gomes *et al.*, 2024). In this case of the SEP, the respective sites were exposed to the mixing zone of AAIW, ESSW and PDW, characterized by low temperatures (~3ºC), dissolved oxygen (~100–218 µmol kg-1) and phosphate concentrations increasing from ~1.9 to > 2.4 µmol kg-1 (Reyes-Macaya *et al.*, 2022; Silva *et al.*, 2009). Additionally, being outside the OMZ, these characteristics were also mirrored by sediment heterogeneity and thereby constitute a heterogeneous zone with greater species diversity for meio– and macrofauna (Neira *et al.*, 2001; Sellanes *et al.*, 2010), hence influencing the functional structure. Environmental heterogeneity generates an assemblage with low redundancy but high niche complementarity.

On the other hand, sites with lowest FRic (<10), low to intermediate FEve (0.2–0.5) and RaoQ (1–18), high FDiv and high abundances were mainly found in the shallow OMZ (9º, 10º, 11º, 12º, 31ºS). The low FRic suggests an environmental filter linked to severe hypoxia in the area, exhibiting a high functional similarity in the assemblage. It was dominated by a few species (low FEve), which possess similar tolerant traits to anoxia conditions such as elongated morphologies and physiological strategies to overcome the dependence on oxygen (Glock, 2023; Koho & Piña-Ochoa, 2012; Mason *et al.*, 2013). This pattern matches with other macrofaunal and meiofaunal assemblages along Peruvian and Chilean OMZ, where low diversities but high densities of hypoxia-tolerant groups dominate (Gómez *et al.*, 2024; Neira *et al.*, 2001; Palma *et al.*, 2005). Despite the restricted functional space, the high FDiv indicates that few surviving taxa occupy distinct positions within the constrained functional space, representing highly specialized and functionally distinct strategies adapted to the OMZ (Mouillot, Bellwood*, et al.*, 2013). Slight variations of this functional combination extend to sites surrounding the OMZ (1°–15°S and 31°–39°S) and at upper bathyal depths (300–800 m). This suggested that although the functional space increases slightly, the dominance of a small set of tolerant traits persists under the influence of low oxygen levels.

8.3. Functional traits distribution

The community-weighted mean (CWM) trait analyses indicated strong latitudinal shifts in morphology, oxygen tolerance, and trophic strategies (Figure 8). The hyaline test type was dominant across the SEP, as this type is considered the most diverse (Murray, 2007). However, agglutinated species predominated (30%) at deeper sites (>990 m). This pattern coincides with the sites showing elevated FRic, which include both test type wall type and multiple morphologies (Bandy & Rodolfo, 1964; Patarroyo & Martinez, 2021) suggesting that sites at intermediate and deeper sites harbor more morphological traits. The lower contribution of porcelanaceous or miliolide species could be related to oxygen conditions of the study area, since *Quinqueloculina, Pyrgo and Triloculina* species prefer cold environments with high oxygenation, low organic carbon content, and sandy to slightly muddy sediments (Anbuselvan & Senthil Nathan, 2019; Narciso-Mezones *et al.*, 2025; Noucoucouk *et al.*, 2023). On the other hand, a distinct pattern was observed in the distribution of agglutinated species (Figure 8), even though they are not well adapted to these conditions (Mallon *et al.*, 2012). None the less, agglutinants such as *Ammoglobigerina globigeriformis, Cyclamina cancellata, Ammodiscus incertus, Eggerella bradyi* was lower (<2%) at certain stations (~3º-12ºS). The proportions of arenaceous species slightly increased (~5–17%) south of the OMZ at 15ºS, which is displayed by *Haplophragmoides, Reophax, Portatrochmmina, Trochammina, Dorothia and Bathysiphon*. These taxa have been associated with low oxic conditions (Gooday *et al.*, 2000; Koho & Piña-Ochoa, 2012; Tetard *et al.*, 2024), suggesting that the environmental conditions along the OMZ are not homogeneous. According to Gooday *et al.* (2009), the abundance of agglutinated species starts to increase beyond 500 m, and beneath the OMZ (~1300 m), from where on the dominates the community.

Morphologies revealed a clear distinction between assemblages found within and outside the OMZ core. Inside and surrounding the OMZ there was a predominance of biserial, triserial and trochospiral species, *e.g. Bolivina, Uvigerina, Bulimina and Fursenkoina* (Table S7). These taxa, also designated as rectilinear or tapered/cylindrical morphogroup, have been reported in similar OMZ ecosystems as a good indicator of these conditions (Kaithwar *et al.*, 2020; Mazumder & Nigam, 2014). Although the prevalence of these morphologies under low oxygen conditions is not fully resolved, it may be related to the elongated and compressed arrangement of the chambers, which provide functional advantages by enhancing gas-exchange efficiency. For instance, species such as *Uvigerina peregrina* increase their chamber size during growth, while *Bolivina* or *Loxostomum* modulate their chamber number (Keating-Bitonti & Payne, 2017). These morphologies may also compensate for the reduced surface area to volume ratios of larger tests. Through increased porosity, they improve gas exchange (Belanger, 2022). This is of particular importance in OMZ ecosystems *Bolivina, Buliminella, Fursenkoina, Nonionella* and *Uvigerina*, need to acquire and store nitrate to perform denitrification, which allows them to respire in the absence of oxygen (Bernhard *et al.*, 2012; Glock *et al.*, 2013; Høgslund *et al.*, 2008). Additionally, those species may rely on kleptoplastidy to supplement their metabolism under oxygen-depleted conditions (Glock, 2023; Meilijson *et al.*, 2015). In the same way, traits such as pore size or density, although not quantified in this study, are recognized as morphological adaptations in the efficiency of gas exchange under low-oxygen conditions (Glock *et al.*, 2019; Glock *et al.*, 2012; Kuhnt *et al.*, 2013). The dominance of species with these adaptations in our sites is consistent with hypoxia and anoxia tolerant traits observed in the CWM analysis, suggesting those traits would be contributing most strongly within the core of the OMZ. Additionally, body size is an important morphological trait because low-oxygen conditions often lead to a higher proportion of small-sized individuals, thereby altering the diversity and abundance of the assemblage (Palmer *et al.*, 2020).

The availability of organic matter is another factor that can modulate foraminiferal test shape (Caulle *et al.*, 2015; Keating-Bitonti & Payne, 2016). These above-mentioned strategies coincide with ecological traits linked to organic-matter utilization. Many of the species dominating oxygen depleted sites exhibited high CWM values for the phytodetritivore trait. Although detritivore trophic behavior was widespread across the study area, phytodetritivore species were particularly abundant in the shallow OMZ core sites and between 33º–42ºS. Those sites are subjected to a high export flux of organic matter to the sediments (Gutiérrez *et al.*, 2011; Loginova *et al.*, 2020). However, C/N ratios in these sites ranged from moderate to high values (~6.5–9.5), indicating that organic matter reaching the sediment is not exclusively fresh in phytodetritus but includes partially degraded material (Figure S1). Consequently, the dominance of phytodetritivore traits does not necessarily reflect strict dependence on labile organic matter, but rather opportunistic strategies of episodic pulses of fresh material. Such feeding strategie has been reported for some species inhabiting OMZ (Cardich *et al.*, 2015; Nomaki *et al.*, 2006), where ecological success relies more on physiological tolerances. Although most foraminiferal species are catalogued at a lower trophic level (Nomaki *et al.*, 2008), yet their feeding strategies are often flexible. At some sites south of 33ºS and below the OMZ core (>600m), where C/N ratios are lower (<7.4) but total abundance decreases, omnivore behavior was more common (>20%) (Figure 8). These settings indicate that the organic matter is fresher, but the flux is lower and competition for resources increases (Neira *et al.*, 2001). Hence, omnivores likely reflect feeding flexibility, enabling them to exploit a wider range of food resources (Gooday *et al.*, 1992; Gooday *et al.*, 2008; Murray, 2006). At the deepest sites, bacterivore species became more abundant (>25%), particularly agglutinated species. However, foraminifera have been considered to not consume bacteria selectively but to ingest them incidentally (Goldstein & Corliss, 1994; Gooday *et al.*, 2008). The apparent bacterivory probably reflects the general low food availability and degradation of sinking organic matter in bathyal to abyssal environments, where the sediments are dominated by microbial biomass and lipids (Dale *et al.*, 2015; Flores *et al.*, 2022). Consequently, the trophic diversity observed here likely reflects opportunistic, deposit or suspension-feeding strategies, where species classified as omnivores or bacterivores may switch between feeding modes depending on food availability and degradation state (Gooday *et al.*, 1992).

The microhabitat preferences trait did not exhibit a strong spatial pattern. It is controlled by oxygen penetration in the sediment, quality and quantity of organic matter, and bioturbation rates (Corliss, 1985; Geslin *et al.*, 2004). Epifaunal and shallow infaunal (SI) species were present in most shallow and hypoxic sites, in particular calcareous rotaliid taxa with tolerance to low oxygen conditions (Figure 8). The microhabitat selection reflects an adaptation to anoxia and preference for labile organic matter (Cardich *et al.*, 2015; Fontanier *et al.*, 2002). These assemblages, as well as the species that occupy deep or intermediate sediments depths in higher oxygenated settings within the SEP OMZ follow the TROX model (Jorissen *et al.*, 1995). In this framework, taxa adjust their microhabitat position based on food availability (Cardich *et al.*, 2015), thereby contributing to sediment mixing as bioturbators (Deldicq *et al.*, 2020; Diz *et al.*, 2023). Additionally, it has been evaluated that some epifaunal species could rework particles at the sediment surface, whereas infaunal species, that live within sediments, contribute to particle mixing from the surface down to the deepest sediment layer they can occupy (Deldicq *et al.*, 2020).

Nevertheless, the SI outside the OMZ, particularly in the southernmost part of the SEP (~31º–50ºS), while intermediate infaunal (II) exhibits more contribution. These sites demonstrate elevated oxygen levels, intermediate values of organic carbon accumulation, as well as less organic matter degradation (Figure S1). Such conditions are likely to facilitate more flexible vertical distribution, therefore benthic foraminifera can occupy the microhabitat that best suits their trophic preferences, bottom water conditions, or sediment grain type (Anbuselvan & Senthil Nathan, 2019; Enge *et al.*, 2016).

8.4. Environmental drivers

GAM analyses highlighted that temperature, salinity, oxygen, phosphate, and silicate concentrations were the main environmental drivers shaping both taxonomic and functional diversity (Table 4). These predictors are linked to the water mass structure and act as integrative descriptors of them rather than independent drivers (Reyes-Macaya *et al.*, 2022; Silva *et al.*, 2009). Temperature and salinity are defined as conservative tracers while the oxygen and nutrients (e.g. nitrate, phosphate, silicate) are non-conservative properties that can change by chemical or biological process in the column water (Talley *et al.*, 2011), while nutrients also represent signals of organic matter remineralization. These bottom water variables have been shown to drive the diversity of other macrobenthic groups (Neira *et al.*, 2001; Ysebaert & Herman, 2002) indicating that the foraminiferal communities respond similarly to environmental gradients. In this context, the effect of this set of variables on taxonomic metrics is captured by the shifts in species dominance and presence/absence patterns among sites, whereas functional richness reflects changes in the extent of functional space, allowing a broader range of ecological strategies to be expanded under specific water mass characteristics (Bandy & Rodolfo, 1964; Ingle *et al.*, 1980). These interactions have been reported in previous studies where some foraminiferal communities adapt to those properties of bottom-water masses (Eichler *et al.*, 2016; Eichler *et al.*, 2008).

Sedimentary and geochemical variables such as opal, $CaCO_3$ content, $\delta^{15}N$ and C/N ratio values contributed to explaining variation in taxonomic indices and functional richness, indicating a relevant role of benthic habitat characteristics. Biogenic opal in surface sediments is widely used as a proxy for past and present primary productivity, reflecting the export of siliceous phytoplankton to the seafloor during upwelling conditions (Mohtadi & Hebbeln, 2004; Romero & Hebbeln, 2003). Therefore, higher opal contents in the study area indicate organic matter fluxes, which can promote species richness and influence dominance patterns through increased food availability. Similarly, $CaCO_3$ content has been shown to contribute to sediment composition and spatial heterogeneity, which has implications for variability in grain-size (Nait-Hammou *et al.*, 2025). In the present study, CaCO3 in surface sediments reflects the biogenic production given by the deposition of calcifying organisms (Mohtadi *et al.*, 2005; Saavedra-Pellitero *et al.*, 2013). Hence, the benthic foraminifera community structure could be influenced by the composition or the sediment grain size (Hromic *et al.*, 2006; Milker *et al.*, 2009). From a functional perspective, biogenic opal likely increases the FRic, due to its association with surface productivity, contributing to trophic strategies and microhabitat (Alve, 2010; Enge *et al.*, 2011). While $CaCO_3$ content could affect the preservation of their tests as well as allow the coexistence of multiple test wall types promote the expansion of functional space (de Nooijer *et al.*, 2014). Additionally, $\delta^{15}N$ is considered a predictor only for functional richness, likely reflecting nitrogen cycling processes and its impact on functional traits. In the SEP, within the OMZ, low δ15N signal reflects the signature of intense sedimentary denitrification, which minimizes isotopic discrimination (Hoogakker *et al.*, 2025). Consequently, functional volume (FRic) is reduced, as only specialized traits adapted to these conditions can persist. Such metabolic strategies would be reflected in species previously mentioned (Glock, 2023; Koho & Piña-Ochoa, 2012).

On the other hand, abundance was associated with C/N ratio, highlighting the importance of organic matter quality in regulating benthic foraminiferal densities.

Zones off Peru and northern Chile, the degradation of nitrogen rich components increases C/N ratios above Redfield values during anaerobic microbial pathways and denitrification process (De Pol-Holz *et al.*, 2009; Flores *et al.*, 2023). These elevated C/N values (>7.5), indicate shifts in the lability and composition of organic matter reaching the seafloor. In this context, in the Peruvian OMZ core, the combined effect of diatom productivity and high organic matter export (Figure S1a, b and d), indicate that C/N values likely reflect the accumulation of relatively fresh phytodetritus, promoting high benthic foraminifera abundances (Cardich *et al.*, 2015). Additionally, those abundances can reflect reproductive responses to pulses of phytodetritus export (Nomaki *et al.*, 2008). The prevalence of *Bolivina* species within the OMZ core (Figure S2-S3) likely implies the ability to exploit a broad spectrum of organic substrates. This is consistent with their documented capacity off the coast of Japan to switch from fresh phytodetritus to degraded organic matter depending on temporal availability (Nomaki *et al.*, 2008), where input of terrigenous material from the continent to the shelf might be like the one in Chile. In contrast, similar C/N values along Chilean margin did not present the same foraminiferal density, suggesting that oxygenation state and organic matter flux regulate the population limiting total foraminiferal abundance ((Neira *et al.*, 2001). This agrees with previous work in the Southeast Pacific, where it has been shown that sedimentary organic matter quality regulates both the distribution and microhabitat of calcareous benthic foraminifera along the central Peruvian margin and northern Chile (Cardich *et al.*, 2015; Castillo *et al.*, 2021).

Among all predictors, oxygen was the only variable that explained variation in FEve and FDis, highlighting its role as environmental filter that impacts community abundance and specialization. Low oxygen concentrations modify food availability by favoring species with specific morphological and physiological adaptations to hypoxia (S Garrido *et al.*, 2025; Glock, 2023; Piña-Ochoa *et al.*, 2010). This limitation results in lower FDis (species with similar traits) and lower FEve (a few tolerant species dominate). Conversely, environments with superior oxygenation exhibit broader and more uniform functional traits.

Finally, our results reveal that FDiv and RaoQ were less sensitive to the measured environmental variables, suggesting that other biotic or unmeasured abiotic factors may influence the distribution of specialized traits. It should be noted that although the GAM analyses were restricted to the 55 stations (Appendix 2) with complete environmental coverage, the patterns detected represent strong relationships for the subset of sites where benthic habitat quality could be fully assessed.

8.5. Realized niche

The The OMI analysis reveals a group of highly specialized taxa within the SEP, characterized by high marginality (OMI) and very low tolerance (Tol) values (Table 6) (Dolédec *et al.*, 2000). Species such as *Vaginulina americana* (Vamer), *Eubuliminella curta* (Ecurt), *Buliminella elegantissima limbosa* (Belim), *Buliminella elegantissima tenuis* (Belte) and *Rhumblerella humboldti* (Rhumb) occupy restricted portions of the environmental gradient, indicating strong ecological specialization. The specific environmental conditions of Ecurt, Belim, Belte occur primarily in the Peruvian zone, at neritic and upper bathyal depths, which are influenced by high NO_2 and low oxygen (Figure 10 a, b). This coincides with previous reports explaining that *B. elegantissima* is associated with shallower environments characterized by high organic matter accumulation (Merma-Mora, 2020). In contrast, the marginality of Vamer, Bpago and Rhumb are evident in the equatorial region of the SEP (ESEP), at shallow depths characterized by higher C/N and warmer temperature. Previous studies have reported the occurrence of these species in similar geographic and bathymetric settings (Mallon, 2011); however, the OMI analysis applied in this study provides an interpretation of the observed distribution by identifying the specific environmental gradients. Similarly, other taxa such *Bathysiphon capillare*, *Martinotiella communis* and *Dorothia scabra* also exhibits a high marginality, at neritic to upper bathyal depths but in the Southern Chilean region. These results indicate a specific ecological specialization for each region within the SEP. Flexible specialist species combined high marginality with moderate to high tolerance (Table 6), indicating specialization within specific environmental settings but retaining ecological flexibility (Dolédec *et al.*, 2000). A representative example of this pattern is *B. seminuda* (Bsemi), which exhibited elevated tolerance (Tol = 5.22). Its niche optimum (Figure 10a) is consistent with previous reports describing the species associated with elevated TOC and nitrogen in suboxic to postoxic sediments (Cardich *et al.*, 2012). However, its broad latitudinal distribution (3°S–35°S) suggests that Bsemi responds to fluctuating redox conditions rather than being restricted to the persistent OMZ core.

Intermediate species occupy transitional ecological positions along environmental gradients, reflected by moderate marginality and variable tolerance values (Dolédec *et al.*, 2000). *Bolivina costata* (Bcost) is within this category, indicating its realized niche located in upper bathyal environments off Ecuador and Peru (Figure 10a, b). Although previous coastal studies have described this species as dominant and tolerant of sulfidic conditions (Cardich *et al.*, 2012; Merma-Mora, 2016), our results suggest a narrower ecological amplitude, preferentially associated with dynamic suboxic environments rather than the persistently anoxic OMZ core. However, within this group, some species exhibited low Tol values, indicating that although their niche occurs under common environmental conditions, they occupied a narrow portion of the available gradient. *Uvigerina canariensis* (Ucana), *U. striata* (Ustri), *Labrospira robusta*, *Bolivinita minuta* and *Ehrenbergina compressa* are primarily associated with areas characterized by elevated TOC, C/N and opal content (Figure 10a, b) (Gutiérrez *et al.*, 2011), suggesting specialization where oxygen fluctuates near hypoxic thresholds. Conversely, *U. semiornata* (Usemi) and *Pseudobrizalina lobata* were linked to deeper bathyal settings with higher oxygen concentrations and salinity in Chile and Northern Peru, respectively (Figure 9a), despite occasional occurrences within OMZ influenced depths (Table S5). This suggests that their ecological optimum lies in more stable deep-water conditions rather than oxygen depleted zones. Overall, taxa within this category reflect specialization in productive, low-oxygen or variable-salinity settings.

In contrast to specialist and intermediate taxa, generalist species occupy the average or "typical" environmental conditions of the study area, their broad tolerance suggests reduced sensitivity to environmental variability (Dolédec *et al.*, 2000; Hernández Fariñas *et al.*, 2015). Examples of this include *Hoeglundina elegans* (Heleg) and *Melonis affinis* (Maffi), present in lower bathyal environments off Chile (Figure 10a, b). Maffi is associated with elevated $\delta^{15}N$ and total Nitrogen in the sediment, whereas Heleg is linked to high oxygen, greater depth and lower C/N ratios. Both species have been widely reported from well-oxygenated slope and deep-water settings (Bandy & Rodolfo, 1964; Gooday, 2003; Ingle *et al.*, 1980), supporting the low marginality and broad tolerance observed here. Additionally, Heleg is described as a shallow infaunal (SI) specie capable of responding to moderate variations in organic matter supply under oxic or suboxic conditions (Venturelli *et al.*, 2018), while Maffi is catalogued as transitional infaunal specie (Rathburn & Corliss, 1994). These traits support their classification as generalists and explain their wide latitudinal and bathymetric distribution (Figure S3, S4), including occurrences at OMZ-influenced depths atypical of their OMI optimum. It should be noted that the ecological categories (Table 6) represent relative positions along continuous marginality–tolerance gradients rather than fixed classifications.

Beyond the ecological categories, OMI results reveal niche differentiation within *Bolivina.* A direct comparison of Bsemi and Bcost further emphasizes species-specific ecological strategies within the genus, given their occurrence in such conditions (Cardich *et al.*, 2012; Merma-Mora, 2016). While *B. interjuncta* and *B. plicata* are associated with suboxic conditions and organic-rich sediments (Cardich, 2012; Cardich *et al.*, 2019; Ingle *et al.*, 1980; Resig, 1981). This coincides with their generalist category and optimal niche in bathyal zones, as well as their restriction to deeper environments (Figure S2, S3), suggesting ecological flexibility constrained by depth. Overall, this partitioning suggests that species within *Bolivina* exploit similar redox–productivity systems through distinct ecological amplitudes rather than identical niche optima. Similar patterns have been documented in other oxygen-depleted systems (Fontanier *et al.*, 2016; Gooday *et al.*, 2008; Tetard *et al.*, 2024). A comparable pattern is observed within Uvigerina, where species display differentiation primarily along depth and oxygen gradients (Ingle *et al.*, 1980; Resig, 1981). Recent findings identify Ucana associated with dysoxic conditions, whereas Uaub and *U. peregrina* are linked to suboxic environments (Tetard et al. 2024). U. peregrina has also been described as part of transitional assemblages outside the OMZ core (Erdem *et al.*, 2020), which may explain the absence of a significant OMI signal in the present study.

Finally, OMI analysis of functional traits revealed a distinct niche among ecological strategies (Figure S6). Most of the functional traits have been discussed in the previous section; however, here we can highlight the optimum of microhabitat traits. Many SI taxa (uvigerinids, bolivinids) are associated with the utilization of low labile organic matter available (Mojtahid *et al.*, 2010). Epifaunal taxa (e.g. *Cancris, Cibicidoides, Eponides, Hoeglundina, Nutallides*) are linked by low C/N, ratios, well-oxygenated and deeper environments (Figure S7), consistent with their preference for low organic carbon flux rate (Altenbach *et al.*, 1999; Singh *et al.*, 2022; Singh *et al.*, 2012). Similarly, agglutinated species (*Crithionina pisum, Lagenammina, Recurvoides, Rhabdammina abyssorum, Trochammina squammata, Saccammina sphaerica*) occurring in similar type of niche (Figure S7a, b) because they can feed on suspended particles (Mojtahid *et al.*, 2010; Schönfeld, 2002). On the other hand, intermediate infaunal (II) taxa are less dependent on fresh organic input and can utilize refractory material (Goldstein & Corliss, 1994; Gooday *et al.*, 1992), allowing persistence under suboxic conditions (Fontanier *et al.*, 2006). Some II species recorded here (*e.g. Chillostomella ovoidea, C. oolina, Cassidulina, Globobulimina* sp., *Melonis* sp.) occur deeper in the sediments since at deepest sites, the oxygen penetration depth increased (Mojtahid *et al.*, 2010). Nevertheless, high oxygen levels permit both shallow and intermediate infaunal traits to extend into bathyal and abyssal zones (Gooday *et al.*, 1992).

9. CONCLUSION

This study demonstrates that benthic foraminiferal communities in the Southeastern Pacific (SEP) are not distributed along a continuous latitudinal gradient but are structured by discrete environmental thresholds that decouple taxonomic and functional diversity. Oxygen availability acts as the dominant ecological filter, defining the breadth of viable strategies across the region. Under depleted oxygen conditions, the communities are restricted by a narrow set of viable strategies, where high abundances mask a contraction of functional space. In contrast, sites with higher species richness may exhibit functional expansion, although this relationship is not consistent across the region. These patterns indicate that functional redundancy becomes more pronounced under low-oxygen conditions, whereas areas characterized by greater environmental heterogeneity allow diversification of trait combinations. These dynamics highlight the importance of oxygen availability as a key factor that modulates not only community composition but also the balance between redundancy and differentiation in benthic ecosystem functioning.

The consistency between generalized additive models and trait-based patterns reinforces oxygen as the principal structuring force, while water mass properties and sedimentary proxies further shape both taxonomic and functional structure. These findings indicate that oxygen constrains which strategies can persist, whereas resource availability regulates their relative abundance. Although environmental drivers were assessed using a subset of stations with complete data, the consistency of these relationships with independent taxonomic, functional, and niche patterns supports their robustness across the broader region.

Overall, the SEP margin represents a mosaic of environmentally filtered assemblages rather than a simple latitudinal gradient. Given the current oceanic deoxygenation, the expansion of OMZ conditions may reduce functional space and constrain the range of ecological responses available to benthic communities.

10. BIBLIOGRAPHIC REFERENCES

Abrantes, F., Lopes, C., Mix, A., & Pisias, N. (2007). Diatoms in Southeast Pacific surface sediments reflect environmental properties. *Quaternary Science Reviews*, *26*(1), 155–169. https://doi.org/https://doi.org/10.1016/j.quascirev.2006.02.022

Allen, K. L., Garwood, J. A., Hu, K., Meselhe, E. A., & Lewis, K. A. (2023). Simulating synergistic impacts of climate change and human induced stressors on a northern Gulf of Mexico estuarine food web [Original Research]. *Frontiers in Marine Science*, *Volume 10 - 2023*. https://doi.org/10.3389/fmars.2023.1213949

Altenbach, A. V., Pflaumann, U., Schiebel, R., Thies, A., Timm, S., & Trauth, M. (1999). Scaling percentages and distributional patterns of benthic Foraminifera with flux rates of organic carbon. *Journal of Foraminiferal Research*, *29*(3), 173–185.

Alve, E. (2010). Benthic foraminiferal responses to absence of fresh phytodetritus: A two-year experiment. *Marine Micropaleontology*, *76*(3), 67–75. https://doi.org/https://doi.org/10.1016/j.marmicro.2010.05.003

Anbuselvan, N., & Senthil Nathan, D. (2019). Benthic foraminiferal distribution and biofacies in the shelf part of Bay of Bengal, east coast of India. *Marine Biodiversity*, *49*(2), 691–706. https://doi.org/10.1007/s12526-018-0845-1

Bandy, O. L. (1949a). EOCENE AND OLIGOCENE FORAMINIFERA FROM LITTLE STAVE CREEK, CLARKE COUNTY, ALABAMA. In C. University, C. U. C. o. Pharmacy., C. University, & P. R. Institution (Eds.), *Bulletins of American paleontology* (Vol. 32, pp. 31). Paleontological Research Institution.

Bandy, O. L. (1949b). New Names for Two Species of Foraminifera from Little Stave Creek, Clarke Co., Alabama. *Journal of Paleontology*, *23*(4), 440–440.

Bandy, O. L., & Rodolfo, K. S. (1964). Distribution of foraminifera and sediments, Peru-Chile trench area. *Deep Sea Research and Oceanographic Abstracts*, *11*(5), 817–837. https://doi.org/https://doi.org/10.1016/0011-7471(64)90951-9

Becker, R. A., Chambers, J. M., & Wilks, A. R. (1988). *The new S language: A programming environment for data analysis and graphics*. Chapman & Hall/CRC. https://doi.org/10.1201/9781351074988

Belanger, C. L. (2022). Volumetric analysis of benthic foraminifera: Intraspecific test size and growth patterns related to embryonic size and food resources. *Marine Micropaleontology*, *176*. https://doi.org/10.1016/j.marmicro.2022.102170

Bernhard, J. M., Casciotti, K. L., McIlvin, M. R., Beaudoin, D. J., Visscher, P. T., & Edgcomb, V. P. (2012). Potential importance of physiologically diverse benthic foraminifera in sedimentary nitrate storage and respiration. *Journal of Geophysical Research: Biogeosciences*, *117*(G3). https://doi.org/https://doi.org/10.1029/2012JG001949

Blackmon, P. D., & Todd, R. (1959). Mineralogy of Some Foraminifera as Related to Their Classification and Ecology. *Journal of Paleontology*, *33*(1), 1–15.

Botta-Dukát, Z. (2005). Rao's quadratic entropy as a measure of functional diversity based on multiple traits. *Journal of Vegetation Science*, *16*(5), 533–540. https://doi.org/https://doi.org/10.1111/j.1654-1103.2005.tb02393.x

Bouchet, V. M. P., Alve, E., Rygg, B., & Telford, R. J. (2012). Benthic foraminifera provide a promising tool for ecological quality assessment of marine waters. *Ecological Indicators*, *23*, 66–75. https://doi.org/https://doi.org/10.1016/j.ecolind.2012.03.011

Bouchet, V. M. P., Telford, R. J., Rygg, B., Oug, E., & Alve, E. (2018). Can benthic foraminifera serve as proxies for changes in benthic macrofaunal community structure? Implications for the definition of reference conditions. *Mar Environ Res*, *137*, 24–36. https://doi.org/10.1016/j.marenvres.2018.02.023

Brandt, S., Karenyi, N., & Atkinson, L. (2024). Benthic taxonomic and functional diversity change across a depth gradient in the Southern Benguela Shelf ecoregion. *Mar Pollut Bull*, *208*, 117023. https://doi.org/10.1016/j.marpolbul.2024.117023

Bremner, J., Rogers, S. I., & Frid, C. L. J. (2006). Matching biological traits to environmental conditions in marine benthic ecosystems. *Journal of Marine Systems*, *60*(3-4), 302–316. https://doi.org/10.1016/j.jmarsys.2006.02.004

Briggs, J. C. (1974). *Marine zoogeography*. McGraw-Hill.

Bugge, T., Maisey, G., Rokoengen, K., Skaar, F., Thusu, B., & Løfaldli, M. (1975). Geological investigation of a lower tertiary/quaternary core, offshore Trøndelag, Norway.

Buhl-Mortensen, L., Buhl-Mortensen, P., Dolan, M. F. J., Dannheim, J., Bellec, V., & Holte, B. (2012). Habitat complexity and bottom fauna composition at different scales on the continental shelf and slope of northern Norway. *Hydrobiologia*, *685*(1), 191–219. https://doi.org/10.1007/s10750-011-0988-6

Cadotte, M. W., Carscadden, K., & Mirotchnick, N. (2011). Beyond species: functional diversity and the maintenance of ecological processes and services. *Journal of Applied Ecology*, *48*(5), 1079–1087. https://doi.org/https://doi.org/10.1111/j.1365-2664.2011.02048.x

Caratelli, M., & Archuby, F. (2023). Paleoenvironmental significance of benthic foraminiferal associations of the Hauterivian to Barremian marine beds of the Neuquén Basin, Patagonia, Argentina. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *618*, 111527. https://doi.org/https://doi.org/10.1016/j.palaeo.2023.111527

Cárdenas-Calle, M., Mora, E., Torres, G., Pérez-Correa, J., Bigatti, G., Signorelli, J., & Coronel, J. (2020). Marine invertebrate and seaweed biodiversity of continental coastal Ecuador. *Biodivers Data J*, *8*, e53818. https://doi.org/10.3897/BDJ.8.e53818

Cardich, J. (2012). *Especies de foraminíferos bentónicos indicadoras del estado de Óxido-reducción del sedimento superficial en el margen continental central del Perú* Universidad Peruana Cayetano Heredia]. Lima, Peru.

Cardich, J., Gutiérrez, D., Romero, D., Pérez, A., Quipúzcoa, L., Marquina, R., Yupanqui, W., Solís, J., Carhuapoma, W., Sifeddine, A., & Rathburn, A. (2015). Calcareous benthic foraminifera from the upper central Peruvian margin: control of the assemblage by pore water redox and sedimentary organic matter. *Marine Ecology Progress Series*, *535*, 63–87. https://doi.org/10.3354/meps11409

Cardich, J., Morales, M., Quipúzcoa, L., Sifeddine, A., & Gutiérrez, D. (2012). Benthic Foraminiferal Communities and Microhabitat Selection on the Continental Shelf Off Central Peru. In A. V. Altenbach, J. M. Bernhard, & J. Seckbach (Eds.), *Anoxia: Evidence for Eukaryote Survival and Paleontological Strategies* (pp. 323–340). Springer Netherlands. https://doi.org/10.1007/978-94-007-1896-8_17

Cardich, J., Sifeddine, A., Salvatteci, R., Romero, D., Briceño-Zuluaga, F., Graco, M., Anculle, T., Almeida, C., & Gutiérrez, D. (2019). Multidecadal Changes in Marine

Subsurface Oxygenation Off Central Peru During the Last ca. 170 Years. *Frontiers in Marine Science*, *6*. https://doi.org/10.3389/fmars.2019.00270

Cardinale, B. J., Nelson, K., & Palmer, M. A. (2000). Linking species diversity to the functioning of ecosystems: on the importance of environmental context. *Oikos*, *91*(1), 175–183. https://doi.org/https://doi.org/10.1034/j.1600-0706.2000.910117.x

Cardinale, B. J., Srivastava, D. S., Emmett Duffy, J., Wright, J. P., Downing, A. L., Sankaran, M., & Jouseau, C. (2006). Effects of biodiversity on the functioning of trophic groups and ecosystems. *Nature*, *443*(7114), 989–992. https://doi.org/10.1038/nature05202

Carvalho, L. R. S., & Barros, F. (2017). Physical habitat structure in marine ecosystems: the meaning of complexity and heterogeneity. *Hydrobiologia*, *797*(1), 1–9. https://doi.org/10.1007/s10750-017-3160-0

Castillo, A., Hromic, T., Uribe, R. A., Valdés, J., Sifeddine, A., Quezada, L., Vega, S.-E., Arencibia, A., Díaz-Ochoa, J., & Guiñez, M. (2021). Living (stained) calcareous benthic foraminiferal assemblages (>125μm) in a coastal upwelling zone of the Humboldt Current System, Northern Chile (~27∘S). *Regional Studies in Marine Science*, *44*. https://doi.org/10.1016/j.rsma.2021.101725

Caulle, C., Mojtahid, M., Gooday, A. J., Jorissen, F. J., & Kitazato, H. (2015). Living (Rose-Bengal-stained) benthic foraminiferal faunas along a strong bottom-water oxygen gradient on the Indian margin (Arabian Sea). *Biogeosciences*, *12*(16), 5005–5019. https://doi.org/10.5194/bg-12-5005-2015

Chaigneau, A., Dominguez, N., Eldin, G., Vasquez, L., Flores, R., Grados, C., & Echevin, V. (2013). Near-coastal circulation in the Northern Humboldt Current System from shipboard ADCP data. *Journal of Geophysical Research: Oceans*, *118*(10), 5251–5266. https://doi.org/https://doi.org/10.1002/jgrc.20328

Chavez, F. P., Bertrand, A., Guevara-Carrasco, R., Soler, P., & Csirke, J. (2008). The northern Humboldt Current System: Brief history, present status and a view towards the future. *Progress in Oceanography*, *79*(2), 95–105. https://doi.org/https://doi.org/10.1016/j.pocean.2008.10.012

Chevene, F., Doléadec, S., & Chessel, D. (1994). A fuzzy coding approach for the analysis of long-term ecological data. *Freshwater Biology*, *31*(3), 295–309. https://doi.org/https://doi.org/10.1111/j.1365-2427.1994.tb01742.x

Corliss, B. H. (1985). Microhabitats of benthic foraminifera within deep-sea sediments. *Nature*, *314*(6010), 435–438. https://doi.org/10.1038/314435a0

Corliss, B. H., & Chen, C. (1988). Morphotype patterns of Norwegian Sea deep-sea benthic foraminifera and ecological implications. *Geology*, *16*(8), 716–719. https://doi.org/10.1130/0091-7613(1988)016<0716:Mponsd>2.3.Co;2

Corliss, B. H., & van Weering, T. C. E. (1993). Living (stained) benthic foraminifera within surficial sediments of the Skagerrak. *Marine Geology*, *111*(3), 323–335. https://doi.org/https://doi.org/10.1016/0025-3227(93)90138-L

Costello, M. J., Coll, M., Danovaro, R., Halpin, P., Ojaveer, H., & Miloslavich, P. (2010). A Census of Marine Biodiversity Knowledge, Resources, and Future Challenges. *PLoS One*, *5*(8), e12110. https://doi.org/10.1371/journal.pone.0012110

D'Andrea, R., & Ostling, A. (2016). Challenges in linking trait patterns to niche differentiation. *Oikos*, *125*(10), 1369–1385. https://doi.org/https://doi.org/10.1111/oik.02979

Dale, A. W., Sommer, S., Lomnitz, U., Montes, I., Treude, T., Liebetrau, V., Gier, J., Hensen, C., Dengler, M., Stolpovsky, K., Bryant, L. D., & Wallmann, K. (2015). Organic carbon production, mineralisation and preservation on the Peruvian margin. *Biogeosciences*, *12*(5), 1537–1559. https://doi.org/10.5194/bg-12-1537-2015

Danovaro, R. (2024). Understanding marine biodiversity patterns and drivers: The fall of Icarus. *Marine Ecology*, *n/a*(n/a), e12814. https://doi.org/https://doi.org/10.1111/maec.12814

Danovaro, R., Gambi, C., Dell'Anno, A., Corinaldesi, C., Fraschetti, S., Vanreusel, A., Vincx, M., & Gooday, A. J. (2008). Exponential decline of deep-sea ecosystem functioning linked to benthic biodiversity loss. *Curr Biol*, *18*(1), 1–8. https://doi.org/10.1016/j.cub.2007.11.056

de Nooijer, L. J., Spero, H. J., Erez, J., Bijma, J., & Reichart, G. J. (2014). Biomineralization in perforate foraminifera. *Earth-Science Reviews*, *135*, 48–58. https://doi.org/https://doi.org/10.1016/j.earscirev.2014.03.013

De Pol-Holz, R., Robinson, R. S., Hebbeln, D., Sigman, D. M., & Ulloa, O. (2009). Controls on sedimentary nitrogen isotopes along the Chile margin. *Deep Sea Research Part II: Topical Studies in Oceanography*, *56*(16), 1042–1054. https://doi.org/https://doi.org/10.1016/j.dsr2.2008.09.014

Debennay, J. P. (2012). *A guide to 1,000 Foraminifera from Southwestern Pacific: New Caledonia*. IRD Éditions; Muséum national d'Histoire naturelle.

Deldicq, N., Seuront, L., Langlet, D., & Bouchet, V. M. P. (2020). Assessing behavioural traits of benthic foraminifera: implications for sediment mixing. *Marine Ecology Progress Series*, *643*, 21–31.

Díaz, S., Lavorel, S., Chapin, F. S., Tecco, P. A., Gurvich, D. E., & Grigulis, K. (2007). Functional Diversity — at the Crossroads between Ecosystem Functioning and Environmental Filters. In J. G. Canadell, D. E. Pataki, & L. F. Pitelka (Eds.), *Terrestrial Ecosystems in a Changing World* (pp. 81–91). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-32730-1_7

Diz, P., González-Guitián, V., González-Villanueva, R., Ovejero, A., & Hernández-Almeida, I. (2023). BENFEP: a quantitative database of benthic foraminifera from surface sediments of the eastern Pacific. *Earth System Science Data*, *15*(2), 697–722. https://doi.org/10.5194/essd-15-697-2023

Dolédec, S., Chessel, D., & Gimaret-Carpentier, C. (2000). NICHE SEPARATION IN COMMUNITY ANALYSIS: A NEW METHOD. *Ecology*, *81*(10), 2914–2927. https://doi.org/https://doi.org/10.1890/0012-9658(2000)081[2914:NSICAA]2.0.CO;2

Dray, S., & Dufour, A.-B. (2007). The ade4 Package: Implementing the Duality Diagram for Ecologists. *Journal of Statistical Software*, *22*(4), 1 – 20. https://doi.org/10.18637/jss.v022.i04

Dubicka, Z., Złotnik, M., & Borszcz, T. (2015). Test morphology as a function of behavioral strategies — Inferences from benthic foraminifera. *Marine Micropaleontology*, *116*, 38–49. https://doi.org/10.1016/j.marmicro.2015.01.003

Eichler, P. P. B., Pimenta, F. M., Eichler, B. B., & Vital, H. (2016). Living benthic foraminiferal species as indicators of cold-warm water masses interaction and upwelling areas. *Continental Shelf Research*, *116*, 116–121. https://doi.org/https://doi.org/10.1016/j.csr.2016.01.006

Eichler, P. P. B., Sen Gupta, B. K., Eichler, B. B., Braga, E. S., & Campos, E. J. (2008). Benthic foraminiferal assemblages of the South Brazil: Relationship to water masses and nutrient distributions. *Continental Shelf Research*, *28*(13), 1674–1686. https://doi.org/https://doi.org/10.1016/j.csr.2007.10.012

Eisenhauer, N., Hines, J., Maestre, F. T., & Rillig, M. C. (2023). Reconsidering functional redundancy in biodiversity research. *npj Biodiversity*, *2*(1), 9. https://doi.org/10.1038/s44185-023-00015-5

Enge, A. J., Nomaki, H., Ogawa, N. O., Witte, U., Moeseneder, M. M., Lavik, G., Ohkouchi, N., Kitazato, H., Kučera, M., & Heinz, P. (2011). Response of the benthic foraminiferal community to a simulated short-term phytodetritus pulse in the abyssal North Pacific. *Marine Ecology Progress Series*, *438*, 129–142.

Enge, A. J., Wukovits, J., Wanek, W., Watzka, M., Witte, U. F. M., Hunter, W. R., & Heinz, P. (2016). Carbon and Nitrogen Uptake of Calcareous Benthic Foraminifera along a Depth-Related Oxygen Gradient in the OMZ of the Arabian Sea [Original Research]. *Frontiers in Microbiology*, *Volume 7 - 2016*. https://doi.org/10.3389/fmicb.2016.00071

Erdem, Z., Schönfeld, J., Rathburn, A. E., Pérez, M.-E., Cardich, J., & Glock, N. (2020). Bottom-water deoxygenation at the Peruvian margin during the last deglaciation recorded by benthic foraminifera. *Biogeosciences*, *17*(12), 3165–3182. https://doi.org/10.5194/bg-17-3165-2020

Fernández, L. D., & Zapata, J. A. (2010). Distribución de foraminíferos bentónicos (Protozoa: Foraminiferida) en la ensenada Quillaipe (41°32' S; 72°44' O), Chile: Implicaciones para el estudio del nivel del mar. *Revista Chilena de Historia Natural*, *83*, 567–583.

Figueroa, D., & Moffat, C. (2000). On the influence of topography in the induction of coastal upwelling along the Chilean Coast. *Geophysical Research Letters*, *27*(23), 3905–3908. https://doi.org/https://doi.org/10.1029/1999GL011302

Figueroa, S., Marchant, M., Giglio, S., & Ramírez, M. (2005). FORAMINIFEROS BENTONICOS ROTALINIDOS DEL CENTRO SUR DE CHILE (36°S - 44°S). *Gayana (Concepción)*, *69*, 329–363.

Figueroa, S., Marchant SM, M., Giglio, S., & Ramírez, M. (2006). FORAMINIFEROS BENTONICOS DEL TALUD CONTINENTAL DESDE CONCEPCION A LAS ISLAS GUAITECAS (36º- 44° S), CHILE (FORAMINIFERA: LAGENINA, MILIOLINA Y ROBERTININA). *Gayana (Concepción)*, *70*, 255–279.

Finger, K. L. (2013). Miocene foraminifera from the south-central coast of Chile. *Micropaleontology*, *59*.

Fischer, F. M., & de Bello, F. (2023). On the uniqueness of functional redundancy. *npj Biodiversity*, *2*(1), 23. https://doi.org/10.1038/s44185-023-00029-z

Flores, E., Cantarero, S. I., Ruiz-Fernández, P., Dildar, N., Zabel, M., Ulloa, O., & Sepúlveda, J. (2022). Bacterial and eukaryotic intact polar lipids point to in situ production as a key source of labile organic matter in hadal surface sediment of the Atacama Trench. *Biogeosciences*, *19*(5), 1395–1420. https://doi.org/10.5194/bg-19-1395-2022

Flores, E., Fernández-Urruzola, I., Cantarero, S. I., Pizarro-Koch, M., Zabel, M., Sepúlveda, J., & Ulloa, O. (2023). Particulate Organic Matter in the Atacama Trench: Tracing Sources and Possible Transport Mechanisms to the Hadal Seafloor. *Journal of Geophysical Research: Biogeosciences*, *128*(8), e2023JG007401. https://doi.org/https://doi.org/10.1029/2023JG007401

Fontanier, C., Garnier, E., Brandily, C., Dennielou, B., Bichon, S., Gayet, N., Eugene, T., Rovere, M., Grémare, A., & Deflandre, B. (2016). Living (stained) benthic foraminifera from the Mozambique Channel (eastern Africa): Exploring ecology of deep-sea unicellular meiofauna. *Deep Sea Research Part I: Oceanographic Research Papers*, *115*, 159–174. https://doi.org/10.1016/j.dsr.2016.06.007

Fontanier, C., Jorissen, F. J., Licari, L., Alexandre, A., Anschutz, P., & Carbonel, P. (2002). Live benthic foraminiferal faunas from the Bay of Biscay: faunal density, composition, and microhabitats. *Deep Sea Research Part I: Oceanographic Research Papers*, *49*(4), 751–785. https://doi.org/https://doi.org/10.1016/S0967-0637(01)00078-4

Fontanier, C., Mackensen, A., Jorissen, F. J., Anschutz, P., Licari, L., & Griveaud, C. (2006). Stable oxygen and carbon isotopes of live benthic foraminifera from the Bay of Biscay: Microhabitat impact and seasonal variability. *Marine Micropaleontology*, *58*(3), 159–183. https://doi.org/10.1016/j.marmicro.2005.09.004

Francisco, V., & de la Cueva, H. (2017). Nuevas perspectivas en la diversidad funcional de ambientes marinos. *Latin American Journal of Aquatic Research*, *45*(2), 261–275. https://doi.org/10.3856/vol45-issue2-fulltext-3

Fuenzalida, R., Schneider, W., Garcés-Vargas, J., Bravo, L., & Lange, C. (2009). Vertical and horizontal extension of the oxygen minimum zone in the eastern South Pacific Ocean. *Deep Sea Research Part II: Topical Studies in Oceanography*, *56*(16), 992–1003. https://doi.org/10.1016/j.dsr2.2008.11.001

Garrido, S., Hoogakker, B. A. A., Richirt, J., Reyes-Macaya, D., Hernández-Almeida, I., Cardich, J., Castillo Bruna, A., Fouet, M., Gayo, E. M., Hebbeln, D., & Jorissen, F. J. (2025). *Benthic foraminifera species pore measurements of surface sediment samples from the Southeast Pacific* (PANGAEA. https://doi.org/10.1594/PANGAEA.973196

Garrido, S., Hoogakker, B. A. A., Richirt, J., Reyes-Macaya, D., Hernández-Almeida, I., Cardich, J., Castillo Bruna, A., Fouet, M. P. A., Gayo, E. M., Hebbeln, D., Farías, L., & Jorissen, F. (2025). Temporal, Morphological, and Taxonomic Frameworks for Calibrating Benthic Foraminiferal Pore Patterns as a Paleoxygenation Proxy. *Paleoceanography and Paleoclimatology*, *40*(5). https://doi.org/10.1029/2024pa005005

Gaston, K. J. (2000). Global patterns in biodiversity. *Nature*, *405*(6783), 220–227. https://doi.org/10.1038/35012228

Geslin, E., Heinz, P., Jorissen, F., & Hemleben, C. (2004). Migratory responses of deep-sea benthic foraminifera to variable oxygen conditions: laboratory investigations. *Marine Micropaleontology*, *53*(3), 227–243. https://doi.org/https://doi.org/10.1016/j.marmicro.2004.05.010

Ghodrati Shojaei, M., Gutow, L., Dannheim, J., Pehlke, H., & Brey, T. (2015). Functional Diversity and Traits Assembly Patterns of Benthic Macrofaunal Communities in the

Southern North Sea. In *Towards an Interdisciplinary Approach in Earth System Science* (pp. 183–195). https://doi.org/10.1007/978-3-319-13865-7_20

Glock, N. (2023). Benthic foraminifera and gromiids from oxygen-depleted environments – survival strategies, biogeochemistry and trophic interactions. *Biogeosciences*, *20*(16), 3423–3447. https://doi.org/10.5194/bg-20-3423-2023

Glock, N., Roy, A.-S., Romero, D., Wein, T., Weissenbach, J., Revsbech, N. P., Høgslund, S., Clemens, D., Sommer, S., & Dagan, T. (2019). Metabolic preference of nitrate over oxygen as an electron acceptor in foraminifera from the Peruvian oxygen minimum zone. *Proceedings of the National Academy of Sciences*, *116*(8), 2860–2865. https://doi.org/doi:10.1073/pnas.1813887116

Glock, N., Schönfeld, J., Eisenhauer, A., Hensen, C., Mallon, J., & Sommer, S. (2013). The role of benthic foraminifera in the benthic nitrogen cycle of the Peruvian oxygen minimum zone. *Biogeosciences*, *10*(7), 4767–4783. https://doi.org/10.5194/bg-10-4767-2013

Glock, N., Schönfeld, J., & Mallon, J. (2012). The Functionality of Pores in Benthic Foraminifera in View of Bottom Water Oxygenation: A Review. In *Anoxia* (pp. 537–552). https://doi.org/10.1007/978-94-007-1896-8_28

Goldstein, S. T., & Corliss, B. H. (1994). Deposit feeding in selected deep-sea and shallow-water benthic foraminifera. *Deep Sea Research Part I: Oceanographic Research Papers*, *41*(2), 229–241. https://doi.org/https://doi.org/10.1016/0967-0637(94)90001-9

Gomes, W. I. A., Jovem-Azevêdo, D., de Melo, D. B., Veríssimo, M. E. S., Milesi, S. V., dos Santos, P. J. P., & Molozzi, J. (2024). Taxonomic richness and its relationship to the functional diversity of polychaetes in tropical estuaries. *Marine Ecology*, *45*(2), e12791. https://doi.org/https://doi.org/10.1111/maec.12791

Gómez, E., Romero, L., Quipúzcoa, L., & Pacheco, A. S. (2024). Macrobenthic community structure and diversity across a bathymetric gradient within and below the oxygen minimum zone in central Peru. *Deep Sea Research Part I: Oceanographic Research Papers*, *209*, 104341. https://doi.org/https://doi.org/10.1016/j.dsr.2024.104341

Gooday, A. J. (2003). Benthic foraminifera (protista) as tools in deep-water palaeoceanography: Environmental influences on faunal characteristics. In *Advances in Marine Biology* (Vol. 46, pp. 1–90). Academic Press. https://doi.org/https://doi.org/10.1016/S0065-2881(03)46002-1

Gooday, A. J., Bernhard, J. M., Levin, L. A., & Suhr, S. B. (2000). Foraminifera in the Arabian Sea oxygen minimum zone and other oxygen-deficient settings: taxonomic composition, diversity, and relation to metazoan faunas. *Deep Sea Research Part II: Topical Studies in Oceanography*, *47*(1), 25–54. https://doi.org/https://doi.org/10.1016/S0967-0645(99)00099-5

Gooday, A. J., Levin, L. A., Aranda da Silva, A., Bett, B. J., Cowie, G. L., Dissard, D., Gage, J. D., Hughes, D. J., Jeffreys, R., Lamont, P. A., Larkin, K. E., Murty, S. J., Schumacher, S., Whitcraft, C., & Woulds, C. (2009). Faunal responses to oxygen gradients on the Pakistan margin: A comparison of foraminiferans, macrofauna and megafauna. *Deep Sea Research Part II: Topical Studies in Oceanography*, *56*(6), 488–502. https://doi.org/https://doi.org/10.1016/j.dsr2.2008.10.003

Gooday, A. J., Levin, L. A., Linke, P., & Heeger, T. (1992). The Role of Benthic Foraminifera in Deep-Sea Food Webs and Carbon Cycling. In G. T. Rowe & V. Pariente (Eds.), *Deep-Sea Food Chains and the Global Carbon Cycle* (pp. 63–91). Springer Netherlands. https://doi.org/10.1007/978-94-011-2452-2_5

Gooday, A. J., Nomaki, H., & Kitazato, H. (2008). Modern deep-sea benthic foraminifera: a brief review of their morphology-based biodiversity and trophic diversity. In W. E. N. Austin & R. H. James (Eds.), *Biogeochemical Controls on Palaeoceanographic Environmental Proxies* (Vol. 303, pp. 0). Geological Society of London. https://doi.org/10.1144/sp303.8

Grassle, J., Lasserre, P., McIntyre, A., & Ray, G. (1991). Marine biodiversity and ecosystem function. *Biology International Special Issue*, *23*, 1–19.

Gray, J. S. (1997). Marine biodiversity: patterns, threats and conservation needs. *Biodiversity & Conservation*, *6*(1), 153–175. https://doi.org/10.1023/A:1018335901847

Gutiérrez, D., Akester, M., & Naranjo, L. (2016). Productivity and Sustainable Management of the Humboldt Current Large Marine Ecosystem under climate change. *Environmental Development*, *17*, 126–144. https://doi.org/10.1016/j.envdev.2015.11.004

Gutiérrez, D., Bouloubassi, I., Sifeddine, A., Purca, S., Goubanova, K., Graco, M., Field, D., Méjanelle, L., Velazco, F., Lorre, A., Salvatteci, R., Quispe, D., Vargas, G., Dewitte, B., & Ortlieb, L. (2011). Coastal cooling and increased productivity in the main upwelling zone off Peru since the mid-twentieth century. *Geophysical Research Letters*, *38*(7). https://doi.org/https://doi.org/10.1029/2010GL046324

Guy-Haim, T., & Bouchet, V. M. P. (2025). Beyond taxonomy: A framework for biological trait analysis to assess the functional structure of benthic foraminiferal communities. *Mar Pollut Bull*, *213*, 117699. https://doi.org/10.1016/j.marpolbul.2025.117699

Hammer, Ø., Harper, D. A., & Ryan, P. D. (2001). PAST: Paleontological statistics software package for education and data analysis. *Palaeontologia Electronica*, *4*(1), 9.

Häussermann, V., & Försterra, G. (2005). Distribution patterns of Chilean shallow-water sea anemones (Cnidaria: Anthozoa: Actiniaria, Corallimorpharia); with a discussion of the taxonomic and zoogeographic relationships between the actinofauna of the South East Pacific, the South West Atlantic and the Antarctic. *Scientia Marina*, *69*(S2), 91–102. https://doi.org/https://doi.org/10.3989/scimar.2005.69s291

Hebbeln, D., Arntz, W., Boening, P., Bohlmann, H., Contardo, X., Dezileau, L., Ferdelman, T., Figueroa, S., Fleming, J., Gallardo, V., Gerdes, D., Giglio, S., Gonzalez, P., González, R., Gutierrez, D., Hayn, C., Kallmeyer, J., Klockgether, G., Lambers, K.,…Wulf, J. (2001). *PUCK: Report and preliminary results of R/V Sonne Cruise SO156, Valparaiso (Chile) - Talcahuano (Chile)* (182). (Berichte aus dem Fachbereich Geowissenschaften der Universität Bremen, Issue. https://media.suub.uni-bremen.de/handle/elib/3847

Hernández Fariñas, T., Bacher, C., Soudant, D., Belin, C., & Barillé, L. (2015). Assessing phytoplankton realized niches using a French national phytoplankton monitoring network. *Estuarine, Coastal and Shelf Science*, *159*, 15–27. https://doi.org/https://doi.org/10.1016/j.ecss.2015.03.010

Hesemann, M. (2023). Benthic Foraminifera Diversity of the Abyssal Northwest Atlantic. *Diversity*, *15*(3), 381.

Høgslund, S., Revsbech, N. P., Cedhagen, T., Nielsen, L. P., & Gallardo, V. A. (2008). Denitrification, nitrate turnover, and aerobic respiration by benthic foraminiferans in the oxygen minimum zone off Chile. *Journal of Experimental Marine Biology and Ecology*, *359*(2), 85–91. https://doi.org/https://doi.org/10.1016/j.jembe.2008.02.015

Hoogakker, B. A. A., Davis, C., Wang, Y., Kusch, S., Nilsson-Kerr, K., Hardisty, D. S., Jacobel, A., Reyes Macaya, D., Glock, N., Ni, S., Sepúlveda, J., Ren, A., Auderset, A., Hess, A. V., Meissner, K. J., Cardich, J., Anderson, R., Barras, C., Basak, C.,…Zhou, Y. (2025). Reviews and syntheses: Review of proxies for low-oxygen paleoceanographic reconstructions. *Biogeosciences*, *22*(4), 863–957. https://doi.org/10.5194/bg-22-863-2025

Hooker, Y., Prieto-Rios, E., & Solís-Marín, F. A. (2013). Echinoderms of Peru. In J. J. Alvarado & F. A. Solis-Marin (Eds.), *Echinoderm Research and Diversity in Latin America* (pp. 277–299). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-20051-9_8

Hooper, D. U., Chapin III, F. S., Ewel, J. J., Hector, A., Inchausti, P., Lavorel, S., Lawton, J. H., Lodge, D. M., Loreau, M., Naeem, S., Schmid, B., Setälä, H., Symstad, A. J., Vandermeer, J., & Wardle, D. A. (2005). EFFECTS OF BIODIVERSITY ON ECOSYSTEM FUNCTIONING: A CONSENSUS OF CURRENT KNOWLEDGE. *Ecological Monographs*, *75*(1), 3–35. https://doi.org/https://doi.org/10.1890/04-0922

Hromic, T., Ishman, S., & Silva, N. (2006). Benthic foraminiferal distributions in Chilean fjords: 47°S to 54°S. *Marine Micropaleontology*, *59*(2), 115–134. https://doi.org/10.1016/j.marmicro.2006.02.001

Huston, M. A. (1999). Local Processes and Regional Patterns: Appropriate Scales for Understanding Variation in the Diversity of Plants and Animals. *Oikos*, *86*(3), 393–401. https://doi.org/10.2307/3546645

Ingle, J. C., Keller, G., & Kolpack, R. L. (1980). Benthic Foraminiferal Biofacies, Sediments and Water Masses of the Southern Peru-Chile Trench Area, Southeastern Pacific Ocean. *Micropaleontology*, *26*(2), 113–150. https://doi.org/10.2307/1485435

Jima, M., Jayachandran, P. R., & Bijoy Nandan, S. (2022). Modern Benthic Foraminiferal Diversity Along the Fjords of Svalbard Archipelago: Diversity Evaluation. *Thalassas: An International Journal of Marine Sciences*, *38*(1), 647–664. https://doi.org/10.1007/s41208-021-00356-7

Jorissen, F. J., de Stigter, H. C., & Widmark, J. G. V. (1995). A conceptual model explaining benthic foraminiferal microhabitats. *Marine Micropaleontology*, *26*(1), 3–15. https://doi.org/https://doi.org/10.1016/0377-8398(95)00047-X

Jorissen, F. J., Fontanier, C., & Thomas, E. (2007). Chapter Seven Paleoceanographical Proxies Based on Deep-Sea Benthic Foraminiferal Assemblage Characteristics. In C. Hillaire–Marcel & A. De Vernal (Eds.), *Developments in Marine Geology* (Vol. 1, pp. 263–325). Elsevier. https://doi.org/https://doi.org/10.1016/S1572-5480(07)01012-3

Kaiho, K. (1994). Benthic foraminiferal dissolved-oxygen index and dissolved-oxygen levels in the modern ocean. *Geology*, *22*(8), 719–722. https://doi.org/10.1130/0091-7613(1994)022<0719:Bfdoia>2.3.Co;2

Kaithwar, A., Singh, D. P., & Saraswat, R. (2020). A highly diverse living benthic foraminiferal assemblage in the oxygen deficient zone of the southeastern Arabian Sea. *Biodiversity and Conservation*, *29*(14), 3925–3958. https://doi.org/10.1007/s10531-020-02056-9

Kaminski, M. A. (2014). The year 2010 classification of the agglutinated foraminifera. *Micropaleontology*, *60*(1), 89–108.

Kaminsky, J., Varisco, M., Fernández, M., Sahade, R., & Archambault, P. (2018). Spatial Analysis of Benthic Functional Biodiversity in San Jorge Gulf, Argentina. *Oceanography*, *31*(4), 104–112.

Kearney, M. (2006). Habitat, environment and niche: what are we modelling? *Oikos*, *115*(1), 186–191. https://doi.org/https://doi.org/10.1111/j.2006.0030-1299.14908.x

Kearney, M., Simpson, S. J., Raubenheimer, D., & Helmuth, B. (2010). Modelling the ecological niche from functional traits. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1557), 3469–3483. https://doi.org/10.1098/rstb.2010.0034

Keating-Bitonti, C. R., & Payne, J. L. (2016). Physicochemical controls on biogeographic variation of benthic foraminiferal test size and shape. *Paleobiology*, *42*(4), 595–611. https://doi.org/10.1017/pab.2016.7

Keating-Bitonti, C. R., & Payne, J. L. (2017). Ecophenotypic responses of benthic foraminifera to oxygen availability along an oxygen gradient in the California Borderland. *Marine Ecology*, *38*(3), e12430. https://doi.org/https://doi.org/10.1111/maec.12430

Khare, N., Nigam, R., Mayenkar, D. N., & Saraswat, R. (2017). Cluster analysis of benthic foraminiferal morpho-groups from the western margin of India reflects its depth preference. *Continental Shelf Research*, *151*, 72–83. https://doi.org/https://doi.org/10.1016/j.csr.2017.10.011

Kirkman, S. P., Yemane, D., Kathena, J., Mafwila, S. K., Nsiangango, S. E., Samaai, T., Axelsen, B., & Singh, L. (2013). Identifying and characterizing demersal fish biodiversity hotspots in the Benguela Current Large Marine Ecosystem: relevance in the light of global changes. *ICES Journal of Marine Science*, *70*(5), 943–954. https://doi.org/10.1093/icesjms/fst040

Koho, K. A., & Piña-Ochoa, E. (2012). Benthic Foraminifera: Inhabitants of Low-Oxygen Environments. In *Anoxia* (pp. 249–285). https://doi.org/10.1007/978-94-007-1896-8_14

Krahmann, G. (2012). *Physical oceanography during METEOR cruise M77/1* (PANGAEA. https://doi.org/10.1594/PANGAEA.777978

Krahmann, G. (2018). *Physical oceanography (CTD) during METEOR cruise M77/2* (PANGAEA. https://doi.org/10.1594/PANGAEA.887705

Kranner, M., Harzhauser, M., Beer, C., Auer, G., & Piller, W. E. (2022). Calculating dissolved marine oxygen values based on an enhanced Benthic Foraminifera Oxygen Index. *Scientific Reports*, *12*(1), 1376. https://doi.org/10.1038/s41598-022-05295-8

Kuhnt, T., Friedrich, O., Schmiedl, G., Milker, Y., Mackensen, A., & Lückge, A. (2013). Relationship between pore density in benthic foraminifera and bottom-water oxygen content. *Deep Sea Research Part I: Oceanographic Research Papers*, *76*, 85–95. https://doi.org/https://doi.org/10.1016/j.dsr.2012.11.013

Laliberte, E., & Legendre, P. (2010). A distance-based framework for measuring functional diversity from multiple traits. *Ecology*, *91*(1), 299–305. https://doi.org/10.1890/08-2244.1

Laliberté, E., Legendre, P., Shipley, B., & Laliberté, M. E. (2014). Package 'fd'. *Measuring functional diversity from multiple traits, and other tools for functional ecology*, *1*, 0–12.

Lancellotti, D. A., & Vásquez, J. A. (1999). Biogeographical patterns of benthic macroinvertebrates in the Southeastern Pacific littoral. *Journal of Biogeography*, *26*(5), 1001–1006. https://doi.org/https://doi.org/10.1046/j.1365-2699.1999.00344.x

Laureto, L. M. O., Cianciaruso, M. V., & Samia, D. S. M. (2015). Functional diversity: an overview of its history and applicability. *Natureza & Conservação*, *13*(2), 112–116. https://doi.org/https://doi.org/10.1016/j.ncon.2015.11.001

Legras, G., Loiseau, N., Gaertner, J. C., Poggiale, J. C., & Gaertner-Mazouni, N. (2020). Assessing functional diversity: the influence of the number of the functional traits. *Theoretical Ecology*, *13*(1), 117–126. https://doi.org/10.1007/s12080-019-00433-x

Levin, L., Gutiérrez, D., Rathburn, A., Neira, C., Sellanes, J., Muñoz, P., Gallardo, V., & Salamanca, M. (2002). Benthic processes on the Peru margin: a transect across the oxygen minimum zone during the 1997–98 El Niño. *Progress in Oceanography*, *53*(1), 1–27. https://doi.org/https://doi.org/10.1016/S0079-6611(02)00022-8

Lipps, J. H. (1973). Test Structure in Foraminifera. *Annual Review of Microbiology*, *27*(Volume 27, 1973), 471–486. https://doi.org/https://doi.org/10.1146/annurev.mi.27.100173.002351

Llanillo, P. J., Karstensen, J., Pelegrí, J. L., & Stramma, L. (2013). Physical and biogeochemical forcing of oxygen and nitrate changes during El Niño/El Viejo and La Niña/La Vieja upper-ocean phases in the tropical eastern South Pacific along 86° W. *Biogeosciences*, *10*(10), 6339–6355. https://doi.org/10.5194/bg-10-6339-2013

Loeblich, A. R., & Tappan, H. (1988). *Foraminiferal Genera and Their Classification* (1 ed.). Springer New York, NY. https://doi.org/https://doi.org/10.1007/978-1-4899-5760-3

Loginova, A. N., Dale, A. W., Le Moigne, F. A. C., Thomsen, S., Sommer, S., Clemens, D., Wallmann, K., & Engel, A. (2020). Sediment release of dissolved organic matter to the oxygen minimum zone off Peru. *Biogeosciences*, *17*(18), 4663–4679. https://doi.org/10.5194/bg-17-4663-2020

Loreau, M., Naeem, S., Inchausti, P., Bengtsson, J., Grime, J. P., Hector, A., Hooper, D. U., Huston, M. A., Raffaelli, D., Schmid, B., Tilman, D., & Wardle, D. A. (2001). Biodiversity and Ecosystem Functioning: Current Knowledge and Future Challenges. *Science*, *294*(5543), 804–808. https://doi.org/doi:10.1126/science.1064088

Mackensen, A. (2008). On the use of benthic foraminiferal δ13C in palaeoceanography: constraints from primary proxy relationships. In W. E. N. Austin & R. H. James (Eds.), *Biogeochemical Controls on Palaeoceanographic Environmental Proxies* (Vol. 303, pp. 0). Geological Society of London. https://doi.org/10.1144/sp303.9

Mallon, J. (2011). *Benthic Foraminifera of the Peruvian & Ecuadorian Continental Margin* [Doctoral thesis, Christian-Albrechts-Universität]. https://oceanrep.geomar.de/id/eprint/19949/

Mallon, J., Glock, N., & Schönfeld, J. (2011). *Distribution of living benthic foraminifera in sediment cores of cruise M77 Leg 1 and 2, 63-2000 µm fraction* (PANGAEA. https://doi.org/10.1594/PANGAEA.757092

Mallon, J., Glock, N., & Schönfeld, J. (2012). The Response of Benthic Foraminifera to Low-Oxygen Conditions of the Peruvian Oxygen Minimum Zone. In (Vol. 21, pp. 305–321). https://doi.org/10.1007/978-94-007-1896-8_16

Manasa, M., Saraswat, R., & Nigam, R. (2016). Assessing the suitability of benthic foraminiferal morpho-groups to reconstruct paleomonsoon from Bay of Bengal. *Journal of Earth System Science*, *125*(3), 571–584. https://doi.org/10.1007/s12040-016-0677-y

Mason, N. W. H., de Bello, F., Mouillot, D., Pavoine, S., Dray, S., & Zobel, M. (2013). A guide for using functional diversity indices to reveal changes in assembly processes along ecological gradients. *Journal of Vegetation Science*, *24*(5), 794–806. https://doi.org/10.1111/jvs.12013

Mason, N. W. H., MacGillivray, K., Steel, J. B., & Wilson, J. B. (2003). An index of functional diversity. *Journal of Vegetation Science*, *14*(4), 571–578. https://doi.org/10.1111/j.1654-1103.2003.tb02184.x

Mason, N. W. H., Mouillot, D., Lee, W. G., & Wilson, J. B. (2005). Functional richness, functional evenness and functional divergence: the primary components of functional diversity. *Oikos*, *111*(1), 112–118. https://doi.org/https://doi.org/10.1111/j.0030-1299.2005.13886.x

Mayor Pastor, S. (1998). Foraminíferos calcáreos bénticos de la plataforma continental del norte peruano. *Informe del Instituto del Mar del Perú*, (136), 161–176.

Mazumder, A., & Nigam, R. (2014). Bathymetric preference of four major genera of rectilinear benthic foraminifera within oxygen minimum zone in Arabian Sea off central west coast of India. *Journal of Earth System Science*, *123*(3), 633–639. https://doi.org/10.1007/s12040-014-0419-y

McCorkle, D. C., Keigwin, L. D., Corliss, B. H., & Emerson, S. R. (1990). The influence of microhabitats on the carbon isotopic composition of deep-sea benthic foraminifera. *Paleoceanography*, *5*(2), 161–185. https://doi.org/https://doi.org/10.1029/PA005i002p00161

Meilijson, A., Ashckenazi-Polivoda, S., Illner, P., Alsenz, H., Speijer, R. P., Almogi-Labin, A., Feinstein, S., Püttmann, W., & Abramovich, S. (2015). Evidence for specific adaptations of fossil benthic foraminifera to anoxic–dysoxic environments. *Paleobiology*, *42*(1), 77–97. https://doi.org/10.1017/pab.2015.31

Merma-Mora, L. (2016). *Foraminíferos bentónicos asociados a condiciones de hipoxia costera y bajo ph en la Bahía de Paracas* Universidad Peruana Cayetano Heredia]. https://hdl.handle.net/20.500.12866/240

Merma-Mora, L. (2020). *Estructura comunitaria de foraminíferos bentónicos en relación a factores ambientales en sedimentos marinos someros de la costa central del Perú* Universidad Nacional Agraria La Molina]. Lima, Perú.

Miljutin, D. M., Miljutina, M. A., Mokievsky, V. O., & Tchesunov, A. V. (2012). Benthic meiofaunal density and community composition in the deep White Sea and their temporal variations. *Polar Biology*, *35*(12), 1837–1850. https://doi.org/10.1007/s00300-012-1226-z

Milker, Y., Schmiedl, G., Betzler, C., Römer, M., Jaramillo-Vogel, D., & Siccha, M. (2009). Distribution of recent benthic foraminifera in shelf carbonate environments of the Western Mediterranean Sea. *Marine Micropaleontology*, *73*(3), 207–225. https://doi.org/https://doi.org/10.1016/j.marmicro.2009.10.003

Miloslavich, P., Klein, E., Díaz, J. M., Hernández, C. E., Bigatti, G., Campos, L., Artigas, F., Castillo, J., Penchaszadeh, P. E., Neill, P. E., Carranza, A., Retana, M. V., Díaz de Astarloa, J. M., Lewis, M., Yorio, P., Piriz, M. L., Rodríguez, D., Yoneshigue-Valentin, Y., Gamboa, L., & Martín, A. (2011). Marine Biodiversity in the Atlantic and Pacific Coasts of South America: Knowledge and Gaps. *PLoS One*, *6*(1), e14631. https://doi.org/10.1371/journal.pone.0014631

Mohtadi, M., & Hebbeln, D. (2004). Mechanisms and variations of the paleoproductivity off northern Chile (24°S–33°S) during the last 40,000 years. *Paleoceanography*, *19*(2). https://doi.org/https://doi.org/10.1029/2004PA001003

Mohtadi, M., Hebbeln, D., & Marchant, M. (2005). Upwelling and productivity along the Peru–Chile Current derived from faunal and isotopic compositions of planktic foraminifera in surface sediments. *Marine Geology*, *216*(3), 107–126. https://doi.org/https://doi.org/10.1016/j.margeo.2005.01.008

Mojtahid, M., Griveaud, C., Fontanier, C., Anschutz, P., & Jorissen, F. J. (2010). Live benthic foraminiferal faunas along a bathymetrical transect (140–4800 m) in the Bay of Biscay (NE Atlantic). *Revue de Micropaléontologie*, *53*(3), 139–162. https://doi.org/10.1016/j.revmic.2010.01.002

Mollier-Vogel, E., Ryabenko, E., Martinez, P., Wallace, D. W. R., Altabet, M. A., & Schneider, R. R. (2012). *Nitrogen and carbon concentrations and isotopic ratios off Peru and Ecuador surface sediments* (PANGAEA. https://doi.org/10.1594/PANGAEA.801886

Montecino, V., & Lange, C. B. (2009). The Humboldt Current System: Ecosystem components and processes, fisheries, and sediment studies. *Progress in Oceanography*, *83*(1-4), 65–79. https://doi.org/10.1016/j.pocean.2009.07.041

Montes, I., Colas, F., Capet, X., & Schneider, W. (2010). On the pathways of the equatorial subsurface currents in the eastern equatorial Pacific and their contributions to the Peru-Chile Undercurrent. *Journal of Geophysical Research: Oceans*, *115*(C9). https://doi.org/https://doi.org/10.1029/2009JC005710

Moodley, L., Boschker, H. T. S., Middelburg, J. J., Pel, R., Herman, P. M. J., Deckere, E., & Heip, C. H. R. (2000). Ecological significance of benthic foraminifera: 13C labelling experiments. *Marine Ecology Progress Series*, *202*, 289–295.

Morales, C. E., Blanco, J. L., Braun, M., Reyes, H., & Silva, N. (1996). Chlorophyll-a distribution and associated oceanographic conditions in the upwelling region off northern Chile during the winter and spring 1993. *Deep Sea Research Part I:*

Oceanographic Research Papers, *43*(3), 267–289. https://doi.org/https://doi.org/10.1016/0967-0637(96)00015-5

Mouillot, D., Bellwood, D. R., Baraloto, C., Chave, J., Galzin, R., Harmelin-Vivien, M., Kulbicki, M., Lavergne, S., Lavorel, S., Mouquet, N., Paine, C. E., Renaud, J., & Thuiller, W. (2013). Rare species support vulnerable functions in high-diversity ecosystems. *PLoS Biol*, *11*(5), e1001569. https://doi.org/10.1371/journal.pbio.1001569

Mouillot, D., Graham, N. A., Villeger, S., Mason, N. W., & Bellwood, D. R. (2013). A functional approach reveals community responses to disturbances. *Trends Ecol Evol*, *28*(3), 167–177. https://doi.org/10.1016/j.tree.2012.10.004

Murray, J. W. (2001). The niche of benthic foraminifera, critical thresholds and proxies. *Marine Micropaleontology*, *41*(1), 1–7. https://doi.org/https://doi.org/10.1016/S0377-8398(00)00057-8

Murray, J. W. (2006). *Ecology and Applications of Benthic Foraminifera*. Cambridge University Press. https://doi.org/DOI: 10.1017/CBO9780511535529

Murray, J. W. (2007). Biodiversity of living benthic foraminifera: How many species are there? *Marine Micropaleontology*, *64*(3), 163–176. https://doi.org/https://doi.org/10.1016/j.marmicro.2007.04.002

Murray, J. W., Alve, E., & Jones, B. W. (2011). A new look at modern agglutinated benthic foraminiferal morphogroups: their value in palaeoecological interpretation. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *309*(3-4), 229–241. https://doi.org/10.1016/j.palaeo.2011.06.006

Murray, J. W., & Bowser, S. S. (2000). MORTALITY, PROTOPLASM DECAY RATE, AND RELIABILITY OF STAINING TECHNIQUES TO RECOGNIZE 'LIVING' FORAMINIFERA: A REVIEW. *Journal of Foraminiferal Research*, *30*(1), 66–70. https://doi.org/10.2113/0300066

Mutschke, E., Gerdes, D., & Ríos, C. (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*(S1), S60–S72–S60–S72.

Nait-Hammou, H., El Khalidi, K., Makaoui, A., Chierici, M., Jamal, C., Mejjad, N., Khalfaoui, O., Salhi, F., Idrissi, M., & Zourarah, B. (2025). Environmental Factors Driving Carbonate Distribution in Marine Sediments in the Canary Current Upwelling System. *Journal of Marine Science and Engineering*, *13*(9), 1709.

Narciso-Mezones, A., Merma-Mora, L., Córdova-Rodríguez, K., Rocca, C., Carré, M., Romero, P. E., Salas, R., Pérez, A., Cruz-Acevedo, E., Ochoa, D., & Cardich, J. (2025). Foraminiferal assemblages and organic matter relationships in a coastal lagoon on the arid coast of the Southeast Pacific. *Marine Ecology Progress Series*, *754*, 17–33.

Neagu, T. (1968). Biostratigraphy of Upper Cretaceous Deposits in the Southern Eastern Carpathians near Braşov. *Micropaleontology*, *14*(2), 225–241. https://doi.org/10.2307/1484736

Neira, C., Sellanes, J., Levin, L. A., & Arntz, W. E. (2001). Meiofaunal distributions on the Peru margin:: relationship to oxygen and organic matter availability. *Deep Sea Research Part I: Oceanographic Research Papers*, *48*(11), 2453–2472. https://doi.org/https://doi.org/10.1016/S0967-0637(01)00018-8

Nomaki, H., Heinz, P., Nakatsuka, T., Shimanaga, M., Ohkouchi, N., Ogawa, N. O., Kogure, K., Ikemoto, E., & Kitazato, H. (2006). Different ingestion patterns of 13C-labeled bacteria and algae by deep-sea benthic foraminifera. *Marine Ecology Progress Series*, *310*, 95–108.

Nomaki, H., Ogawa, N. O., Ohkouchi, N., Suga, H., Toyofuku, T., Shimanaga, M., Nakatsuka, T., & Kitazato, H. (2008). Benthic foraminifera as trophic links between phytodetritus and benthic metazoans: carbon and nitrogen isotopic evidence. *Marine Ecology Progress Series*, *357*, 153–164. https://doi.org/10.3354/meps07309

Noucoucouk, A. A., Silva, M. R., Melo, R. M., Maia, R. J. A., Bergue, C. T., & Piovesan, E. K. (2023). Paleoenvironmental significance of Benthic Foraminifera and Ostracoda from the late Quaternary of the Ceará Basin, Brazilian Equatorial Margin. *Brazilian Journal of Geology*, *53*.

Owens, H. L., & Rahbek, C. (2025). Depth Matters for Marine Biodiversity. *Journal of Biogeography*, *52*(12), e70080. https://doi.org/https://doi.org/10.1111/jbi.70080

Palacio, F. X., Callaghan, C. T., Cardoso, P., Hudgins, E. J., Jarzyna, M. A., Ottaviani, G., Riva, F., Graco-Roza, C., Shirey, V., & Mammola, S. (2022). A protocol for reproducible functional diversity analyses. *Ecography*, *2022*(11), e06287. https://doi.org/https://doi.org/10.1111/ecog.06287

Palma, M., Quiroga, E., Gallardo, V. A., Arntz, W., Gerdes, D., Schneider, W., & Hebbeln, D. (2005). Macrobenthic animal assemblages of the continental margin off Chile (22° to 42°S). *Journal of the Marine Biological Association of the United Kingdom*, *85*(2), 233–245. https://doi.org/10.1017/S0025315405011112h

Palmer, H. M., Hill, T. M., Roopnarine, P. D., Myhre, S. E., Reyes, K. R., & Donnenfield, J. T. (2020). Southern California margin benthic foraminiferal assemblages record recent centennial-scale changes in oxygen minimum zone. *Biogeosciences*, *17*(11), 2923–2937. https://doi.org/10.5194/bg-17-2923-2020

Patarroyo, G. D., & Martinez, J. I. (2021). Composition and diversity patterns of deep sea benthic foraminifera from the Panama basin, eastern equatorial Pacific. *Deep Sea Research Part I: Oceanographic Research Papers*, *169*. https://doi.org/10.1016/j.dsr.2021.103470

Patterson, R. T., & Burbidge, S. M. (1995). New Late Oligocene to Pleistocene hyaline calcareous unilocular foraminifera from DSDP site 357 (Leg 39) on the Rio Grande Rise, southwest Atlantic Ocean. *Journal of Paleontology*, *69*(4), 635–655. https://doi.org/10.1017/S0022336000035174

Patterson, R. T., & Pettis, R. H. (1986). Galwayella, a new foraminiferal genus and new names for two foraminiferal homonyms. *Journal of Foraminiferal Research*, *16*(1), 74–75. https://doi.org/10.2113/gsjfr.16.1.74

Petchey, O. L., & Gaston, K. J. (2002). Functional diversity (FD), species richness and community composition. *Ecology Letters*, *5*(3), 402–411. https://doi.org/10.1046/j.1461-0248.2002.00339.x

Petchey, O. L., & Gaston, K. J. (2006). Functional diversity: back to basics and looking forward. *Ecol Lett*, *9*(6), 741–758. https://doi.org/10.1111/j.1461-0248.2006.00924.x

Piacenza, S. E., Barner, A. K., Benkwitt, C. E., Boersma, K. S., Cerny-Chipman, E. B., Ingeman, K. E., Kindinger, T. L., Lee, J. D., Lindsley, A. J., Reimer, J. N., Rowe, J.

C., Shen, C., Thompson, K. A., Thurman, L. L., & Heppell, S. S. (2015). Patterns and Variation in Benthic Biodiversity in a Large Marine Ecosystem. *PLoS One*, *10*(8), e0135135. https://doi.org/10.1371/journal.pone.0135135

Piña-Ochoa, E., Høgslund, S., Geslin, E., Cedhagen, T., Revsbech, N. P., Nielsen, L. P., Schweizer, M., Jorissen, F., Rysgaard, S., & Risgaard-Petersen, N. (2010). Widespread occurrence of nitrate storage and denitrification among Foraminifera and <i>Gromiida</i>. *Proceedings of the National Academy of Sciences*, *107*(3), 1148–1153. https://doi.org/doi:10.1073/pnas.0908440107

Popova, E., Yool, A., Byfield, V., Cochrane, K., Coward, A. C., Salim, S. S., Gasalla, M. A., Henson, S. A., Hobday, A. J., Pecl, G. T., Sauer, W. H., & Roberts, M. J. (2016). From global to regional and back again: common climate stressors of marine ecosystems relevant for adaptation across five ocean warming hotspots. *Global Change Biology*, *22*(6), 2038–2053. https://doi.org/https://doi.org/10.1111/gcb.13247

Prahl, F. G., Mix, A. C., & Sparrow, M. A. (2006). Alkenone paleothermometry: Biological lessons from marine sediment records off western South America. *Geochimica et Cosmochimica Acta*, *70*(1), 101–117. https://doi.org/https://doi.org/10.1016/j.gca.2005.08.023

Qi, Q., He, C., Liu, X., Wang, F., Zhang, Z., Feng, K., & Lai, H. (2025). Spatial niche differentiation and key driving factors of dominant benthic macroinvertebrates in Qinhuangdao City, China. *Scientific Reports*, *15*(1), 24072. https://doi.org/10.1038/s41598-025-09965-1

Ramírez, F., Afán, I., Davis, L. S., & Chiaradia, A. (2017). Climate impacts on global hot spots of marine biodiversity. *Science Advances*, *3*(2), e1601198. https://doi.org/doi:10.1126/sciadv.1601198

Rathburn, A. E., & Corliss, B. H. (1994). The ecology of living (stained) deep-sea benthic foraminifera from the Sulu Sea. *Paleoceanography*, *9*(1), 87–150. https://doi.org/https://doi.org/10.1029/93PA02327

Rathburn, A. E., Willingham, J., Ziebis, W., Burkett, A. M., & Corliss, B. H. (2018). A New biological proxy for deep-sea paleo-oxygen: Pores of epifaunal benthic foraminifera. *Scientific Reports*, *8*(1), 9456. https://doi.org/10.1038/s41598-018-27793-4

Reolid, M., & Martínez-Ruiz, F. (2013). Comparison of benthic foraminifera and geochemical proxies in shelf deposits from the Upper Jurassic of the Prebetic (southern Spain). *Journal of Iberian Geology*, *38*(2). https://doi.org/10.5209/rev_JIGE.2012.v38.n2.40468

Reolid, M., Nagy, J., Rodríguez-Tovar, F. J., & Olóriz, F. (2008). Foraminiferal Assemblages as Palaeoenvironmental Bioindicators in Late Jurassic Epicontinental Platforms: Relation with Trophic Conditions. *Acta Palaeontologica Polonica*, *53*(4), 705–722, 718.

Resig, J. M. (1981). Biogeography of benthic foraminifera of the northern Nazca plate and adjacent continental margin. In L. V. D. Kulm, J. Dymond, E. J. Dasch, D. M. Hussong, & R. Roderick (Eds.), *Nazca Plate: Crustal Formation and Andean Convergence* (pp. 0). Geological Society of America. https://doi.org/10.1130/MEM154-p619

Reyes-Macaya, D., Santamarina, P., & Troncoso, R. (2024). *BOT, a code to calculate bottom water hydrological parameters: a case in the Southeast and East Equatorial Pacific (v1.0.0) [Data set]* (Version 1.0.0) Zenodo. https://doi.org/https://doi.org/10.5281/zenodo.13362423

Reyes-Macaya, D., Hoogakker, B., Martínez-Méndez, G., Llanillo, P. J., Grasse, P., Mohtadi, M., Mix, A., Leng, M. J., Struck, U., McCorkle, D. C., Troncoso, M., Gayo, E. M., Lange, C. B., Farias, L., Carhuapoma, W., Graco, M., Cornejo-D'Ottone, M., De Pol Holz, R., Fernandez, C.,…Hebbeln, D. (2022). Isotopic Characterization of Water Masses in the Southeast Pacific Region: Paleoceanographic Implications. *Journal of Geophysical Research: Oceans*, *127*(1). https://doi.org/10.1029/2021jc017525

Richirt, J., Champmartin, S., Schweizer, M., Mouret, A., Petersen, J., Ambari, A., & Jorissen, F. J. (2019). Scaling laws explain foraminiferal pore patterns. *Scientific Reports*, *9*(1), 9149. https://doi.org/10.1038/s41598-019-45617-x

Rombouts, I., Beaugrand, G., & Dauvin, J.-C. (2012). Potential changes in benthic macrofaunal distributions from the English Channel simulated under climate change scenarios. *Estuarine, Coastal and Shelf Science*, *99*, 153–161. https://doi.org/https://doi.org/10.1016/j.ecss.2011.12.026

Romero, D., Merma-Mora, L., Marquina, R., Flores, G., Quipúzcoa, L., Solís, J., & Cardich, J. (2023). Living benthic foraminifera from El Ferrol Bay: A pollution critical area in northern-central Peru. *Revista Peruana de Biología*, *30*.

Romero, O., & Hebbeln, D. (2003). Biogenic silica and diatom thanatocoenosis in surface sediments below the Peru–Chile Current: controlling mechanisms and relationship with productivity of surface waters. *Marine Micropaleontology*, *48*(1), 71–90. https://doi.org/https://doi.org/10.1016/S0377-8398(02)00161-5

Rosales Quintana, G. M., Marsh, R., & Icochea Salas, L. A. (2021). Interannual variability in contributions of the Equatorial Undercurrent (EUC) to Peruvian upwelling source water. *Ocean Sci.*, *17*(5), 1385–1402. https://doi.org/10.5194/os-17-1385-2021

S, N. S., & Neshyba, S. (1979). On the southernmost extension of the Peru-Chile undercurrent. *Deep Sea Research Part A. Oceanographic Research Papers*, *26*(12), 1387–1393. https://doi.org/https://doi.org/10.1016/0198-0149(79)90006-2

S. dos S. de Jesus, M., Frontalini, F., Bouchet, V. M. P., Yamashita, C., Sartoretto, J. R., Figueira, R. C. L., & de Mello e Sousa, S. H. (2020). Reconstruction of the palaeo-ecological quality status in an impacted estuary using benthic foraminifera: The Santos Estuary (São Paulo state, SE Brazil). *Marine Environmental Research*, *162*, 105121. https://doi.org/https://doi.org/10.1016/j.marenvres.2020.105121

Saalim, S. M., Saraswat, R., Suokhrie, T., & Nigam, R. (2019). Assessing the ecological preferences of agglutinated benthic foraminiferal morphogroups from the western Bay of Bengal. *Deep Sea Research Part II: Topical Studies in Oceanography*, *161*, 38–51. https://doi.org/10.1016/j.dsr2.2018.02.002

Saavedra-Pellitero, M., Baumann, K. H., Hernández-Almeida, I., Flores, J. A., & Sierro, F. J. (2013). Modern sea surface productivity and temperature estimations off Chile as detected by coccolith accumulation rates. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *392*, 534–545. https://doi.org/https://doi.org/10.1016/j.palaeo.2013.10.010

Sakko, A. L. (1998). The influence of the Benguela upwelling system on Namibia's marine biodiversity. *Biodiversity & Conservation*, *7*(4), 419–433. https://doi.org/10.1023/A:1008867310010

Schönfeld, J. (2002). Recent benthic foraminiferal assemblages in deep high-energy environments from the Gulf of Cadiz (Spain). *Marine Micropaleontology*, *44*(3), 141–162. https://doi.org/https://doi.org/10.1016/S0377-8398(01)00039-1

Schönfeld, J., Alve, E., Geslin, E., Jorissen, F., Korsun, S., & Spezzaferri, S. (2012). The FOBIMO (FOraminiferal BIo-MOnitoring) initiative—Towards a standardised protocol for soft-bottom benthic foraminiferal monitoring studies. *Marine Micropaleontology*, *94-95*, 1–13. https://doi.org/https://doi.org/10.1016/j.marmicro.2012.06.001

Schumacher, S., Jorissen, F. J., Dissard, D., Larkin, K. E., & Gooday, A. J. (2007). Live (Rose Bengal stained) and dead benthic foraminifera from the oxygen minimum zone of the Pakistan continental margin (Arabian Sea). *Marine Micropaleontology*, *62*(1), 45–73. https://doi.org/https://doi.org/10.1016/j.marmicro.2006.07.004

Scott, D. B., Tobin, R., Williamson, M., Medioli, F. S., Latimer, J. S., Boothman, W. A., Asioli, A., & Haury, V. (2005). POLLUTION MONITORING IN TWO NORTH AMERICAN ESTUARIES: HISTORICAL RECONSTRUCTIONS USING BENTHIC FORAMINIFERA. *Journal of Foraminiferal Research*, *35*(1), 65–82. https://doi.org/10.2113/35.1.65

Sellanes, J., Neira, C., Quiroga, E., & Teixido, N. (2010). Diversity patterns along and across the Chilean margin: a continental slope encompassing oxygen gradients and methane seep benthic habitats. *Marine Ecology*, *31*(1), 111–124. https://doi.org/10.1111/j.1439-0485.2009.00332.x

Sen Gupta, B. K. (2002). *Modern foraminifera* (1 ed.). Springer. https://doi.org/10.1007/0-306-48104-9

Silva, C. P. d. (2011). *Bioestratigrafia e paleoecologia de foraminíferos da Bacia de Barreirinhas, cretácio, margem equatorial brasileira* Universidade Federal do Rio Grande do Sul. Instituto de Geociências]. http://hdl.handle.net/10183/38528

Silva, N., Rojas, N., & Fedele, A. (2009). Water masses in the Humboldt Current System: Properties, distribution, and the nitrate deficit as a chemical water mass tracer for Equatorial Subsurface Water off Chile. *Deep Sea Research Part II: Topical Studies in Oceanography*, *56*(16), 1004–1020. https://doi.org/10.1016/j.dsr2.2008.12.013

Singh, D. P., Saraswat, R., & Pawar, R. (2022). Distinct environmental parameters influence the abundance of living benthic foraminifera morphogroups in the southeastern Arabian Sea. *Environmental Science and Pollution Research*, *29*(54), 82541–82558. https://doi.org/10.1007/s11356-022-21492-4

Singh, R. K., Gupta, A. K., & Das, M. (2012). Paleoceanographic significance of deep-sea benthic foraminiferal species diversity at southeastern Indian Ocean Hole 752A during the Neogene. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *361-362*, 94–103. https://doi.org/https://doi.org/10.1016/j.palaeo.2012.08.008

Sommer, S., & Dale, A. W. (2019). *Particulate geochemistry of sediment core M77/2_047-3* (PANGAEA. https://doi.org/10.1594/PANGAEA.909563

Soto, E., Quiroga, E., Ganga, B., & Alarcón, G. (2017). Influence of organic matter inputs and grain size on soft-bottom macrobenthic biodiversity in the upwelling ecosystem of central Chile. *Marine Biodiversity*, *47*(2), 433–450. https://doi.org/10.1007/s12526-016-0479-0

Strub, P. T., Mesias, J. M., Montecino, V., Rutllant, J., & Salinas, S. (1998). Coastal ocean circulation off western South America. In A. R. Robinson & K. H. Brink (Eds.), *The Sea* (Vol. 11, pp. 273–313). John Wiley & Sons.

Susaya-Vicente, K., Farias, L., Garrido, S., Kinniburgh, K., Troncoso, R., Santamarina, P., & Reyes-Macaya, D. A. (2025). *A Hydrographic Dataset for Computing Bottom Water Parameters in the Southeast and East Equatorial Pacific [Data set]* (Zenodo. https://doi.org/10.5281/zenodo.17353475

Talley, L. D., Pickard, G. L., Emery, W. J., & Swift, J. H. (2011). Chapter 3 - Physical Properties of Seawater. In L. D. Talley, G. L. Pickard, W. J. Emery, & J. H. Swift (Eds.), *Descriptive Physical Oceanography (Sixth Edition)* (pp. 29–65). Academic Press. https://doi.org/https://doi.org/10.1016/B978-0-7506-4552-2.10003-4

Tapia, R., Lange, C. B., & Marchant, M. (2008). Living (stained) calcareous benthic foraminifera from recent sediments off Concepción, central-southern Chile (~36º S). *Revista Chilena de Historia Natural*, *81*(3), 403–416. (IN FILE)

Tarazona, J., & Arntz, W. (2001). The Peruvian Coastal Upwelling System. In U. Seeliger & B. Kjerfve (Eds.), *Coastal Marine Ecosystems of Latin America* (pp. 229–244). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-662-04482-7_17

Tarazona, J., Gutiérrez, D., Paredes, C., & Indacochea, A. (2003). Overview and challenges of marine biodiversity research in Peru una revision y desafios Para la investigacion en biodiversidad marina en Peru. *Gayana*, *67*(2), 206–231.

Tasso, V., El Haddad, M., Assadi, C., Canales, R., Aguirre, L., & Vélez-Zuazo, X. (2018). Macrobenthic fauna from an upwelling coastal area of Peru (Warm Temperate South-eastern Pacific province -Humboldtian ecoregion). *Biodivers Data J*(6), e28937. https://doi.org/10.3897/BDJ.6.e28937

Tavera Martínez, L., Marchant, M., Díaz, R. T. A., Arrojo, M. Á., & Muñoz, P. (2023). Benthic Foraminifera as Pollution Biomarkers: a Morphological Approach. *Microbial Ecology*, *86*(4), 2802–2818. https://doi.org/10.1007/s00248-023-02282-y

Tavera Martínez, L., Marchant, M., Muñoz, P., & Abdala Díaz, R. T. (2022). Spatial and Vertical Benthic Foraminifera Diversity in the Oxygen Minimum Zone of Mejillones Bay, Northern Chile [Original Research]. *Frontiers in Marine Science*, *Volume 9 - 2022*. https://doi.org/10.3389/fmars.2022.821564

Tetard, M., Prebble, J. G., & Cortese, G. (2024). Dissolved oxygen affinities of hundreds of benthic foraminiferal species. *Marine Micropaleontology*, *190*, 102380. https://doi.org/https://doi.org/10.1016/j.marmicro.2024.102380

Thiel, M., Macaya, E., Acuña, E., Arntz, W., Bastias, H., Brokordt, K., Camus, P., Castilla, J., Castro, L., & Cortés, M. (2007). The Humboldt Current System of Northern and Central Chile: oceanographic processes, ecological interactions and socioeconomic feedback. *Oceanography and Marine Biology: An Annual Review*.

Thiel, M. M., E.C.; Acuña, E.; Arntz, W.E.; Bastias, H.; Brokordt, K.; Camus, P.A.; Castilla, J.C.; Castro, L.R.; Cortés, M.; Dumont, C.P.; Escribano, R.; Fernandez, M.; Gajardo, J.A.; Gaymer, C.F.; Gomez, I.; González, A.E.; González, H.E.; Haye, P.A.; Illanes, J.-E.; Iriarte, J.L.; Lancellotti, D.A.; Luna-Jorquera, G.; Luxoro, C.; Manriquez, P.H.; Marín, V.; Muñoz, P.; Navarrete, S.A.; Perez, E.; Poulin, E.;

Sellanes, J.; Sepúlveda, H.H.; Stotz, W.; Tala, F.; Thomas, A.; Vargas, C.A.; Vasquez, J.A.; Vega, J.M. (2007). The Humboldt Current System of Northern and Central Chile: Oceanographic processes, ecological interactions and socioeconomic feedback. *Oceanography and Marine Biology: An Annual Review*, 195–344.

Tilman, D., Knops, J., Wedin, D., Reich, P., Ritchie, M., & Siemann, E. (1997). The Influence of Functional Diversity and Composition on Ecosystem Processes. *Science*, *277*(5330), 1300–1302. https://doi.org/doi:10.1126/science.277.5330.1300

Tittensor, D. P., Mora, C., Jetz, W., Lotze, H. K., Ricard, D., Berghe, E. V., & Worm, B. (2010). Global patterns and predictors of marine biodiversity across taxa. *Nature*, *466*(7310), 1098–1101. https://doi.org/10.1038/nature09329

Valdés, L., & Moral, M. (1998). Time-series analysis of copepod diversity and species richness in the southern Bay of Biscay off Santander, Spain, in relation to environmental conditions. *ICES Journal of Marine Science*, *55*(4), 783–792. https://doi.org/10.1006/jmsc.1998.0386

Venturelli, R. A., Rathburn, A. E., Burkett, A. M., & Ziebis, W. (2018). Epifaunal Foraminifera in an Infaunal World: Insights Into the Influence of Heterogeneity on the Benthic Ecology of Oxygen-Poor, Deep-Sea Habitats. *Frontiers in Marine Science*, *5*. https://doi.org/10.3389/fmars.2018.00344

Villeger, S., Mason, N. W., & Mouillot, D. (2008). New multidimensional functional diversity indices for a multifaceted framework in functional ecology. *Ecology*, *89*(8), 2290–2301. https://doi.org/10.1890/07-1206.1

Violle, C., Navas, M.-L., Vile, D., Kazakou, E., Fortunel, C., Hummel, I., & Garnier, E. (2007). Let the concept of trait be functional! *Oikos*, *116*(5), 882–892. https://doi.org/https://doi.org/10.1111/j.0030-1299.2007.15559.x

Wagner, D., Friedlander, A. M., Pyle, R. L., Brooks, C. M., Gjerde, K. M., & Wilhelm, T. A. (2020). Coral Reefs of the High Seas: Hidden Biodiversity Hotspots in Need of Protection [Original Research]. *Frontiers in Marine Science*, *Volume 7 - 2020*. https://doi.org/10.3389/fmars.2020.567428

Waśkowska, A. (2021). Agglutinated Foraminiferal Acmes and Their Role in the Biostratigraphy of the Campanian–Eocene Outer Carpathians. *Geosciences*, *11*(9), 367.

Weigel, B., Blenckner, T., & Bonsdorff, E. (2016). Maintained functional diversity in benthic communities in spite of diverging functional identities. *Oikos*, *125*(10), 1421–1433. https://doi.org/10.1111/oik.02894

Williams, G. A. (1993). Seasonal variation in algal species richness and abundance in the presence of molluscan herbivores on a tropical rocky shore. *Journal of Experimental Marine Biology and Ecology*, *167*(2), 261–275. https://doi.org/https://doi.org/10.1016/0022-0981(93)90034-L

Włodarska-Kowalczuk, M., Aune, M., Michel, L. N., Zaborska, A., & Legeżyńska, J. (2019). Is the trophic diversity of marine benthic consumers decoupled from taxonomic and functional trait diversity? Isotopic niches of Arctic communities. *Limnology and Oceanography*, *64*(5), 2140–2151. https://doi.org/https://doi.org/10.1002/lno.11174

Wood, S., & Wood, M. S. (2015). Package ‘mgcv’. *R package version*, *1*(29), 729.

Xie, C., Ma, J., Yao, H., Wang, J., & Zhou, Q. (2025). Effects of environmental heterogeneity on fish biodiversity and ecosystem functioning (BEF) relationships in the Yangtze River, China. *Ecological Processes*, *14*(1). https://doi.org/10.1186/s13717-025-00632-x

Yanko, V., Kronfeld, J., & Flexer, A. (1994). Response of benthic foraminifera to various pollution sources: implications for pollution monitoring. *Journal of Foraminiferal Research*, *24*(1), 1–17.

Ysebaert, T., & Herman, P. M. J. (2002). Spatial and temporal variation in benthic macrofauna and relationships with environmental variables in an estuarine, intertidal soft-sediment environment. *Marine Ecology Progress Series*, *244*, 105–124.

Zapata, J., Zapata, C., & Gutierrez, A. (1995). FORAMINIFEROS BENTONICOS RECIENTES DEL SUR DE CHILE. *Gayana Zoologîa*, *53*(1), 23–40.

Zettler, M. L., Bochert, R., & Pollehne, F. (2013). Macrozoobenthic biodiversity patterns in the northern province of the Benguela upwelling system. *African Journal of Marine Science*, *35*(2), 283–290. https://doi.org/10.2989/1814232X.2013.798592

Zuta, S., & Guillen, O. (1970). Oceanografía de las aguas costeras de Perú. *Boletin Instituto del Mar del Perú*, *2*(5), 157–324.

APPENDIXES.

Appendix 1. Geochemistry sediment dataset from M77, SO156 and RR9702A cruise in the Southeastern Pacific. The data for the M77 cruise was obtained from Mollier-Vogel et al. (2012) and Sommer et al. (2019). Data for the RR9702A cruise was obtained from Prahl et al. (2006). Data for the SO156 cruise was obtained from Romero & Hebbeln (2003).

*Note about total nitrogen and total carbon are the mean of the data from Mollier-Vogel et al (2012) and Sommer et al. (2019)

ID	**Cruise**	**Station**	**Long**	**Lat**	**Depth (m)**	**Total Organic Carbon [wt%]**	**Nitrogen Total [wt%]**	**CaCO3 [wt%]**	**C/N ratio**	**Opal [wt%]**	**δ15N bulk [per mil]**
Site_1_207	M77/2	772	-81.12	-1.95	207	1	0.12	9.63	8.71	2.98	4.62
Site_1_526	M77/2	767	-82.62	-1.75	526	2.92	0.33	9.84	10.09	2.97	4.81
Site_1_2092	M77/2	776	-81.20	-1.89	2092	1.70	0.22	41.59	8.36	8.23	4.74
Site_3_350	M77/2	744	-81.12	-3.75	350	2.99	0.36	6.86	9.42	3.12	4.78
Site_3_700	M77/2	757	-81.26	-3.85	700	3.31	0.40	6.34	9.34	3.27	4.4
Site_3_995	M77/2	753	-81.32	-3.95	995	3.27	0.36	-	9.26	7.02	4.27
Site_7_359	M77/2	716	-80.34	-8.00	359	9.70	1.25	11.72	-	-	-
Site_7_627	M77/2	723	-80.52	-7.87	627	4.91	0.58	18.32	8.91	3.64	4.5
Site_9_115	M77/2	694	-79.45	-9.05	115	1.57	0.16	25.66	11.11	2.61	5.27
Site_9_437	M77/2	692	-79.28	-9.28	437	8.45	0.77	15.59	10.43	3.53	4.53
Site_9_1105	M77/2	684	-79.90	-9.29	1105	5.27	0.61	19.56	8.34	4.55	4.45
Site_10_521	M77/1	553	-78.90	-10.44	521	4.16	0.41	-	10.2	1.21	6.83
Site_10_1004	M77/1	549	-78.52	-11.00	1004	-	-	-	-	-	-
Site_10_1923	M77/2	669	-78.77	-10.89	1923	2.98	0.36	6.83	8.26	3.55	5.04
Site_11_79	M77/1	540	-77.79	-11.00	79	3.26	0.5	-	6.53	12.88	4.82
Site_11_145	M77/1	470	-77.94	-11.00	145	7.48	0.91	-	8.21	17.62	6.02
Site_11_211	M77/2	676	-78.02	-11.08	211		0.77	-		9.78	6.11
Site_11_248	M77/1	583	-78.05	-11.11	248	-	-	-	-	-	-
Site_11_291	M77/1	582	-78.08	-11.16	291	10.25	1.37	-	7.4	9.64	6.09
Site_11_317	M77/1	473	-78.17	-11.00	317	12.32	1.4	-	7.35	9.87	6.68
Site_11_319	M77/1	449	-78.17	-11.00	319	12.2	1.46	-	7.28	9.12	6.28
Site_11_375	M77/1	482	-78.24	-11.00	375	13.98	1.71	-	8.43	5.72	6.35
Site_11_465	M77/1	456	-78.32	-11.00	465	6.87	0.7	-	9.74	2.43	7.27
Site_11_511	M77/1	516	-78.33	-11.00	511	9.49	1.2	-	7.88	6.93	6.23
Site_11_579	M77/1	487	-78.39	-11.00	579	4.75	0.82	-	5.98	2.93	6.18
Site_11_697	M77/1	459	-78.43	-11.00	697	6.55	0.73	-	8.92	2.44	5.01
Site_12_152	M77/1	619	-77.32	-12.30	152	8.85	1.2	-	7.59	17.39	7.23
Site_12_214	M77/2	635	-77.67	-12.09	214	12.75	1.32	-	-	9.9	6.67
Site_12_302	M77/1	616	-77.48	-12.38	302	-	-	-	-	-	-
Site_12_823	M77/1	622	-77.58	-12.55	823	-	-	-	7.81	4.94	5.82
Site_15_522	M77/1	421	-75.58	-15.19	522	6.74	0.81	-	8.28	-	7.36
Site_16_2575	GenesisIII RR-9702a	66MC	-77.10	-16.13	2575	-	-	-	-	-	-
Site_16_3228	GenesisIII RR-9702a	68MC	-76.38	-16.07	3228	-	-	-	-	-	-
Site_16_4124	GenesisIII RR-9702a	70MC	-76.01	-16.73	4124	-	-	-	-	-	-
Site_17_298	M77/1	403	-71.86	-17.43	298	1.7	0.22	-	9.51	2.22	9.17
Site_17_492	M77/1	406	-71.87	-17.47	492	2.37	0.3	-	8.92	2.73	8.61
Site_17_918	M77/1	410	-71.97	-17.64	918	2.76	0.33	-	9.12	3.85	8.19
Site_23_523	Sonne156	71	-70.6	-23.9998	523	3.34	0.38	24.24	8.81	1.42	11.77

Site_23_1395	Sonne156	7114-1	-70.83	-24.00	1395	1.91	6.35	16.73	6.35	2.73	12.25
Site_23_3396	GenesisIII RR-9702a	50MC	-73.61	-23.61	3396	0.27	-	63.4	-	-	-
Site_25_1442	Sonne156	7121-1	-70.90	-26.00	1442	1.09	7.89	12.74	7.89	0.86	11.88
Site_26_673	Sonne156	7122-2	-70.85	-26.01	673	0.95	7.85	14.63	7.85	0.42	11.08
Site_26_1996	Sonne156	7116-1	-71.00	-26.00	1996	0.73	7.31	15.9	7.31	1.16	-
Site_27_557	Sonne156	7123-1	-71.05	-27.29	557	1.35	8.62	9.4	8.62	1.42	10.35
Site_28_473	Sonne156	7129-1	-71.33	-28.42	476	2.09	7.36	19.4	7.36	0.67	10.73
Site_28_1462	Sonne156	7127-1	-71.47	-28.38	1462	0.66	7.45	8.93	7.45	1.11	10.92
Site_28_1650	Sonne156	7131-1	-71.50	-28.38	1650	0.63	7.47	8.73	7.47	0.92	-
Site_28_2080	Sonne156	7130-1	-71.61	-28.42	2080	0.49	7.63	8.9	7.63	0.72	-
Site_29_635	Sonne156	7133-1	-71.64	-29.38	635	1.33	7.65	12.0	7.65	1.08	11.11
Site_29_1432	Sonne156	7135-1	-71.68	-29.67	1432	1.57	7.44	13.54	7.44	2.07	11.49
Site_29_3252	Sonne156	7132-1	-71.89	-29.47	3252	1.25	6.66	16.3	6.66	3.3	11.95
Site_30_1199	Sonne156	7137-2	-71.73	-30.17	1199	1.73	7.42	10.41	7.42	2.02	11.08
Site_30_2733	Sonne156	7138-1	-71.87	-30.13	2733	1.48	7.05	-	7.05	3.98	11.23
Site_30_3267	Sonne156	7139-1	-71.98	-30.20	3267	1.41	7.14	9.53	7.14	4.18	-
Site_31_183	Sonne156	7146-1	-71.63	-31.97	183	-	-	-	-	-	-
Site_31_301	Sonne156	7141-1	-71.75	-31.09	301	1.30	8.02	32.7	8.02	0.1	10.3
Site_31_326	Sonne156	7145-1	-71.70	-31.88	326	1.15	9.23	13.72	9.23	0.24	-
Site_31_398	Sonne156	7147-1	-71.67	-31.98	398	0.93	8.05	7.73	8.05	0.53	10.06
Site_31_481	Sonne156	7142-2	-71.75	-31.18	481	1.07	7.63	8.26	7.63	0.8	10.52
Site_31_1371	Sonne156	7143-1	-71.88	-31.11	1371	-	-	-	-	-	-
Site_31_2289	Sonne156	7148-1	-71.93	-31.97	2289	0.91	7.14	13.73	7.14	1.83	-
Site_31_3086	Sonne156	7149-1	-72.00	-31.49	3086	1.06	6.83	10.62	6.83	3.13	-
Site_32_1591	Sonne156	7150-1	-71.95	-32.28	1591	0.63	7.18	8.67	7.18	0.98	11.07
Site_32_3920	GenesisIII RR-9702a	48 MC5	-73.65	-32.59	3920	0.56	-	23.3	-	-	-
Site_33_420	Sonne156	7152-1	-72.11	-33.80	420	1.13	7.65	2.66	7.65	2.38	10.16
Site_33_863	Sonne156	7153-1	-72.16	-33.80	863	1.60	7.3	4.58	7.3	2.65	10.41
Site_33_1385	Sonne156	7154-2	-72.27	-33.80	1385	2.18	7.78	4.4	7.78	2.87	10.63
Site_33_3852	GenesisIII RR-9702a	46 MC4	-73.53	-33.28	3852	0.94	-	7.8	-	-	-
Site_34_1247	Sonne156	7156-1	-72.51	-34.58	1247	2.04	7.95	2.71	7.95	3.97	10.36
Site_35_506	Sonne156	7159-1	-73.23	-35.78	506	0.74	8.9	0.28	8.9	1.26	9.68
Site_35_1563	Sonne156	7158-1	-73.48	-35.78	1563	2.76	8.02	1.42	8.02	5.94	10.11
Site_35_2103	Sonne156	7157-1	-73.59	-35.78	2103	2.76	8	1.09	8	5.81	10.13
Site_36_366	Sonne156	7160-4	-73.07	-36.04	366	2.97	7.89	0.95	7.89	5.01	10
Site_36_538	Sonne156	7163-5	-73.91	-36.46	538	-	-	-	-	-	-
Site_36_1294	Sonne156	7166-3	-73.77	-36.47	1294	3.08	7.92	0.64	7.92	5.34	10.32
Site_36_2064	Sonne156	7167-4	-73.91	-36.45	2064	3.04	7.73	0.48	7.73	7.04	10.52
Site_37_124	Sonne156	7205-1	-73.73	-38.00	124	-	-	-	-	-	-
Site_37_1386	Sonne156	7171-2	-73.95	-37.40	1386	2.90	7.95	1.52	7.95	6.68	10.39
Site_38_281	Sonne156	7203-1	-73.96	-38.04	281	0.77	8.79	0.26	8.79	0.9	9.75
Site_38_700	Sonne156	7201-1	-74.06	-38.09	700	-	-	-	-	-	-
Site_38_2287	Sonne156	7198-1	-74.39	-38.17	2287	2.49	8.08	0.87	8.08	6.5	10.27
Site_39_112	Sonne156	7220-1	-73.90	-39.77	112	-	-	-	-	-	-
Site_39_174	Sonne156	7217-1	-73.93	-39.99	174	-	-	-	-	-	-
Site_39_498	Sonne156	7215-1	-74.00	-39.48	498	1.40	8.02	2.04	8.02	2.83	10.22
Site_39_638	Sonne156	7218-1	-73.88	-39.91	638	2.74	7.98	2.36	7.98	6.51	9.9
Site_39_772	Sonne156	7214-1	-74.17	-39.88	772	-	-	-	-	-	-
Site_39_890	Sonne156	7211-1	-74.27	-39.93	890	1.28	8.19	3.72	8.19	2.56	10.58
Site_39_1190	Sonne156	7213-1	-74.29	-39.73	1190	-	-	-	-	3.14	-
Site_39_1469	Sonne156	7212-1	-74.38	-39.70	1469	-	-	-	-	3.74	-
Site_39_1798	Sonne156	7208-1	-74.21	-39.01	1794	-	-	-	-	4.7	-
Site_39_2236	Sonne156	7207-1	-74.37	-39.07	2236	2.34	7.71	2.62	7.71	4.92	10.67
Site_40_165	Sonne156	7216-1	-73.94	-40.04	165	0.73	8.69	0.49	8.69	1.88	9.73
Site_40_816	Sonne156	7197-1	-73.94	-41.00	816	2.35	7.85	4.57	7.85	4.6	-

Site_40_3850	GenesisIII RR-9702a	27 MC5	-75.92	-40.48	3850	1.2	-	0.4	-	-	-
Site_41_308	Sonne156	7194-1	-74.43	-41.42	308	1.79	8.25	7.01	8.25	1.89	10.04
Site_41_521	Sonne156	7195-1	-74.41	-41.21	521	1.55	7.98	4.35	7.98	2.51	10.17
Site_42_160	Sonne156	7173-5	-74.56	-42.09	160	1.34	8.31	3.54	8.31	1.68	9.79
Site_42_206	Sonne156	7193-1	-74.71	-42.18	206	-	-	-	-	-	-
Site_42_299	Sonne156	7172-5	-74.79	-42.41	299	-	-	-	-	-	-
Site_42_301	Sonne156	7182-1	-74.84	-42.58	301	-	-	-	-	-	-
Site_42_909	Sonne156	7177-1	-74.84	-42.59	909	3.53	8.6	3.39	8.6	4.24	9.59
Site_42_1967	Sonne156	7181-1	-74.79	-42.41	1967	3.12	10.19	7.63	10.19	4.21	9.75
Site_42_2760	Sonne156	7175-4	-75.34	-42.57	2760	2.51	8.09	4.62	8.09	5.35	9.62
Site_43_1212	Sonne156	7179-1	-75.21	-42.45	1222	3.40	8.02	7.39	8.02	5.79	9.78
Site_42_1222	Sonne156	7174-2	-75.28	-43.37	1212	1.52	8.24	5.45	8.24	3.03	9.22
Site_43_3485	Sonne156	7180-1	-75.57	-43.37	3485	1.68	7.83	2.58	7.83	3.7	9.67
Site_43_3523	GenesisIII RR-9702a	12 MC4	-76.25	-43.42	3523	1.3	-	1.8	-	-	-
Site_44_476	Sonne156	7187-1	-75.17	-44.20	476	1.32	7.5	2.9	7.5	2.56	9.22
Site_44_868	Sonne156	7189-1	-75.59	-44.28	868	1.58	7.81	4.73	7.81	3.6	9.07
Site_44_1171	Sonne156	7186-1	-75.16	-44.15	1171	2.37	7.5	5.91	7.5	4.74	9.29
Site_44_1939	Sonne156	7191-1	-75.17	-44.20	1939	1.54	7.61	6.05	7.61	3.75	9.37
Site_44_3285	Sonne156	7190-1	-75.39	-44.28	3285	1.32	7.5	3.44	7.5	4.24	9.29
Site_46_3014	GenesisIII RR-9702a	8 MC8	-76.67	-46.35	3014	5.4	-	1	-	-	-
Site_50_3964	GenesisIII RR-9702a	1 MC5	-76.96	-50.65	3964	0.29	-	5.6	-	-	-

Appendix 2. Dataset of environmental variables used for the GAM and OMI analyses.

*: No data

ID	Longitude	Latitude	Depth	Temp	Salinity	Oxygen	Phosphate	Nitrate	Nitrite	Silicate	TOC	TN	$CaCO_3$	C/N	Opal	δ15N
Site_1_207	-81.12	-1.95	207	13.23	34.93	27.78	1.84	22.63	0.07	17.73	1.01	0.12	9.63	8.71	2.98	4.62
Site_1_526	-81.20	-1.89	526	8.45	34.65	15.48	2.75	33.17	0.06	42.61	2.92	0.33	9.84	10.09	2.97	4.81
Site_1_2092	-82.62	-1.75	2092	2.20	34.66	100.83	2.81	37.45	0.16	134.96	1.70	0.22	41.59	8.36	8.23	4.74
Site_3_350	-81.12	-3.75	350	10.23	34.75	5.96	2.74	35.62	0.02	35.50	2.99	0.355	6.86	9.42	3.12	4.78
Site_3_700	-81.26	-3.85	700	6.24	34.58	37.98	3.12	44.12	0.04	64.23	3.31	0.40	6.34	9.34	3.27	4.4
Site_3_995	-81.32	-3.95	995	4.86	34.57	55.76	3.07	43.77	0.00	86.85	3.27	0.36	*	9.26	7.02	4.27
Site_7_359	-80.34	-8.00	359	10.26	34.75	2.36	2.77	32.27	0.44	32.28	9.70	1.25	11.72	*	*	*
Site_7_627	-80.52	-7.87	627	7.09	34.60	9.09	3.13	44.06	0.08	51.56	4.91	0.58	18.32	8.91	3.64	4.5
Site_9_115	-79.45	-9.05	115	14.44	35.02	4.61	2.47	24.31	0.17	21.46	1.57	0.16	25.66	11.11	2.61	5.27
Site_9_437	-79.28	-9.28	437	9.00	34.67	2.23	2.99	38.14	1.12	35.40	8.45	0.77	15.59	10.43	3.53	4.53
Site_9_1105	-79.90	-9.29	1105	4.32	34.56	56.26	3.25	45.63	0.02	68.41	5.27	0.61	19.56	8.34	4.55	4.45
Site_10_521	-78.90	-10.44	521	8.07	34.62	3.05	3.24	37.82	0.05	42.39	4.16	0.41	*	10.2	1.21	6.83
Site_10_1004	-78.52	-11.00	1004	4.50	34.55	49.19	3.37	49.23	0.07	69.69	*	*	*	*	*	*
Site_10_1923	-78.77	-10.89	1923	2.38	34.64	97.15	2.91	42.06	0.14	112.06	2.98	0.36	6.83	8.26	3.55	5.04
Site_11_79	-77.79	-11.00	79	13.64	34.96	2.30	2.73	31.74	0.40	22.95	3.26	0.5	*	6.53	12.88	4.82
Site_11_145	-77.94	-11.00	145	12.88	34.92	2.53	2.58	26.88	0.80	27.08	7.48	0.91	*	8.21	17.62	6.02
Site_11_211	-78.02	-11.08	211	12.10	34.87	2.14	2.49	25.09	1.12	24.90	*	0.77	*	*	9.78	6.11
Site_11_248	-78.05	-11.11	248	11.79	34.85	2.20	2.52	25.33	1.30	24.39	*	*	*	*	*	*
Site_11_291	-78.08	-11.16	291	11.31	34.82	2.31	2.61	26.11	2.04	24.73	10.25	1.37	*	7.4	9.64	6.09
Site_11_317	-78.17	-11.00	317	10.79	34.78	2.44	2.68	27.00	2.40	25.64	12.32	1.4	*	7.35	9.87	6.68
Site_11_319	-78.17	-11.00	319	10.79	34.78	2.44	2.68	27.00	2.40	25.64	12.2	1.46	*	7.28	9.12	6.28
Site_11_375	-78.24	-11.00	375	9.58	34.70	2.67	2.82	28.84	2.42	29.52	13.98	1.71	*	8.43	5.72	6.35
Site_11_465	-78.32	-11.00	465	8.43	34.64	3.67	3.01	31.07	1.01	36.82	6.87	0.7	*	9.74	2.43	7.27
Site_11_511	-78.33	-11.00	511	7.98	34.62	4.37	3.16	31.94	0.41	41.31	9.49	1.2	*	7.88	6.93	6.23
Site_11_579	-78.39	-11.00	579	7.24	34.58	6.34	3.41	36.28	0.32	47.82	4.75	0.82	*	5.98	2.93	6.18
Site_11_697	-78.43	-11.00	697	6.40	34.56	11.41	3.50	44.52	0.28	55.59	6.55	0.73	*	8.92	2.44	5.01
Site_12_152	-77.32	-12.30	152	13.17	34.94	2.44	2.61	16.75	4.47	26.40	8.85	1.2	*	7.59	17.39	7.23
Site_12_214	-77.67	-12.09	214	12.91	34.92	1.35	2.60	20.17	4.93	25.55	12.754	1.323	7.69	*	9.9	6.67
Site_12_302	-77.48	-12.38	302	11.35	34.82	3.15	2.58	23.17	5.76	26.36	*	*	*	*	*	*
Site_12_823	-77.58	-12.55	823	5.86	34.55	16.46	3.25	44.90	0.08	60.57	*	*	*	7.81	4.94	5.82
Site_15_522	-75.58	-15.19	522	7.57	34.57	14.04	3.02	39.58	0.12	40.70	6.74	0.81	*	8.28	*	7.36
Site_16_2575	-77.10	-16.13	2575	1.87	34.67	135.04	2.67	26.78	0.45	88.88	1.6	*	6.4	*	*	*
Site_16_3228	-76.38	-16.07	3228	1.78	34.68	144.88	2.79	32.61	0.18	107.71	1.6	*	0	*	*	*
Site_16_4124	-76.01	-16.73	4124	1.78	34.70	148.53	2.79	36.93	0.05	123.53	0.67	*	0	*	*	*
Site_17_298	-71.86	-17.43	298	9.92	34.70	2.71	2.89	27.03	0.61	25.88	1.7	0.22	*	9.51	2.22	9.17
Site_17_492	-71.87	-17.47	492	7.25	34.54	23.81	3.20	43.65	0.20	29.79	2.37	0.3	*	8.92	2.73	8.61
Site_17_918	-71.97	-17.64	918	4.48	34.52	59.17	3.30	47.52	0.01	56.39	2.76	0.33	*	9.12	3.85	8.19
Site_23_523	-70.60	-24.00	523	7.37	34.51	29.57	2.30	31.94	0.04	25.45	3.34	0.38	24.24	8.81	1.42	11.77
Site_23_3396	-73.61	-23.61	3396	1.75	34.68	134.07	2.46	26.62	0.08	69.95	0.27	*	63.4	*	*	*
Site_25_1442	-70.90	-26.00	1442	2.96	34.57	98.99	2.83	39.40	0.07	79.28	1.09	7.89	12.74	7.89	0.86	11.88
Site_26_673	-70.85	-26.01	673	5.94	34.46	94.95	2.57	42.39	0.03	28.95	0.95	7.85	14.63	7.85	0.42	11.08
Site_26_1996	-71.00	-26.00	1996	2.24	34.63	113.61	2.62	34.26	0.22	89.63	0.73	7.31	15.9	7.31	1.16	*
Site_27_557	-71.05	-27.29	557	6.97	34.44	69.44	2.67	43.97	0.03	24.85	1.35	8.62	9.4	8.62	1.42	10.35
Site_28_473	-71.33	-28.42	476	7.78	34.49	5.31	2.74	42.30	0.06	23.07	2.09	7.36	19.4	7.36	0.67	10.73
Site_28_1462	-71.47	-28.38	1462	2.95	34.57	103.26	2.81	39.89	0.04	88.61	0.66	7.45	8.93	7.45	1.11	10.92
Site_28_1650	-71.50	-28.38	1650	2.63	34.60	109.90	2.74	38.35	0.09	95.85	0.63	7.47	8.73	7.47	0.92	*
Site_28_2080	-71.61	-28.42	2080	2.16	34.64	124.06	2.59	34.91	0.14	102.38	0.49	7.63	8.9	7.63	0.72	*
Site_29_635	-71.64	-29.38	635	5.96	34.43	76.46	2.52	45.07	0.00	26.31	1.33	7.65	12.89	7.65	1.08	11.11
Site_29_1432	-71.68	-29.67	1432	3.00	34.57	104.97	2.81	40.18	0.01	91.28	1.57	7.44	13.54	7.44	2.07	11.49
Site_29_3252	-71.89	-29.47	3252	1.75	34.68	144.27	2.45	32.40	0.07	105.87	1.25	6.66	16.3	6.66	3.3	11.95
Site_30_1199	-71.73	-30.17	1199	3.52	34.53	96.98	2.86	41.71	0.03	78.35	1.73	7.42	10.41	7.42	2.02	11.08
Site_30_2733	-71.87	-30.13	2733	1.83	34.67	144.22	2.47	33.53	0.06	111.30	1.48	7.05	*	7.05	3.98	11.23
Site_30_3267	-71.98	-30.20	3267	1.75	34.68	146.16	2.46	33.34	0.04	112.16	1.41	7.14	9.53	7.14	4.18	*
Site_31_183	-71.63	-31.97	183	10.84	34.60	13.87	2.66	24.61	0.08	19.27	*	*	*	*	*	*
Site_31_301	-71.75	-31.09	301	9.52	34.62	9.02	2.68	28.52	0.15	23.24	1.30	8.02	32.7	8.02	0.1	10.3
Site_31_326	-71.70	-31.88	326	9.15	34.58	16.23	2.69	32.27	0.04	23.67	1.15	9.23	13.72	9.23	0.24	*
Site_31_398	-71.67	-31.98	398	8.14	34.52	33.28	2.60	35.07	0.03	22.81	0.93	8.05	7.73	8.05	0.53	10.06
Site_31_481	-71.75	-31.18	481	7.03	34.47	60.19	2.40	38.03	0.03	20.74	1.07	7.63	8.26	7.63	0.8	10.52
Site_31_1371	-71.88	-31.11	1371	3.11	34.56	105.86	2.82	40.16	0.02	90.89	*	*	*	*	*	*
Site_31_2289	-71.93	-31.97	2289	2.00	34.65	140.96	2.55	36.01	0.04	120.16	0.91	7.14	13.73	7.14	1.83	*
Site_31_3086	-72.00	-31.49	3086	1.79	34.68	148.49	2.47	34.79	0.03	121.42	1.06	6.83	10.62	6.83	3.13	*
Site_32_1591	-71.95	-32.28	1591	2.69	34.59	116.73	2.72	38.47	0.00	102.98	0.63	7.18	8.67	7.18	0.98	11.07
Site_32_3920	-73.65	-32.59	3920	1.72	34.69	160.07	2.43	34.83	0.01	123.86	0.56	*	23.3	*	*	*
Site_33_420	-72.11	-33.80	420	7.65	34.45	55.70	2.88	34.29	0.01	22.88	1.13	7.65	2.66	7.65	2.38	10.16
Site_33_863	-72.16	-33.80	863	4.41	34.37	136.52	2.52	33.87	0.02	41.92	1.60	7.3	4.58	7.3	2.65	10.41
Site_33_1385	-72.27	-33.80	1385	3.04	34.55	112.76	2.74	37.82	0.03	90.73	2.18	7.78	4.4	7.78	2.87	10.63
Site_33_3852	-73.53	-33.28	3852	1.73	34.69	160.77	2.43	34.99	0.03	125.42	0.94	*	7.8	*	*	*
Site_34_1247	-72.51	-34.58	1247	3.31	34.51	111.58	2.70	36.15	0.05	78.55	2.04	7.95	2.71	7.95	3.97	10.36
Site_35_506	-73.23	-35.78	506	6.20	34.33	158.69	2.11	29.89	0.04	19.26	0.74	8.9	0.28	8.9	1.26	9.68
Site_35_1563	-73.48	-35.78	1563	2.75	34.58	118.15	2.68	36.74	0.08	97.01	2.76	8.02	1.42	8.02	5.94	10.11
Site_35_2103	-73.59	-35.78	2103	2.21	34.64	130.14	2.61	37.32	0.04	112.19	2.76	8	1.09	8	5.81	10.13

Site_36_366	-73.07	-36.04	366	8.01	34.46	51.19	2.57	35.00	0.04	24.27	2.97	7.89	0.95	7.89	5.01	10
Site_36_538	-73.91	-36.46	538	5.74	34.30	194.43	1.95	29.22	0.04	18.20	*	0.263	*	*	*	*
Site_36_1294	-73.77	-36.47	1294	3.19	34.51	117.67	2.60	33.84	0.12	76.22	3.08	7.92	0.64	7.92	5.34	10.32
Site_36_2064	-73.91	-36.45	2064	2.25	34.64	127.67	2.62	37.36	0.08	111.00	3.04	7.73	0.48	7.73	7.04	10.52
Site_37_124	-73.73	-38.00	124	10.26	34.23	87.64	1.84	25.48	0.04	19.90	*	*	*	*	*	*
Site_37_1386	-73.95	-37.40	1386	3.00	34.53	119.18	2.61	34.24	0.15	81.79	2.90	7.95	1.52	7.95	6.68	10.39
Site_38_281	-73.96	-38.04	281	8.81	34.50	46.86	2.35	31.24	0.04	23.31	0.77	8.79	0.26	8.79	0.9	9.75
Site_38_700	-74.06	-38.09	700	4.77	34.27	198.23	1.86	24.97	0.06	20.13	*	*	*	*	*	*
Site_38_2287	-74.39	-38.17	2287	2.13	34.66	128.29	2.60	37.22	0.19	116.05	2.49	8.08	0.87	8.08	6.5	10.27
Site_39_112	-73.90	-39.77	112	10.15	34.05	139.50	1.19	15.42	0.05	9.76	0.586	0.064	0.1	9.18	1.49	9.59
Site_39_174	-73.93	-39.99	174	9.41	34.34	68.81	1.82	24.26	0.02	14.10	*	*	*	*	*	*
Site_39_498	-74.00	-39.48	498	5.95	34.28	183.64	1.61	23.34	0.03	13.03	1.40	8.02	2.04	8.02	2.83	10.22
Site_39_772	-74.17	-39.88	772	4.49	34.28	175.81	1.78	21.91	0.12	20.41	*	*	*	*	*	*
Site_39_890	-74.27	-39.93	890	4.08	34.33	153.53	1.93	22.36	0.15	28.47	1.28	8.19	3.72	8.19	2.56	10.58
Site_39_1190	-74.29	-39.73	1190	3.30	34.46	132.39	2.39	29.58	0.20	59.53	*	*	*	*	3.14	*
Site_39_1469	-74.38	-39.70	1469	2.85	34.55	120.23	2.62	34.70	0.24	84.95	*	*	*	*	3.74	*
Site_39_1798	-74.21	-39.01	1794	2.48	34.61	118.41	2.67	36.99	0.21	103.12	*	*	*	*	4.7	*
Site_40_165	-73.94	-40.04	165	9.49	34.31	76.06	1.75	23.54	0.02	13.57	0.73	8.69	0.49	8.69	1.88	9.73
Site_40_816	-73.94	-41.00	816	4.32	34.29	160.56	1.79	20.96	0.17	21.70	2.35	7.85	4.57	7.85	4.6	*
Site_40_3850	-75.92	-40.48	3850	2.06	34.72	162.49	2.39	33.07	0.65	116.84	1.20	*	0.4	*	*	*
Site_41_308	-74.43	-41.42	308	7.85	34.37	83.97	1.85	18.47	0.08	11.68	1.79	8.25	7.01	8.25	1.89	10.04
Site_41_521	-74.41	-41.21	521	5.78	34.25	183.37	1.56	18.75	0.08	10.62	1.55	7.98	4.35	7.98	2.51	10.17
Site_42_160	-74.56	-42.09	160	9.19	34.26	105.67	1.32	17.81	0.14	8.68	1.34	8.31	3.54	8.31	1.68	9.79
Site_42_206	-74.71	-42.18	206	8.69	34.36	77.21	1.71	21.05	0.13	10.99	*	*	*	*	*	*
Site_42_299	-74.79	-42.41	299	7.75	34.35	91.18	1.80	17.90	0.17	10.52	1.56	0.175	4.72	8.89	1.56	10
Site_42_301	-74.84	-42.58	301	7.72	34.35	92.06	1.80	18.01	0.17	10.40	*	*	*	*	*	*
Site_42_909	-74.84	-42.59	909	4.03	34.32	141.52	1.93	21.56	0.23	26.72	3.53	8.6	3.39	8.6	4.24	9.59
Site_42_1222	-75.28	-43.37	1212	3.17	34.46	129.37	2.49	32.90	0.27	62.25	1.52	8.24	5.45	8.24	3.03	9.22
Site_42_1967	-74.79	-42.41	1967	2.30	34.63	116.19	2.66	37.27	0.40	108.36	3.12	10.19	7.63	10.19	4.21	9.75
Site_42_2760	-75.34	-42.57	2760	2.05	34.70	127.26	2.50	35.46	0.59	119.66	2.51	8.09	4.62	8.09	5.35	9.62
Site_43_1212	-75.21	-42.45	1222	3.17	34.47	129.69	2.46	31.83	0.26	62.57	3.40	8.02	7.39	8.02	5.79	9.78
Site_43_3523	-76.25	-43.42	3523	2.14	34.73	155.75	2.40	32.57	0.85	113.00	1.30	*	1.8	*	*	*
Site_44_476	-75.17	-44.20	476	5.87	34.24	164.59	1.61	18.37	0.15	8.70	1.32	7.5	2.9	7.5	2.56	9.22
Site_44_868	-75.59	-44.28	868	4.14	34.29	145.95	2.07	24.64	0.17	25.94	1.58	7.81	4.73	7.81	3.6	9.07
Site_44_1171	-75.16	-44.15	1171	3.23	34.44	130.39	2.48	33.28	0.25	58.69	2.37	7.5	5.91	7.5	4.74	9.29
Site_44_1939	-75.17	-44.20	1939	2.28	34.63	116.04	2.66	37.27	0.43	107.87	1.54	7.61	6.05	7.61	3.75	9.37
Site_44_3285	-75.39	-44.28	3285	2.13	34.73	142.26	2.41	32.94	0.84	113.57	1.32	7.5	3.44	7.5	4.24	9.29
Site_46_3014	-76.67	-46.35	3014	2.13	34.73	120.85	2.42	32.90	0.85	111.31	1.00	*	5.4	*	*	*
Site_50_3964	-76.96	-50.65	3964	2.64	34.77	79.83	2.28	26.75	1.39	84.30	1.25	*	0.29	*	*	*

Appendix 3. List of living benthic foraminifera species present in the Southeastern Pacific Ocean

Class	Order	Family	Genus	Specie	Authority
Monothalamea	Astrorhizida	Astrorhizidae	Astrorhiza	*Astrorhiza arenaria*	Carpenter in Norman, 1877
		Astrorhizidae	Astrorhiza	*Astrorhiza granulosa*	(Brady, 1879)
		Astrorhizidae	Astrorhizoides	*Astrorhizoides cornutus*	(Brady, 1879)
		Crithioninidae	Crithionina	*Crithionina pisum*	Goës, 1896
		Dendrophryidae	Psammatodendron	*Psammatodendron arborescens*	Norman in Brady, 1881
		Hyperamminidae	Hyperammina	*Hyperammina*	Brady, 1878
		Hyperamminidae	Hyperammina	*Hyperammina echinata*	Saidova, 1970
		Hyperamminidae	Hyperammina	*Hyperammina elongata*	Brady, 1878
		Hyperamminidae	Hyperammina	*Hyperammina friabilis*	Brady, 1884
		Hyperamminidae	Saccorhiza	*Saccorhiza ramosa*	(Brady, 1879)
		Psammosphaeridae	Psammosphaera	*Psammosphaera fusca*	Schulze, 1875
		Rhabdamminidae	Bathysiphon	*Bathysiphon capillare*	Folin, 1886

		Rhabdamminidae	Bathysiphon	*Bathysiphon fusca*	Cushman, 1927
		Rhabdamminidae	Bathysiphon	*Bathysiphon*	Sars, 1872
		Rhabdamminidae	Marsipella	*Marsipella elongata*	Norman, 1878
		Rhabdamminidae	Psammosiphonella	*Psammosiphonella discreta*	(Brady, 1881)
		Rhabdamminidae	Rhabdammina	*Rhabdammina abyssorum*	Sars in Carpenter, 1869
		Rhabdamminidae	Rhabdammina	*Rhabdammina pacifica*	Shchedrina, 1952
		Rhabdamminidae	Rhabdammina	*Rhabdammina sp.*	Sars in Carpenter, 1869
		Rhabdamminidae	Rhabdamminella	*Rhabdamminella cylindrica*	(Brady, 1882)
		Rhizamminidae	Rhizammina	*Rhizammina algaeformis*	Brady, 1879
		Rhizamminidae	Rhizammina	*Rhizammina*	Brady, 1879
		Saccamminidae	Astrammina	*Astrammina rara*	Rhumbler, 1931
		Saccamminidae	Lagenammina	*Lagenammina ampullacea*	(Brady, 1881)
		Saccamminidae	Lagenammina	*Lagenammina difflugiformis*	(Brady, 1879)
		Saccamminidae	Saccammina	*Saccammina sphaerica*	Brady, 1871
		Saccamminidae	Technitella	*Technitella*	Norman, 1878
		Saccamminidae	Technitella	*Technitella melo*	Norman, 1878
		Saccamminidae	Thurammina	*Thurammina albicans*	Brady, 1879
Globotalamea	Lituolida	Adercotrymidae	Adercotryma	*Adercotryma glomeratum*	(Brady, 1878)
		Ammomassilinidae	Ammomassilina	*Ammomassilina alveoliniformis*	(Millett, 1898)
		Ammosphaeroidinidae	Ammosphaeroidina	*Ammosphaeroidina grandis*	Cushman, 1910
		Ammosphaeroidinidae	Cribrostomoides	*Cribrostomoides evolutus*	(Natland, 1938)
		Ammosphaeroidinidae	Cribrostomoides	*Cribrostomoides jeffreysii*	(Williamson, 1858)
		Ammosphaeroidinidae	Cribrostomoides	*Cribrostomoides nitidus*	(Goës, 1896)
		Ammosphaeroidinidae	Cribrostomoides	*Cribrostomoides sphaerilocula*	(Cushman, 1910)
		Ammosphaeroidinidae	Cribrostomoides	*Cribrostomoides subglobosus*	(Cushman, 1910)
		Ammosphaeroidinidae	Recurvoidella	*Recurvoidella bradyi*	(Robertson, 1891)
		Ammosphaeroidinidae	Recurvoides	*Recurvoides contortus*	Earland, 1934
		Ammosphaeroidinidae	Recurvoides	*Recurvoides turbinatus*	(Brady, 1881)
		Discamminidae	Glaphyrammina	*Glaphyrammina americana*	(Cushman, 1910)
		Haplophragmoididae	Buzasina	*Buzasina ringens*	(Brady, 1879)
		Haplophragmoididae	Buzasina	*Buzasina sp.*	Loeblich & Tappan, 1985
		Haplophragmoididae	Evolutinella	*Evolutinella rotulata*	(Brady, 1881)

		Haplophragmoididae	Haplophragmoides	*Haplophragmoides bulloides*	Beissel, 1886
		Haplophragmoididae	Haplophragmoides	*Haplophragmoides mexicanus*	Kornfeld, 1931
		Haplophragmoididae	Haplophragmoides	*Haplophragmoides planissima*	Cushman, 1927
		Haplophragmoididae	Haplophragmoides	*Haplophragmoides pusillus*	Collins, 1974
		Haplophragmoididae	Haplophragmoides	*Haplophragmoides sp.*	Cushman, 1910
		Haplophragmoididae	Haplophragmoides	*Haplophragmoides subsphaeroides*	Subbotina, 1950
		Haplophragmoididae	Haplophragmoides	*Haplophragmoides wilberti*	Andersen, 1953
		Haplophragmoididae	Labrospira	*Labrospira crassimargo*	(Norman, 1892)
		Haplophragmoididae	Labrospira	*Labrospira robusta*	Cushman & McCulloch, 1948
		Haplophragmoididae	Veleroninoides	*Veleroninoides scitulus*	(Brady, 1881)
		Lituolidae	Ammobaculites	*Ammobaculites agglutinans*	(d'Orbigny, 1846)
		Lituolidae	Ammomarginulina	*Ammomarginulina catenulata*	(Cushman & McCulloch, 1939)
		Lituolidae	Eratidus	*Eratidus foliaceus*	(Brady, 1881)
		Prolixoplectidae	Eggerelloides	*Eggerelloides advena*	(Cushman, 1922)
		Prolixoplectidae	Eggerelloides	*Eggerelloides scabrum*	(Williamson, 1858)
		Sigmoilopsidae	Spirosigmoilinella	*Spirosigmoilinella*	Matsunaga, 1955
		Spiroplectamminidae	Spiroplectammina	*Spiroplectammina biformis*	(Parker & Jones, 1865)
		Trochamminidae	Ammoglobigerina	*Ammoglobigerina globigeriniformis*	(Parker & Jones, 1865)
		Trochamminidae	Ammoglobigerina	*Ammoglobigerina globulosa*	(Cushman, 1920)
		Trochamminidae	Paratrochammina	*Paratrochammina challengeri*	Brönnimann & Whittaker, 1988
		Trochamminidae	Paratrochammina	*Paratrochammina globorotaliformis*	(Zheng, 1988)
		Trochamminidae	Polystomammina	*Polystomammina nitida*	(Brady, 1881)
		Trochamminidae	Portatrochammina	*Portatrochammina karica*	(Shchedrina, 1946)
		Trochamminidae	Portatrochammina	*Portatrochammina murrayi*	Brönnimann & Zaninetti, 1984
		Trochamminidae	Portatrochammina	*Portatrochammina pacifica*	(Cushman, 1925)
		Trochamminidae	Trochammina	*Trochammina inflata*	(Montagu, 1808)
		Trochamminidae	Trochammina	*Trochammina intermedia*	Rhumbler, 1938
		Trochamminidae	Trochammina	*Trochammina nana*	(Brady, 1881)
		Trochamminidae	Trochammina	*Trochammina*	Parker & Jones, 1859

		Trochamminidae	Trochammina	*Trochammina squamata*	Jones & Parker, 1860
		Trochamminidae	Trochammina	*Trochammina triloba*	van Voorthuysen, 1969
Globothalamea	Loftusiida	Cyclamminidae	Alveolophragmium	*Alveolophragmium orbiculatum*	Shchedrina, 1936
		Cyclamminidae	Cyclammina	*Cyclammina cancellata*	Brady, 1879
		Cyclamminidae	Cyclammina	*Cyclammina trullissata*	(Brady, 1879)
		Globotextulariidae	Liebusella	*Liebusella goesi*	Höglund, 1947
		Globotextulariidae	Rhumblerella	*Rhumblerella humboldti*	(Todd & Brönniman, 1957)
		Globotextulariidae	Verneuilinulla	*Verneuilinulla propinqua*	(Brady, 1884)
	Robertinida	Epistominidae	Hoeglundina	*Hoeglundina elegans*	(d'Orbigny, 1826)
		Robertinidae	Robertina	*Robertina sp.*	d'Orbigny, 1846
		Robertinidae	Robertinoides	*Robertinoides bradyi*	(Cushman & Parker, 1936)
		Robertinidae	Robertinoides	*Robertinoides oceanicum*	(Cushman & Parker, 1947)
	Rotaliida	Alabaminidae	Oridorsalis	*Oridorsalis pauciapertura*	Belford, 1966
		Alabaminidae	Oridorsalis	*Oridorsalis tenerus subsp. profundus*	Saidova, 1975
		Alabaminidae	Oridorsalis	*Oridorsalis umbonatus*	(Reuss, 1851)
		Anomalinidae	Anomalinoides	*Anomalinoides*	Brotzen, 1942
		Astrononionidae	Astrononion	*Astrononion echolsi*	Kennett, 1967
		Astrononionidae	Astrononion	*Astrononion stellatum*	(Terquem, 1882)
		Bagginidae	Rotalina	*Rotalina pleurostomata*	Schlumberger, 1883
		Bolivinitidae	Bolivina	*Bolivina (Loxostomum) boltovskoyi*	Smith, 1963
		Bolivinitidae	Bolivina	*Bolivina (Loxostomum) salvadorensis*	Smith, 1963
		Bolivinitidae	Bolivina	*Bolivina alata*	(Seguenza, 1862)
		Bolivinitidae	Bolivina	*Bolivina costata*	d'Orbigny, 1839
		Bolivinitidae	Bolivina	*Bolivina humilis*	Cushman & McCulloch, 1942
		Bolivinitidae	Bolivina	*Bolivina interjuncta*	Cushman, 1926
		Bolivinitidae	Bolivina	*Bolivina pacifica*	Cushman & McCulloch, 1942
		Bolivinitidae	Bolivina	*Bolivina plicata*	d'Orbigny, 1839
		Bolivinitidae	Bolivina	*Bolivina seminuda*	Cushman, 1911
		Bolivinitidae	Bolivina	*Bolivina spissa*	Cushman, 1926

		Bolivinitidae	Bolivina	*Bolivina subadvena*	Cushman, 1926
		Bolivinitidae	Bolivina	*Bolivina subadvena subsp. acuminata*	Natland, 1946
		Bolivinitidae	Bolivina	*Bolivina subaenariensis*	Cushman, 1922
		Bolivinitidae	Bolivina	*Bolivina variabilis*	(Williamson, 1858)
		Bolivinitidae	Bolivinita	*Bolivinita minuta*	(Natland, 1938)
		Bolivinitidae	Fursenkoina	*Fursenkoina bradyi*	(Cushman, 1922)
		Bolivinitidae	Fursenkoina	*Fursenkoina schreibersiana*	(Cžjžek, 1848)
		Bolivinitidae	Fursenkoina	*Fursenkoina texturata*	(Brady, 1884)
		Bolivinitidae	Loxostomina	*Loxostomina limbata*	(Brady, 1881)
		Bolivinitidae	Lugdunum	*Lugdunum hantkenianum*	(Brady, 1881)
		Bolivinitidae	Pseudobrizalina	*Pseudobrizalina lobata*	(Brady, 1881)
		Bolivinitidae	Rutherfordoides	*Rutherfordoides rotundatus*	(Parr, 1950)
		Bolivinitidae	Suggrunda	*Suggrunda eckisi*	Natland, 1950
		Bolivinitidae	Suggrunda	*Suggrunda kleinpelli*	Bramlette, 1951
		Bolivinitidae	Suggrunda	*Suggrunda porosa*	Hoffmeister & Berry, 1937
		Buliminellidae	Buliminella	*Buliminella elegantissima var. limbosa*	Cushman & McCulloch, 1948
		Buliminellidae	Buliminella	*Buliminella elegantissima var. tenuis*	Cushman & McCulloch, 1948
Globothalamea	Rotaliida	Buliminidae	Bulimina	*Bulimina aculeata*	d'Orbigny, 1826
		Buliminidae	Bulimina	*Bulimina denudata*	Cushman & Parker, 1938
		Buliminidae	Bulimina	*Bulimina elongata*	d'Orbigny, 1846
		Buliminidae	Bulimina	*Bulimina marginata*	d'Orbigny, 1826
		Buliminidae	Bulimina	*Bulimina pagoda*	Cushman, 1927
		Buliminidae	Bulimina	*Bulimina striata*	d'Orbigny in Guérin-Méneville, 1832
		Buliminidae	Bulimina	*Bulimina*	d'Orbigny, 1826
		Buliminidae	Bulimina	*Bulimina truncana*	Gümbel, 1870
		Buliminidae	Praeglobobulimina	*Praeglobobulimina primitiva*	(Todd, 1952)
		Buliminidae	Praeglobobulimina	*Praeglobobulimina spinescens*	(Brady, 1884)
		Buliminidae	Protoglobobulimina	*Protoglobobulimina pupoides*	(d'Orbigny, 1846)
		Cancrisidae	Cancris	*Cancris auricula*	(Fichtel & Moll, 1798)
		Cancrisidae	Cancris	*Cancris carmenensis*	Natland, 1950

		Cancrisidae	Cancris	*Cancris oblongus*	(d'Orbigny, 1839)
		Cancrisidae	Cancris	*Cancris*	Montfort, 1808
		Cancrisidae	Gyroidinoides	*Gyroidinoides*	Brotzen, 1942
		Cancrisidae	Valvulineria	*Valvulineria araucana*	(d'Orbigny, 1839)
		Cancrisidae	Valvulineria	*Valvulineria bradyana*	(Fornasini, 1900)
		Cancrisidae	Valvulineria	*Valvulineria glabra*	Cushman, 1927
		Cancrisidae	Valvulineria	*Valvulineria inflata*	(d'Orbigny, 1839)
		Cancrisidae	Valvulineria	*Valvulineria inaequalis*	(d'Orbigny, 1839)
		Cassidulinidae	Cassidulina	*Cassidulina auka*	Boltovskoy & Theyer, 1970
		Cassidulinidae	Cassidulina	*Cassidulina carinata*	Silvestri, 1896
		Cassidulinidae	Cassidulina	*Cassidulina laevigata*	d'Orbigny, 1826
		Cassidulinidae	Cassidulina	*Cassidulina*	d'Orbigny, 1826
		Cassidulinidae	Cassidulinoides	*Cassidulinoides parkeriana*	(Brady, 1881)
		Cassidulinidae	Cassidulinoides	*Cassidulinoides*	Cushman, 1927
		Cassidulinidae	Ehrenbergina	*Ehrenbergina compressa*	Cushman, 1927
		Cassidulinidae	Ehrenbergina	*Ehrenbergina trigona*	Goës, 1896
		Cassidulinidae	Globocassidulina	*Globocassidulina crassa*	(d'Orbigny, 1839)
		Cassidulinidae	Globocassidulina	*Globocassidulina minima*	(Saidova, 1975)
		Cassidulinidae	Globocassidulina	*Globocassidulina*	Voloshinova, 1960
		Cassidulinidae	Globocassidulina	*Globocassidulina subglobosa*	(Brady, 1881)
		Cassidulinidae	Paracassidulina	*Paracassidulina minuta*	(Cushman, 1933)
		Cassidulinidae	Takayanagia	*Takayanagia delicata*	(Cushman, 1927)
		Chilostomellidae	Chilostomella	*Chilostomella oolina*	Schwager, 1878
		Chilostomellidae	Chilostomella	*Chilostomella ovoidea*	Reuss, 1850
		Chilostomellidae	Chilostomella	*Chilostomella*	Reuss in Cžjžek, 1849
Globothalamea	Rotaliida	Cibicididae	Cibicides	*Cibicides pachyderma*	(Rzehak, 1886)
		Cibicididae	Cibicidoides	*Cibicidoides cicatricosus*	(Schwager, 1866)
		Cibicididae	Cibicidoides	*Cibicidoides dispars*	(d'Orbigny, 1839)
		Cibicididae	Cibicidoides	*Cibicidoides mckannai*	(Galloway & Wissler, 1927)
		Cibicididae	Cibicidoides	*Cibicidoides mundulus*	(Brady, Parker & Jones, 1888)
		Cibicididae	Cibicidoides	*Cibicidoides robertsonianus*	(Brady, 1881)
		Cibicididae	Cibicidoides	*Cibicidoides*	Thalmann, 1939

		Cibicididae	Cibicidoides	*Cibicidoides variabilis*	(d'Orbigny, 1826)
		Cibicididae	Heterolepa	*Heterolepa bradyi*	(Trauth, 1918)
		Cibicididae	Heterolepa	*Heterolepa broeckhiana*	(Karrer, 1878)
		Cibicididae	Heterolepa	*Heterolepa*	Franzenau, 1884
		Cibicididae	Lobatula	*Lobatula lobatula*	(Walker & Jacob, 1798)
		Cibicididae	Lobatula	*Lobatula ungeriana*	(d'Orbigny, 1846)
		Cibicididae	Lobatula	*Lobatula wuellerstorfi*	(Schwager, 1866)
		Discorbidae	Discorbis	*Discorbis peruvianus*	(d'Orbigny, 1839)
		Discorbidae	Discorbis	*Discorbis*	Lamarck, 1804
		Discorbidae	Discorbis	*Discorbis vilardeboanus*	(d'Orbigny, 1839)
		Discorbinellidae	Discorbinella	*Discorbinella bertheloti*	(d'Orbigny, 1839)
		Discorbinellidae	Hanzawaia	*Hanzawaia boueana*	(d'Orbigny, 1846)
		Discorbinellidae	Hanzawaia	*Hanzawaia mexicana*	Lankford, 1973
		Discorbinellidae	Hanzawaia	*Hanzawaia prona*	Poag, 1966
		Epistomariidae	Nuttallides	*Nuttallides umbonifer*	(Cushman, 1933)
		Eponididae	Eponides	*Eponides*	Montfort, 1808
		Gavelinellidae	Gyroidina	*Gyroidina altiformis*	Stewart & Stewart, 1930
		Gavelinellidae	Gyroidina	*Gyroidina gemma*	Bandy, 1953
		Gavelinellidae	Gyroidina	*Gyroidina lamarckiana*	(d'Orbigny, 1839)
		Gavelinellidae	Gyroidina	*Gyroidina polia*	(Phleger & Parker, 1951)
		Gavelinellidae	Gyroidina	*Gyroidina orbicularis*	d'Orbigny in Parker, Jones & Brady, 1865
		Gavelinellidae	Gyroidina	*Gyroidina rothwelli*	Natland, 1950
		Gavelinellidae	Gyroidina	*Gyroidina multilocula*	Coryell & Mossman, 1942
		Gavelinellidae	Gyroidina	*Gyroidina*	d'Orbigny, 1826
		Gavelinellidae	Hansenisca	*Hansenisca soldanii*	(d'Orbigny, 1826)
	Rotaliida	Globobuliminidae	Globobulimina	*Globobulimina affinis*	(d'Orbigny, 1839)
		Globobuliminidae	Globobulimina	*Globobulimina auriculata*	(Bailey, 1851)
		Globobuliminidae	Globobulimina	*Globobulimina hoeglundi*	Uchio, 1960
		Globobuliminidae	Globobulimina	*Globobulimina notovata*	(Chapman, 1941)
		Globobuliminidae	Globobulimina	*Globobulimina pacifica*	Cushman, 1927
		Globobuliminidae	Globobulimina	*Globobulimina*	Cushman, 1927
		Globobuliminidae	Globobulimina	*Globobulimina spinifera*	Uchio, 1960

		Globobuliminidae	Globobulimina	*Globobulimina subaffinis*	(Cushman, 1921)
		Globobuliminidae	Globobulimina	*Globobulimina turgida*	(Bailey, 1851)
		Melonidae	Melonis	*Melonis affinis*	(Reuss, 1851)
		Melonidae	Melonis	*Melonis pompilioides*	(Fichtel & Moll, 1798)
		Nonionidae	Nonion	*Nonion commune*	(d'Orbigny, 1846)
		Nonionidae	Nonion	*Nonion pacificum*	(Cushman, 1924)
		Nonionidae	Nonionella	*Nonionella astricta*	McCulloch, 1965
		Nonionidae	Nonionella	*Nonionella auris*	(d'Orbigny, 1839)
		Nonionidae	Nonionella	*Nonionella*	Cushman, 1926
		Nonionidae	Nonionella	*Nonionella stella*	Cushman & Moyer, 1930
		Nonionidae	Nonionoides	*Nonionoides grateloupii*	(d'Orbigny, 1839)
		Nonionidae	Nonionoides	*Nonionoides turgidus*	(Williamson, 1858)
		Notorotaliidae	Buccella	*Buccella peruviana*	(d'Orbigny, 1839)
		Planulinidae	Planulina	*Planulina ecuadorana*	Cushman & Stevenson, 1948
		Pseudoparrellidae	Epistominella	*Epistominella afueraensis*	McCulloch, 1977
		Pseudoparrellidae	Epistominella	*Epistominella exigua*	(Brady, 1884)
		Pseudoparrellidae	Epistominella	*Epistominella obesa*	Bandy & Arnal, 1957
		Pseudoparrellidae	Epistominella	*Epistominella pulchella*	Husezima & Maruhasi, 1944
		Pseudoparrellidae	Epistominella	*Epistominella*	Husezima & Maruhasi, 1944
		Pseudoparrellidae	Pseudoparrella	*Pseudoparrella pacifica*	(Cushman, 1927)
		Pseudoparrellidae	Pseudoparrella	*Pseudoparrella subperuviana*	(Cushman, 1926)
Globothalamea	Rotaliida	Pulleniidae	Pullenia	*Pullenia bulloides*	(d'Orbigny, 1846)
		Pulleniidae	Pullenia	*Pullenia elegans*	Cushman & Todd, 1943
		Pulleniidae	Pullenia	*Pullenia quinqueloba*	(Reuss, 1851)
		Pulleniidae	Pullenia	*Pullenia*	Parker & Jones in Carpenter et al., 1862
		Pulleniidae	Pullenia	*Pullenia subcarinata*	(d'Orbigny, 1839)
		Pulleniidae	Pulleniella	*Pulleniella asymmetrica*	Ujiié, 1990
		Rosalinidae	Rosalina	*Rosalina globularis*	d'Orbigny, 1826
		Sphaeroidinidae	Eusphaeroidina	*Eusphaeroidina*	Ujiié, 1990

		Sphaeroidinidae	Sphaeroidina	*Sphaeroidina bulloides*	d'Orbigny in Deshayes, 1832
		Sphaeroidinidae	Sphaeroidina	*Sphaeroidina*	d'Orbigny, 1826
		Stainforthiidae	Cassidelina	*Cassidelina spinescens*	(Cushman, 1911)
		Stainforthiidae	Stainforthia	*Stainforthia fusiformis*	(Williamson, 1858)
		Turrilinidae	Eubuliminella	*Eubuliminella basispinata*	(Stewart & Stewart, 1930)
		Turrilinidae	Eubuliminella	*Eubuliminella curta*	(Cushman, 1925)
		Turrilinidae	Eubuliminella	*Eubuliminella exilis*	(Brady, 1884)
		Uvigerinidae	Siphouvigerina	*Siphouvigerina hispida*	(Schwager, 1866)
		Uvigerinidae	Siphouvigerina	*Siphouvigerina proboscidea*	(Schwager, 1866)
		Uvigerinidae	Trifarina	*Trifarina angulosa*	(Williamson, 1858)
		Uvigerinidae	Uvigerina	*Uvigerina auberiana*	d'Orbigny, 1839
		Uvigerinidae	Uvigerina	*Uvigerina canariensis*	d'Orbigny, 1839
		Uvigerinidae	Uvigerina	*Uvigerina dirupta*	Todd, 1948
		Uvigerinidae	Uvigerina	*Uvigerina peregrina*	Cushman, 1923
		Uvigerinidae	Uvigerina	*Uvigerina semiornata*	d'Orbigny, 1846
		Uvigerinidae	Uvigerina	*Uvigerina senticosa*	Cushman, 1927
		Uvigerinidae	Uvigerina	*Uvigerina shiwoensis*	Asano, 1958
		Uvigerinidae	Uvigerina	*Uvigerina*	d'Orbigny, 1826
		Uvigerinidae	Uvigerina	*Uvigerina striata*	d'Orbigny, 1839
Globothalamea	Textulariida	Eggerellidae	Dorothia	*Dorothia bradyana*	Cushman, 1936
		Eggerellidae	Dorothia	*Dorothia pseudoturris*	(Cushman, 1922)
		Eggerellidae	Dorothia	*Dorothia scabra*	(Brady, 1884)
		Eggerellidae	Eggerella	*Eggerella bradyi*	(Cushman, 1911)
		Eggerellidae	Eggerella	*Eggerella*	Cushman, 1933
		Eggerellidae	Karreriella	*Karreriella baccata*	(Schwager, 1866)
		Eggerellidae	Karreriella	*Karreriella bradyi*	(Cushman, 1911)
		Eggerellidae	Martinottiella	*Martinottiella communis*	(d'Orbigny, 1846)
		Eggerellidae	Martinottiella	*Martinottiella nodulosa*	Cushman, 1933
		Textulariidae	Sahulia	*Sahulia conica*	(d'Orbigny, 1839)
		Textulariidae	Textularia	*Textularia earlandi*	Parker, 1952
		Textulariidae	Textularia	*Textularia gramen*	d'Orbigny, 1846
		Textulariidae	Textularia	*Textularia lythostrota*	(Schwager, 1866)

		Textulariidae	Textularia	*Textularia porrecta*	Brady, 1884
		Valvulinidae	Cribrogoesella	*Cribrogoesella pacifica*	Cushman & Mcculloch, 1939
Nodosariata	Lagenidae	Lagenidae	Hyalinonetrion	Hyalinonetrion clavatum	(d'Orbigny, 1846)
		Lagenidae	Hyalinonetrion	Hyalinonetrion gracillimum	(Seguenza, 1862)
		Lagenidae	Lagena	Lagena aspera	Reuss, 1862
		Lagenidae	Lagena	Lagena hispidula	Cushman, 1913
		Lagenidae	Lagena	Lagena parvulipora	Bandy, 1949
		Lagenidae	Lagena	Lagena striata	(d'Orbigny, 1839)
		Lagenidae	Lagena	Lagena substriata	Williamson, 1848
		Lagenidae	Lagena	Lagena sulcata	(Walker & Jacob, 1798)
		Lagenidae	Procerolagena	Procerolagena distoma	(Parker & Jones, 1864)
		Lagenidae	Procerolagena	Procerolagena gracilis	(Williamson, 1848)
		Lagenidae	Reussoolina	Reussoolina apiculata	(Reuss, 1851)
		Lagenidae	Reussoolina	Reussoolina laevis	(Montagu, 1803)
		Nodosariidae	Dentalina	Dentalina	Risso, 1826
	Nodosariidae	Nodosariidae	Laevidentalina	Laevidentalina baggi	(Galloway & Wissler, 1927)
		Nodosariidae	Laevidentalina	Laevidentalina communis	(d'Orbigny, 1826)
		Nodosariidae	Laevidentalina	Laevidentalina elegans	(d'Orbigny, 1846)
		Nodosariidae	Laevidentalina	Laevidentalina filiformis	(d'Orbigny, 1826)
		Nodosariidae	Laevidentalina	Laevidentalina subsoluta	(Cushman, 1923)
		Ellipsolagenidae	Fissurina	*Fissurina annectens*	(Burrows & Holland, 1895)
Nodosariata	Polymorphinida	Ellipsolagenidae	Fissurina	*Fissurina circularis*	Todd, 1954
		Ellipsolagenidae	Fissurina	*Fissurina cucullata*	Silvestri, 1902
		Ellipsolagenidae	Fissurina	*Fissurina cucurbitasema*	Loeblich & Tappan, 1953
		Ellipsolagenidae	Fissurina	*Fissurina gravata*	McCulloch, 1977
		Ellipsolagenidae	Fissurina	*Fissurina granifera*	(Buchner, 1940)
		Ellipsolagenidae	Fissurina	*Fissurina laevigata*	Reuss, 1850
		Ellipsolagenidae	Fissurina	*Fissurina marginata*	(Montagu, 1803)
		Ellipsolagenidae	Fissurina	*Fissurina orbignyana*	Seguenza, 1862
		Ellipsolagenidae	Fissurina	*Fissurina (Fissurina) ovata*	Seguenza, 1862
		Ellipsolagenidae	Fissurina	*Fissurina piriformis*	(Buchner, 1940)
		Ellipsolagenidae	Fissurina	*Fissurina*	Reuss, 1850
		Ellipsolagenidae	Fissurina	*Fissurina marginata*	(Montagu, 1803)

		Ellipsolagenidae	Fissurina	*Fissurina susanae*	Figueroa, Marchant & Ramírez in Figueroa et al., 2006
		Ellipsolagenidae	Galwayella	*Galwayella trigonoornata*	(Brady, 1881)
		Ellipsolagenidae	Oolina	*Oolina globosa*	(Montagu, 1803)
		Ellipsolagenidae	Palliolatella	*Palliolatella bradii*	(Silvestri, 1902)
		Ellipsolagenidae	Parafissurina	*Parafissurina lateralis*	(Cushman, 1913)
		Ellipsolagenidae	Parafissurina	*Parafissurina ovata*	(Wiesner, 1931)
		Ellipsolagenidae	Parafissurina	*Parafissurina*	Parr, 1947
		Ellipsolagenidae	Parafissurina	*Parafissurina ventricosa*	(Silvestri, 1904)
		Ellipsolagenidae	Vasicostella	*Vasicostella inflatiperforata*	(McCulloch, 1977)
		Glandulinidae	Glandulina	*Glandulina laevigata*	(d'Orbigny, 1826)
		Glandulinidae	Glandulina	*Glandulina ovula*	d'Orbigny, 1846
		Glandulinidae	Glandulina	*Glandulina symmetrica*	(McCulloch, 1977)
		Pleurostomellidae	Obesopleurostomella	*Obesopleurostomella brevis*	(Schwager, 1866)
		Polymorphinidae	Pyrulina	*Pyrulina*	d'Orbigny, 1839
		Polymorphinidae	Pyrulina	*Pyrulina angusta*	(Egger, 1857)
		Vaginulinidae	Astacolus	*Astacolus insolitus*	(Schwager, 1866)
Nodosariata	Vaginulinida	Vaginulinidae	Lenticulina	*Lenticulina convergens*	(Bornemann, 1855)
		Vaginulinidae	Lenticulina	*Lenticulina gibba*	(d'Orbigny, 1839)
		Vaginulinidae	Lenticulina	*Lenticulina inornata*	(d'Orbigny, 1846)
		Vaginulinidae	Lenticulina	*Lenticulina pliocaena*	(Silvestri, 1898)
		Vaginulinidae	Lenticulina	*Lenticulina rotulata*	(Lamarck, 1804)
		Vaginulinidae	Lenticulina	*Lenticulina*	Lamarck, 1804
		Vaginulinidae	Lenticulina	*Lenticulina thalmanni*	(Hessland, 1943)
		Vaginulinidae	Saracenaria	*Saracenaria stolidota*	Loeblich & Tappan, 1994
		Vaginulinidae	Vaginulina	*Vaginulina americana*	Cushman, 1923
		Ammolagenidae	Ammolagena	*Ammolagena clavata*	(Jones & Parker, 1860)
		Hormosinellidae	Hormosinella	*Hormosinella distans*	(Brady, 1881)
		Hormosinellidae	Hormosinelloides	*Hormosinelloides guttifer*	(Brady, 1881)
		Hormosinidae	Hormosina	*Hormosina globulifera*	Brady, 1879
		Hormosinidae	Nodosinum	*Nodosinum gaussicum*	(Rhumbler, 1913)

		Hormosinidae	Pseudonodosinella	*Pseudonodosinella nodulosa*	(Brady, 1879)
		Reophacidae	Nodulina	*Nodulina dentaliniformis*	(Brady, 1881)
		Reophacidae	Reophax	*Reophax apiculatus*	Zheng, 1988
		Reophacidae	Reophax	*Reophax bradyi*	Brönnimann & Whittaker, 1980
		Reophacidae	Reophax	*Reophax duplex*	Grzybowski, 1896
		Reophacidae	Reophax	*Reophax fusiformis*	(Williamson, 1858)
		Reophacidae	Reophax	*Reophax globosus*	Sliter, 1968
		Reophacidae	Reophax	*Reophax insectus*	Goës, 1896
		Reophacidae	Reophax	*Reophax pilulifer*	Brady, 1884
		Reophacidae	Reophax	*Reophax pisiformis*	Zheng, 1988
		Reophacidae	Reophax	*Reophax regularis*	Höglund, 1947
		Reophacidae	Reophax	*Reophax scorpiurus*	Montfort, 1808
		Reophacidae	Reophax	*Reophax*	Montfort, 1808
		Reophacidae	Reophax	*Reophax subdentaliniformis*	Parr, 1950
		Reophacidae	Reophax	*Reophax subfusiformis*	Earland Em. Höglund, 1947
		Cornuspiridae	Cornuspira	*Cornuspira involvens*	(Reuss, 1850)
Tubothalamea	Miliolida	Hauerinidae	Miliolinella	*Miliolinella subrotunda*	(Montagu, 1803)
		Hauerinidae	Nummoloculina	*Nummoloculina*	Steinmann, 1881
		Hauerinidae	Pyrgo	*Pyrgo depressa*	(d'Orbigny, 1826)
		Hauerinidae	Pyrgo	*Pyrgo elongata*	(d'Orbigny, 1826)
		Hauerinidae	Pyrgo	*Pyrgo murrhina*	(Schwager, 1866)
		Hauerinidae	Pyrgo	*Pyrgo sarsi*	(Schlumberge, 1891)
		Hauerinidae	Pyrgo	*Pyrgo*	Defrance, 1824
		Hauerinidae	Pyrgoella	*Pyrgoella irregularis*	(d'Orbigny, 1839)
		Hauerinidae	Pyrgoella	*Pyrgoella sphaera*	(d'Orbigny, 1839)
		Hauerinidae	Quinqueloculina	*Quinqueloculina seminulum*	(Linnaeus, 1758)
		Hauerinidae	Quinqueloculina	*Quinqueloculina*	d'Orbigny, 1826
		Hauerinidae	Quinqueloculina	*Quinqueloculina weaveri*	Rau, 1948
		Hauerinidae	Sigmoilina	*Sigmoilina*	Schlumberger, 1887
		Hauerinidae	Spirosigmoilina	*Spirosigmoilina tenuis*	(Cžjžek, 1848)
		Hauerinidae	Triloculina	*Triloculina tricarinata*	d'Orbigny in Deshayes, 1832
		Hauerinidae	Triloculina	*Triloculina trigonula*	(Lamarck, 1804)
		Miliolidae	Planispirinoides	*Planispirinoides bucculentus*	(Brady, 1884)

		Nubeculariidae	Nubeculina	*Nubeculina*	Cushman, 1924
		Spiroloculinidae	Spiroloculina	*Spiroloculina robusta*	Brady, 1884
		Spiroloculinidae	Spiroloculina	*Spiroloculina*	d'Orbigny, 1826
		Ammodiscidae	Arenoturrispirillina	*Arenoturrispirillina catinus*	(Höglund, 1947)
	Spirillinida	Ammodiscidae	Ammodiscus	*Ammodiscus incertus*	(d'Orbigny, 1839)
		Ammodiscidae	Ammodiscus	*Ammodiscus planorbis*	Höglund, 1947
		Ammodiscidae	Ammodiscus	*Ammodiscus tenuis*	(Brady, 1881)
		Ammodiscidae	Glomospira	*Glomospira gordialis*	(Jones & Parker, 1860)
		Ammodiscidae	Tolypammina	*Tolypammina vagans*	(Brady, 1879)
		Spirillinidae	Spirillina	*Spirillina*	Ehrenberg, 1843

Appendix 3. Taxonomic and Functional Indices of benthic foraminifera from the Southeastern Pacific

ID	**Abundance (ind/50cm^3)**	**Taxa**	**Simpson**	**Shannon**	**Pielou**	**Fisher_α**	**FRic**	**FDiv**	**FDis**	**FEve**	**RaoQ**
Site_1_207	2222.22	26	0.85	2.29	0.70	5.54	16.94	0.68	3.78	0.43	15.33
Site_1_526	850.21	35	0.92	2.86	0.81	10.45	13.65	0.66	4.29	0.53	18.93
Site_1_2092	197.55	40	0.95	3.31	0.90	20.47	97.72	0.79	4.79	0.64	24.39
Site_3_350	380.39	11	0.67	1.57	0.66	2.53	1.78	0.70	3.02	0.55	10.28
Site_3_700	554.35	13	0.44	1.01	0.39	2.90	4.47	0.86	2.97	0.64	12.66
Site_3_995	195.04	40	0.94	3.22	0.87	16.21	95.80	0.72	4.35	0.62	20.22
Site_7_359	5376.96	10	0.18	0.48	0.21	1.54	2.77	0.96	0.59	0.53	1.94
Site_7_627	437.36	19	0.71	1.72	0.58	5.22	14.27	0.93	2.95	0.50	12.48
Site_9_115	72709.28	13	0.39	0.95	0.37	2.39	1.13	0.91	1.87	0.53	7.07
Site_9_437	19184.61	17	0.70	1.68	0.59	2.85	4.74	0.84	2.01	0.54	7.03
Site_9_1105	193.90	19	0.75	2.10	0.71	8.93	43.76	0.88	4.41	0.60	21.51
Site_10_521	3523.61	24	0.89	2.47	0.78	5.49	17.36	0.75	3.70	0.46	15.53
Site_10_1004	1080.51	36	0.88	2.81	0.79	13.66	79.77	0.79	4.81	0.60	24.64
Site_10_1923	615.41	33	0.91	2.92	0.83	13.28	74.70	0.75	4.98	0.60	25.58
Site_11_79	34709.82	12	0.57	1.12	0.45	1.83	9.05	0.43	3.18	0.22	10.33
Site_11_145	486.19	6	0.39	0.77	0.43	1.20	0.16	0.87	1.91	0.44	5.69
Site_11_211	275.82	7	0.25	0.61	0.31	1.49	0.25	0.96	1.15	0.29	3.72
Site_11_248	105558.44	11	0.18	0.48	0.20	1.66	1.72	0.93	0.79	0.26	2.33
Site_11_291	30088.31	12	0.57	1.30	0.52	2.39	4.78	0.89	2.01	0.58	6.21
Site_11_317	52324.32	10	0.51	1.06	0.46	1.78	1.50	0.91	1.40	0.50	3.84
Site_11_319	25854.59	17	0.63	1.56	0.55	3.13	5.54	0.93	2.05	0.32	7.26
Site_11_375	29295.62	17	0.71	1.72	0.61	3.17	4.75	0.83	2.45	0.30	7.53
Site_11_465	15370.69	35	0.75	2.05	0.58	7.00	26.13	0.90	2.80	0.49	11.01

Site_11_511	3943.61	22	0.80	2.09	0.68	5.65	15.62	0.76	3.57	0.48	13.53
Site_11_579	2420.38	19	0.74	1.91	0.65	5.26	7.32	0.66	4.46	0.56	20.38
Site_11_697	3146.69	34	0.88	2.45	0.70	7.02	66.48	0.70	4.78	0.43	23.18
Site_12_152	38.67	2	0.05	0.12	0.17	0.45	0	0	0.21	0	0.43
Site_12_214	14760.30	14	0.27	0.76	0.29	2.51	5.60	0.95	1.25	0.61	4.40
Site_12_302	41601.51	15	0.65	1.41	0.52	2.30	5.03	0.87	1.70	0.29	5.23
Site_12_823	1527.21	36	0.91	2.79	0.78	9.06	89.27	0.69	4.72	0.50	22.56
Site_15_522	470.93	10	0.70	1.55	0.67	2.36	4.95	0.81	3.84	0.33	16.38
Site_16_2575	113.85	23	0.80	2.21	0.71	8.45	25.78	0.74	2.58	0.50	8.78
Site_16_3228	39.41	20	0.89	2.59	0.87	10.23	33.24	0.81	4.78	0.63	24.11
Site_16_4124	6.59	6	0.76	1.61	0.90	6.33	7.57	0.84	5.23	0.69	29.07
Site_17_298	852.22	15	0.83	2.11	0.78	3.20	2.83	0.77	3.00	0.57	11.03
Site_17_492	1076.92	18	0.86	2.35	0.81	7.03	14.73	0.71	4.66	0.64	21.87
Site_17_918	162.16	9	0.86	2.09	0.95	16.36	20.69	0.71	3.96	0.76	18.11
Site_23_523	120.38	30	0.92	2.88	0.85	10.05	28.92	0.80	4.10	0.58	17.37
Site_23_3396	24.35	15	0.88	2.40	0.89	8.35	10.32	0.58	3.66	0.63	14.70
Site_25_1442	31.21	25	0.93	2.98	0.92	20.44	14.95	0.83	4.68	0.65	23.09
Site_26_673	2.55	13	0.90	2.41	0.94	10.35	9.71	0.83	5.20	0.80	28.36
Site_26_1996	16.56	4	0.75	1.39	1.00	0	0.05	0.76	3.21	0.96	10.52
Site_27_557	40.76	17	0.78	2.03	0.72	7.57	45.34	0.74	3.72	0.65	15.64
Site_28_473	87.90	26	0.89	2.60	0.80	9.47	28.30	0.84	4.46	0.65	21.02
Site_28_1462	59.24	24	0.89	2.59	0.82	10.48	82.83	0.84	5.00	0.57	26.06
Site_28_1650	42.04	18	0.90	2.57	0.89	8.15	13.69	0.88	4.68	0.63	22.54
Site_28_2080	15.92	11	0.84	2.10	0.87	7.50	13.07	0.92	4.85	0.80	23.85
Site_29_635	56.05	25	0.92	2.79	0.87	11.65	67.06	0.71	3.93	0.60	17.04
Site_29_1432	246.50	54	0.93	3.16	0.79	17.06	101.46	0.80	4.60	0.50	22.31
Site_29_3252	58.60	26	0.91	2.76	0.85	12.07	90.27	0.77	4.95	0.60	25.84
Site_30_1199	84.08	29	0.73	2.17	0.65	11.48	83.54	0.81	3.95	0.69	18.53
Site_30_2733	7.01	4	0.55	1.03	0.75	2.26	0.61	0.88	3.63	0.71	14.82
Site_30_3267	43.95	14	0.76	1.81	0.69	5.30	7.53	0.83	4.19	0.63	18.63
Site_31_183	5580.25	21	0.60	1.14	0.38	2.58	7.24	0.79	3.04	0.24	10.17
Site_31_301	86.62	15	0.84	2.16	0.80	4.31	23.01	0.71	4.02	0.51	17.62
Site_31_326	136.31	13	0.69	1.57	0.61	3.05	5.07	0.82	3.75	0.52	15.21
Site_31_398	1010.19	51	0.91	2.84	0.72	10.07	38.60	0.76	4.20	0.38	18.61
Site_31_481	187.26	45	0.96	3.37	0.89	14.82	80.69	0.76	4.28	0.54	19.78
Site_31_1371	92.99	34	0.92	2.90	0.82	13.93	85.25	0.84	4.49	0.56	21.00
Site_31_2289	37.58	26	0.93	2.98	0.92	17.77	81.48	0.69	5.36	0.63	29.68
Site_31_3086	56.69	24	0.90	2.68	0.84	10.79	21.61	0.80	4.90	0.58	25.35
Site_32_1591	262.42	48	0.91	2.96	0.76	14.08	94.49	0.91	4.28	0.50	19.74

Site_32_3920	77.18	21	0.87	2.37	0.78	6.13	16.24	0.62	3.42	0.60	12.76
Site_33_420	60.51	28	0.67	1.72	0.52	6.66	26.67	0.70	4.11	0.58	18.06
Site_33_863	54.95	37	0.80	2.48	0.69	10.97	28.32	0.83	4.03	0.53	17.72
Site_33_1385	280.25	22	0.88	2.52	0.81	8.98	12.32	0.85	4.38	0.63	19.86
Site_33_3852	196.82	18	0.86	2.33	0.81	7.17	23.66	0.86	3.53	0.70	15.12
Site_34_1247	40.13	14	0.86	2.20	0.83	5.58	3.33	0.60	3.87	0.62	16.81
Site_35_506	150.96	20	0.72	1.88	0.63	5.21	9.91	0.78	4.30	0.53	19.40
Site_35_1563	109.55	20	0.64	1.64	0.55	5.86	12.09	0.85	3.96	0.61	17.46
Site_35_2103	24.20	15	0.89	2.43	0.90	9.15	25.25	0.69	4.65	0.70	24.12
Site_36_366	38.22	8	0.61	1.28	0.62	2.48	0.96	0.73	3.74	0.38	15.42
Site_36_538	175.80	28	0.77	2.01	0.60	7.79	21.26	0.81	4.49	0.62	20.65
Site_36_1294	8.28	6	0.77	1.61	0.90	4.32	11.08	0.83	4.97	0.92	24.90
Site_36_2064	8.28	8	0.83	1.93	0.93	8.85	1.57	0.67	3.74	0.61	14.40
Site_37_124	816.56	14	0.73	1.63	0.62	2.20	6.74	0.82	3.54	0.33	13.19
Site_37_1386	15.92	12	0.80	2.06	0.83	9.06	5.77	0.89	4.92	0.80	25.04
Site_38_281	9.55	4	0.73	1.34	0.97	1.78	0.86	0.84	3.77	0.91	14.34
Site_38_700	45.86	23	0.92	2.85	0.91	11.68	14.99	0.78	3.90	0.59	17.09
Site_38_2287	11.46	9	0.83	1.98	0.90	7.16	4.64	0.81	5.81	0.84	34.90
Site_39_112	5.10	4	0.72	1.32	0.95	3.18	1.13	0.75	4.05	0.78	17.38
Site_39_174	268.79	17	0.74	1.72	0.61	3.55	17.00	0.62	4.51	0.54	21.01
Site_39_498	5.10	3	0.59	0.97	0.89	1.74	0.00	0.00	3.04	0.00	9.83
Site_39_772	136.31	39	0.90	2.84	0.77	13.97	19.69	0.68	4.35	0.58	19.53
Site_39_890	40.76	20	0.88	2.46	0.82	9.99	16.06	0.74	3.80	0.52	16.79
Site_39_1190	134.39	41	0.90	2.84	0.76	15.18	20.44	0.85	4.81	0.55	23.58
Site_39_1469	28.03	10	0.73	1.70	0.74	4.04	6.60	0.72	4.06	0.60	17.98
Site_39_1798	3.82	4	0.67	1.24	0.90	5.24	2.13	0.83	4.42	0.89	19.88
Site_40_165	217.20	18	0.70	1.68	0.58	4.05	55.56	0.69	3.91	0.44	16.87
Site_40_816	19.75	17	0.92	2.70	0.95	15.43	10.23	0.85	3.98	0.80	16.88
Site_40_3850	27.09	16	0.84	2.30	0.83	12.73	18.04	0.75	3.67	0.66	16.73
Site_41_308	424.20	44	0.72	2.15	0.57	10.58	91.47	0.74	3.90	0.51	17.96
Site_41_521	38.22	13	0.58	1.50	0.58	5.11	8.69	0.66	3.83	0.66	18.63
Site_42_160	130.57	21	0.85	2.33	0.77	5.86	24.43	0.84	4.11	0.68	18.02
Site_42_206	63.69	16	0.81	2.12	0.77	5.38	23.24	0.74	4.09	0.66	18.57
Site_42_299	421.66	49	0.90	2.78	0.71	12.22	37.26	0.86	4.43	0.54	20.56
Site_42_301	128.03	30	0.88	2.60	0.77	9.77	16.97	0.83	4.69	0.58	22.37
Site_42_909	14.65	12	0.90	2.38	0.96	10.12	12.21	0.71	4.29	0.60	19.87
Site_42_1222	31.85	17	0.88	2.47	0.87	9.07	9.93	0.61	4.46	0.61	20.71
Site_42_1967	32.48	12	0.72	1.69	0.68	4.95	18.70	0.83	4.40	0.68	19.83
Site_42_2760	8.92	6	0.71	1.48	0.82	3.98	0.08	0.69	3.88	0.64	15.29

Site_43_1212	68.15	27	0.85	2.49	0.76	11.62	16.27	0.69	4.17	0.55	18.65
Site_43_3523	89.59	26	0.92	2.80	0.86	11.06	29.23	0.79	4.52	0.55	22.06
Site_44_476	32.48	15	0.87	2.31	0.85	7.16	15.90	0.84	4.13	0.70	17.69
Site_44_868	4.46	6	0.82	1.75	0.98	19.95	1.76	0.64	3.80	0.86	16.32
Site_44_1171	33.76	14	0.87	2.29	0.87	6.21	6.78	0.76	4.05	0.66	18.28
Site_44_1939	16.56	9	0.79	1.87	0.85	4.88	5.67	0.85	4.97	0.70	24.93
Site_44_3285	19.75	8	0.73	1.58	0.76	3.49	6.20	0.82	5.25	0.65	27.62
Site_46_3014	77.83	20	0.88	2.40	0.80	6.77	24.78	0.81	3.11	0.59	11.83
Site_50_3964	64.99	21	0.92	2.72	0.89	6.99	15.99	0.69	4.48	0.46	21.29

Appendix 4. Species of benthic foraminifera with abundance of >100 ind/50cm^3 in all marine surface sediment stations of the Southeastern Pacific.

Species	**Abundance (ind/cm^3)**	**Species**	**Abundance (ind/cm^3)**	**Species**	**Abundance (ind/cm^3)**
Bolivina seminuda	297513.1148	*Eggerella bradyi*	890.4306983	*Eratidus foliaceus*	196.4395842
Bolivina costata	49807.72173	*Globocassidulina crassa*	855.4442349	*Eggerelloides scabrum*	187.7608415
Bolivina plicata	24447.11439	*Takayanagia delicata*	852.1055755	*Uvigerina auberiana*	181.0884174
Bolivina interjuncta	13846.08513	*Hoeglundina elegans*	826.6384681	*Cyclammina cancellata*	179.9099485
Nonionella stella	12912.80563	*Epistominella exigua*	757.8257267	*Melonis affinis*	176.7979682
Valvulineria glabra	12276.00427	*Pullenia elegans*	719.8391069	*Ammobaculites agglutinans*	176.5745616
Uvigerina peregrina	7459.73682	*Uvigerina striata*	712.3500255	*Glaphyrammina americana*	168.5770594
Cancris carmenensis	7152.499951	*Reophax scorpiurus*	690.4081316	*Pullenia subcarinata*	166.0457993
Stainforthia fusiformis	6447.063767	*Pseudoparrella subperuviana*	665.099804	*Recurvoides contortus*	156.6548545
Epistominella obesa	6123.406176	*Lobatula wuellerstorfi*	640.7627639	*Reophax bradyi*	154.7770701
Buliminella elegantissima tenuis	5479.454832	*Hanzawaia prona*	527.8350515	*Ammodiscus incertus*	150.791102
Cassidulina auka	4711.16336	*Cassidulina carinata*	520.413514	*Adercotryma glomeratum*	150.1245927
Valvulineria inflata	2617.197452	*Eubuliminella curta*	518.1479153	*Nodulina dentaliniformis*	147.595177
Buliminella elegantissima limbosa	2052.548198	*Suggrunda porosa*	438.4322437	*Oridorsalis umbonatus*	141.6770055
Gyroidina soldanii var multilocula	1924.478004	*Nonion commune*	405.0438932	*Hanzawaia mexicana*	141.6409699
Bolivina spissa	1911.722829	*Pseudoparrella pacifica*	387.9809104	*Chilostomella oolina*	137.2697182
Protoglobobulimina pupoides	1644.692942	*Eubuliminella basispinata*	324.3799292	*Cassidulina laevigata*	128.0254777

Bolivina alata	1582.880978	*Pseudobrizalina lobata*	285.1161164	*Lagenammina difflugiformis*	122.4833748
Bolivinita minuta	1514.238575	*Reophax apiculatus*	277.7199072	*Globobulimina affinis*	114.6496815
Trifarina angulosa	1267.635619	*Nonionoides grateloupii*	273.468043	*Glomospira gordialis*	111.8838404
Fursenkoina texturata	1164.04971	*Cancris oblongus*	206.4912026	*Globocassidulina subglobosa*	107.3386082
Hansenisca soldanii	974.315306	*Bolivina subadvena subsp. Acuminata*	204.3981278	*Ammoglobigerina globigeriniformis*	104.2367674

Table S5. Matrix of functional traits of benthic foraminifera in the Southeastern Pacific. SI: Shallow infaunal. II: Intermedia infaunal

Specie	**Type of wall**	**Morphology**	**Microhabitat**	**Oxygen condition**	**Trophic behavior**
Adercotryma glomeratum	Agglutinated	Globose, subglobose, ovoid or streptospiral	Epifaunal	Oxic	Herbivore / Phytodetritivore
Alveolophragmium orbiculatum	Agglutinated	Planispiral	Shallow Infaunal	Oxic	Detritivore
Ammobaculites agglutinans	Agglutinated	Planispiral	Shallow Infaunal	Oxic - Hypoxic	Bacterivore
Ammodiscus catinus	Agglutinated	Planispiral	Epifaunal	Hypoxic - Anoxic	Detritivore
Ammodiscus incertus	Agglutinated	Planispiral	Epifaunal	Hypoxic - Anoxic	Detritivore
Ammodiscus planorbis	Agglutinated	Planispiral	Epifaunal	Hypoxic - Anoxic	Detritivore
Ammodiscus tenuis	Agglutinated	Planispiral	Epifaunal	Hypoxic - Anoxic	Detritivore
Ammoglobigerina globigeriniformis	Agglutinated	Trochospiral	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Ammoglobigerina globulosa	Agglutinated	Trochospiral	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Ammolagena clavata	Agglutinated	Irregular	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Ammomarginulina catenulata	Agglutinated	Planispiral	Shallow Infaunal	Oxic - Hypoxic	Bacterivore
Ammomassilina alveoliniformis	Porcellaneous	Miliolide	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Ammosphaeroidina grandis	Agglutinated	Globose, subglobose, ovoid or streptospiral	Intermedia infaunal	Oxic - Hypoxic	Detritivore
Anomalinoides sp	Hyaline	Trochospiral	Epifaunal	Oxic - Hypoxic	Detritivore
Astacolus insolitus	Hyaline	Planispiral	Shallow Infaunal	Oxic - Hypoxic	Detritivore

Astrammina rara	Agglutinated	Irregular	Intermedia infaunal	Oxic	Carnivore Bacterivore
Astrononion echolsi	Hyaline	Planispiral	Shallow Infaunal	Oxic - Hypoxic	Phytodetritivore
Astrononion stellatum	Hyaline	Planispiral	Shallow Infaunal	Oxic	Phytodetritivore
Astrorhiza arenaria	Agglutinated	Irregular	Intermedia infaunal	Oxic	Bacterivore
Astrorhiza granulosa	Agglutinated	Irregular	Intermedia infaunal	Oxic	Bacterivore
Astrorhizoides cornutus	Agglutinated	Tubular	Epifaunal	Oxic	Bacterivore
Bathysiphon capillare	Agglutinated	Tubular	Shallow Infaunal	Oxic - Hypoxic	Phytodetritivore
Bathysiphon fusca	Agglutinated	Tubular	Shallow Infaunal	Oxic - Hypoxic	Phytodetritivore
Bathysiphon sp.	Agglutinated	Tubular	Shallow Infaunal	Oxic - Hypoxic	Phytodetritivore
Bolivina (Loxostomum) boltovskoyi	Hyaline	Biserial	Epifaunal	Oxic - Anoxic	Phytodetritivore
Bolivina (Loxostomum) salvadorensis	Hyaline	Biserial	Epifaunal	Oxic - Anoxic	Phytodetritivore
Bolivina alata	Hyaline	Biserial	Shallow Infaunal	Hypoxic - Anoxic	Phytodetritivore
Bolivina alata	Hyaline	Biserial	Shallow Infaunal	Hypoxic - Anoxic	Phytodetritivore
Bolivina costata	Hyaline	Biserial	Shallow Infaunal	Oxic - Anoxic	Phytodetritivore
Bolivina interjuncta	Hyaline	Biserial	Epifaunal	Oxic - Anoxic	Phytodetritivore
Bolivina pacifica	Hyaline	Biserial	Epifaunal	Hypoxic	Phytodetritivore
Bolivina plicata	Hyaline	Biserial	Epifaunal	Oxic - Anoxic	Phytodetritivore
Bolivina seminuda	Hyaline	Biserial	Epifaunal	Oxic - Anoxic	Phytodetritivore
Bolivina spissa	Hyaline	Biserial	Epifaunal	Oxic - Anoxic	Phytodetritivore
Bolivina subadvena	Hyaline	Biserial	Epifaunal	Hypoxic	Phytodetritivore
Bolivina subadvena subsp. Acuminata	Hyaline	Biserial	Epifaunal	Hypoxic	Phytodetritivore
Bolivina subaenariensis	Hyaline	Biserial	Shallow Infaunal	Hypoxic	Phytodetritivore
Bolivina variabilis	Hyaline	Biserial	Epifaunal	Oxic - Hypoxic	Phytodetritivore
Bolivinita minuta	Hyaline	Biserial	Epifaunal	Hypoxic - Anoxic	Phytodetritivore
Buccella peruviana	Hyaline	Trochospiral	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Bulimina aculeata	Hyaline	Triserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Bulimina aculeata	Hyaline	Triserial	SI/II	Oxic - Hypoxic	Detritivore

Bulimina denudata	Hyaline	Triserial	SI/II	Oxic - Hypoxic	Detritivore
Bulimina elongata	Hyaline	Triserial	SI/II	Oxic - Hypoxic	Detritivore
Bulimina pagoda	Hyaline	Triserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Bulimina sp.	Hyaline	Triserial	SI/II	Oxic - Hypoxic	Detritivore
Bulimina truncana	Hyaline	Triserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Bulimina truncata	Hyaline	Triserial	SI/II	Oxic - Hypoxic	Detritivore
Buliminella elegantissima var limbosa	Hyaline	Trochospiral	Epifaunal	Hypoxic - anoxic	Detritivore
Buliminella elegantissima var tenuis	Hyaline	Trochospiral	Epifaunal	Hypoxic - anoxic	Detritivore
Buzasina ringens	Agglutinated	Planispiral	Intermedia infaunal	Oxic	Detritivore
Buzasina sp.	Agglutinated	Planispiral	Intermedia infaunal	Oxic	Detritivore
Cancris auricula	Hyaline	Trochospiral	Intermedia infaunal	Hypoxic	Detritivore
Cancris carmenensis	Hyaline	Trochospiral	Intermedia infaunal	Hypoxic - Anoxic	Detritivore
Cancris oblongus	Hyaline	Trochospiral	Intermedia infaunal	Hypoxic	Detritivore
Cancris sp	Hyaline	Trochospiral	Intermedia infaunal	Hypoxic	Detritivore
Cassidelina spinescens	Hyaline	Biserial	Shallow Infaunal	Anoxic	Detritivore
Cassidulina auka	Hyaline	Planispiral	Intermedia infaunal	Hypoxic - Anoxic	Phytodetritivore
Cassidulina carinata	Hyaline	Planispiral	Intermedia infaunal	Oxic - Hypoxic	Phytodetritivore
Cassidulina laevigata	Hyaline	Planispiral	Intermedia infaunal	Oxic - Hypoxic	Phytodetritivore
Cassidulina sp	Hyaline	Planispiral	Intermedia infaunal	Oxic - Hypoxic	Phytodetritivore
Cassidulinoides parkeriana	Hyaline	Planispiral	Intermedia infaunal	Oxic - Hypoxic	Phytodetritivore
Cassidulinoides sp	Hyaline	Planispiral	Intermedia infaunal	Oxic - Hypoxic	Phytodetritivore
Chilostomella oolina	Hyaline	Globose, subglobose, ovoid or streptospiral	Intermedia infaunal	Oxic - Hypoxic	Detritivore
Chilostomella ovoidea	Hyaline	Globose, subglobose, ovoid or streptospiral	Intermedia infaunal	Oxic - Hypoxic	Detritivore
Chilostomella sp	Hyaline	Globose, subglobose,	Intermedia infaunal	Oxic - Hypoxic	Detritivore

		ovoid or streptospiral			
Cibicides pachyderma	Hyaline	Trochospiral	Epifaunal/SI	Oxic	Phytodetritivore
Cibicidoides cicatricosus	Hyaline	Trochospiral	Epifaunal/SI	Oxic - Hypoxic	Phytodetritivore
Cibicidoides dispars	Hyaline	Trochospiral	Epifaunal/SI	Oxic	Phytodetritivore
Cibicidoides mckannai	Hyaline	Trochospiral	Epifaunal	Oxic	Phytodetritivore
Cibicidoides mundulus	Hyaline	Trochospiral	Epifaunal/SI	Oxic - Hypoxic	Phytodetritivore
Cibicidoides robertonianus	Hyaline	Trochospiral	Epifaunal/SI	Oxic	Phytodetritivore
Cibicidoides sp	Hyaline	Trochospiral	Epifaunal/SI	Oxic	Phytodetritivore
Cibicidoides variabilis	Hyaline	Trochospiral	Epifaunal/SI	Oxic	Phytodetritivore
Cornuspira involvens	Porcellaneous	Planispiral	Epifaunal - Shallow Infaunal	Oxic - Anoxic	Phytodetritivore
Cribrogoesella pacifica	Agglutinated	Trochospiral	Intermedia infaunal	Oxic - Hypoxic	Detritivore
Cribrostomoides jeffreysii	Agglutinated	Planispiral	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Cribrostomoides nitidus	Agglutinated	Planispiral	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Cribrostomoides sphaerilocula	Agglutinated	Planispiral	Shallow Infaunal	Oxic	Detritivore
Cribrostomoides subglobosus	Agglutinated	Planispiral	Shallow Infaunal	Oxic	Detritivore
Crithionina pisum	Agglutinated	Spheric unilocular and elongated spheric	Shallow Infaunal-II	Oxic - Hypoxic	Detritivore/ Bacterivore
Cyclammina cancellata	Agglutinated	Planispiral	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Cyclammina trullissata	Agglutinated	Planispiral	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Dentalina sp.	Hyaline	Uniserial	Shallow Infaunal	Hypoxic	Detritivore
Discorbinella bertheloti	Hyaline	Trochospiral	Epifaunal/SI	Oxic - Hypoxic	Herbivore
Discorbis peruvianus	Hyaline	Trochospiral	Epifaunal/SI	Oxic - Hypoxic	Herbivore
Discorbis sp	Hyaline	Trochospiral	Epifaunal/SI	Oxic - Hypoxic	Herbivore
Discorbis vilardeboanus	Hyaline	Trochospiral	Epifaunal/SI	Oxic	Herbivore
Dorothia bradyana	Agglutinated	Biserial	Intermedia infaunal	Oxic	Detritivore
Dorothia pseudoturris	Agglutinated	Biserial	Intermedia infaunal	Oxic	Detritivore
Dorothia scabra	Agglutinated	Biserial	Intermedia infaunal	Oxic	Detritivore
Eggerella bradyi	Agglutinated	Triserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore

Eggerella sp	Agglutinated	Triserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Eggerelloides advena	Agglutinated	Triserial	Infaunal	Oxic - Hypoxic	Detritivore
Eggerelloides scabrum	Agglutinated	Triserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Ehrenbergina compressa	Hyaline	Biserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Ehrenbergina trigona	Hyaline	Biserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Epistominella afueraensis	Hyaline	Trochospiral	Shallow Infaunal	Oxic - Hypoxic	Phytodetritivore
Epistominella exigua	Hyaline	Trochospiral	Shallow Infaunal	Oxic - Hypoxic	Phytodetritivore
Epistominella obesa	Hyaline	Trochospiral	Shallow Infaunal	Hypoxic - anoxic	Phytodetritivore
Epistominella sp	Hyaline	Trochospiral	Shallow Infaunal	Oxic - Hypoxic	Phytodetritivore
Eponides sp.	Hyaline	Trochospiral	Epifaunal	Oxic	Phytodetritivore
Eratidus foliaceus	Agglutinated	Planispiral	Shallow Infaunal	Oxic - Hypoxic	Bacterivore
Eubuliminella basispinata	Hyaline	Triserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Eubuliminella curta	Hyaline	Triserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Eubuliminella exilis	Hyaline	Triserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Eusphaeroidina sp	Hyaline	Globose, subglobose, ovoid or streptospiral	Shallow Infaunal	Oxic	Detritivore
Evolutinella rotulata	Agglutinated	Planispiral	Intermedia infaunal	Hypoxic	Detritivore
Fissurina (Fissurina) ovata	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Fissurina annectens	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Fissurina circularis	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Fissurina cucullata	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Fissurina cucurbitasema	Hyaline	Spheric unilocular	Shallow Infaunal	Oxic - Hypoxic	Detritivore

		and elongated spheric			
Fissurina granifera	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Fissurina gravata	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Fissurina laevigata	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Fissurina marginata	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Fissurina orbignyana	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Fissurina piriformis	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Fissurina sp.	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Fissurina submarginata	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Fissurina susanae	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Fursenkoina bradyi	Hyaline	Biserial	Intermedia Infaunal	Hypoxic - anoxic	Detritivore
Fursenkoina schreibersiana	Hyaline	Biserial	Intermedia Infaunal	Hypoxic - anoxic	Detritivore
Fursenkoina texturata	Hyaline	Biserial	Intermedia Infaunal	Hypoxic - anoxic	Detritivore

Galwayella trigonoornata	Hyaline	Spheric unilocular and elongated spheric	Intermedia Infaunal	Oxic	Detritivore
Glandulina laevigata	Hyaline	Uniserial	Intermedia Infaunal	Oxic	Detritivore
Glandulina ovula	Hyaline	Uniserial	Intermedia Infaunal	Oxic	Detritivore
Glandulina symmetrica	Hyaline	Uniserial	Intermedia Infaunal	Oxic	Detritivore
Glaphyrammina americana	Agglutinated	Planispiral	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Globobulimina affinis	Hyaline	Triserial	Intermedia Infaunal	Oxic - Hypoxic	Detritivore
Globobulimina auriculata	Hyaline	Triserial	Intermedia Infaunal	Oxic - Hypoxic	Carnivore
Globobulimina hoeglundi	Hyaline	Triserial	Intermedia Infaunal	Oxic - Hypoxic	Detritivore
Globobulimina notovata	Hyaline	Triserial	Intermedia Infaunal	Oxic - Hypoxic	Detritivore
Globobulimina pacifica	Hyaline	Triserial	Intermedia Infaunal	Oxic - Hypoxic	Detritivore
Globobulimina sp	Hyaline	Triserial	Intermedia Infaunal	Oxic - Hypoxic	Detritivore
Globobulimina spinifera	Hyaline	Triserial	Intermedia Infaunal	Oxic - Hypoxic	Detritivore
Globobulimina subaffinis	Hyaline	Triserial	Intermedia Infaunal	Oxic - Hypoxic	Detritivore
Globobulimina turgida	Hyaline	Triserial	Intermedia Infaunal	Oxic - Hypoxic	Carnivore
Globocassidulina crassa	Hyaline	Globose, subglobose, ovoid or streptospiral	Shallow Infaunal	Oxic - Anoxic	Detritivore
Globocassidulina minima	Hyaline	Globose, subglobose, ovoid or streptospiral	Infaunal	Oxic - Anoxic	Detritivore
Globocassidulina sp	Hyaline	Globose, subglobose, ovoid or streptospiral	Infaunal	Oxic - Anoxic	Detritivore
Globocassidulina subglobosa	Hyaline	Globose, subglobose, ovoid or streptospiral	Epifaunal	Oxic - Anoxic	Detritivore
Glomospira gordialis	Agglutinated	Irregular	Epifauna/Shallow Infaunal	Hypoxic - anoxic	Phytodetritivore
Gyroidina altiformis	Hyaline	Trochospiral	Epifaunal/SI	Oxic - Hypoxic	Detritivore
Gyroidina gemma	Hyaline	Trochospiral	Epifaunal/SI	Oxic - Hypoxic	Detritivore
Gyroidina lamarckiana	Hyaline	Trochospiral	Epifaunal/SI	Oxic - Hypoxic	Detritivore

Gyroidina orbicularis	Hyaline	Trochospiral	Epifaunal/SI	Oxic - Hypoxic	Detritivore
Gyroidina polia	Hyaline	Trochospiral	Epifaunal/SI	Oxic - Hypoxic	Detritivore
Gyroidina rothwelli	Hyaline	Trochospiral	Epifaunal/SI	Oxic - Hypoxic	Detritivore
Gyroidina soldanii var multilocula	Hyaline	Trochospiral	Epifaunal/SI	Oxic - Hypoxic	Detritivore
Gyroidinoides sp	Hyaline	Trochospiral	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Hansenisca soldanii	Hyaline	Trochospiral	Shallow Infaunal	Oxic - Anoxic	Detritivore
Hansenisca sp	Hyaline	Trochospiral	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Hanzawaia boueana	Hyaline	Trochospiral	Shallow Infaunal	Hypoxic	Phytodetritivore
Hanzawaia mexicana	Hyaline	Trochospiral	Shallow Infaunal	Hypoxic	Phytodetritivore
Hanzawaia prona	Hyaline	Trochospiral	Shallow Infaunal	Hypoxic	Phytodetritivore
Haplophragmoides bulloides	Agglutinated	Planispiral	Intermedia Infaunal	Oxic	Phytodetritivore
Haplophragmoides evoluta	Agglutinated	Planispiral	Intermedia Infaunal	Oxic	Phytodetritivore
Haplophragmoides mexicanus	Agglutinated	Planispiral	Intermedia Infaunal	Oxic	Phytodetritivore
Haplophragmoides planissima	Agglutinated	Planispiral	Intermedia Infaunal	Oxic - Hypoxic	Phytodetritivore
Haplophragmoides pusillus	Agglutinated	Planispiral	Intermedia Infaunal	Oxic - Hypoxic	Phytodetritivore
Haplophragmoides sp	Agglutinated	Planispiral	Intermedia Infaunal	Oxic - Hypoxic	Phytodetritivore
Haplophragmoides subsphaeroides	Agglutinated	Planispiral	Intermedia Infaunal	Oxic - Hypoxic	Phytodetritivore
Haplophragmoides wilberti	Agglutinated	Planispiral	Intermedia Infaunal	Oxic	Phytodetritivore
Heterolepa bradyi	Hyaline	Trochospiral	Shallow Infaunal	Oxic	Detritivore
Heterolepa broeckiana	Hyaline	Trochospiral	Shallow Infaunal	Oxic	Detritivore
Heterolepa sp	Hyaline	Trochospiral	Shallow Infaunal	Oxic	Detritivore
Hoeglundina elegans	Hyaline	Trochospiral	Epifaunal/SI	Oxic - Hypoxic	Omnivore
Hormosina globulifera	Agglutinated	Uniserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Hormosinella distans	Agglutinated	Uniserial	Shallow Infaunal	Oxic	Detritivore
Hormosinelloides guttifer	Agglutinated	Uniserial	Shallow Infaunal	Oxic	Detritivore
Hyalinonetrion clavatum	Hyaline	Spheric unilocular and elongated spheric	Intermedia infaunal	Oxic - Hypoxic	Detritivore
Hyalinonetrion gracillimum	Hyaline	Spheric unilocular and	Intermedia infaunal	Oxic - Hypoxic	Detritivore

		elongated spheric			
Hyperammina	Agglutinated	Tubular	Shallow Infaunal	Oxic - Hypoxic	Bacterivore
Hyperammina echinata	Agglutinated	Tubular	Shallow Infaunal	Oxic - Hypoxic	Bacterivore
Hyperammina elongata	Agglutinated	Tubular	Shallow Infaunal	Oxic - Hypoxic	Bacterivore
Hyperammina friabilis	Agglutinated	Tubular	Shallow Infaunal	Oxic - Hypoxic	Bacterivore
Karreriella baccata	Agglutinated	Biserial	Shallow Infaunal	Hypoxic	Detritivore
Karreriella bradyi	Agglutinated	Biserial	Shallow Infaunal	Hypoxic	Detritivore
Labrospira crassimargo	Agglutinated	Planispiral	Shallow Infaunal	Oxic	Detritivore
Labrospira robusta	Agglutinated	Planispiral	Shallow Infaunal	Oxic	Detritivore
Laevidentalina baggi	Hyaline	Uniserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Laevidentalina communis	Hyaline	Uniserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Laevidentalina elegans	Hyaline	Uniserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Laevidentalina filiformis	Hyaline	Uniserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Laevidentalina subsoluta	Hyaline	Uniserial	Shallow Infaunal	Oxic	Detritivore/ Phytodetritivore
Lagena aspera	Hyaline	Spheric unilocular and elongated spheric	Intermedia Infaunal	Oxic	Detritivore
Lagena hispidula	Hyaline	Spheric unilocular and elongated spheric	Intermedia Infaunal	Oxic	Detritivore
Lagena parvulipora	Hyaline	Spheric unilocular and elongated spheric	Intermedia Infaunal	Oxic	Detritivore
Lagena striata	Hyaline	Spheric unilocular and elongated spheric	Intermedia Infaunal	Oxic	Detritivore
Lagena substriata	Hyaline	Spheric unilocular and elongated spheric	Intermedia Infaunal	Oxic - Hypoxic	Detritivore
Lagena sulcata	Hyaline	Spheric unilocular and elongated spheric	Intermedia Infaunal	Oxic - Hypoxic	Detritivore

Lagenammina ampullacea	Agglutinated	Spheric unilocular and elongated spheric	Epifaunal/SI	Oxic	Bacterivore
Lagenammina difflugiformis	Agglutinated	Spheric unilocular and elongated spheric	Epifaunal/SI	Oxic - Hypoxic	Bacterivore
Lenticulina convergens	Hyaline	Planispiral	Epifaunal	Oxic - Hypoxic	Detritivore
Lenticulina gibba	Hyaline	Planispiral	Epifaunal/SI	Oxic - Hypoxic	Detritivore
Lenticulina inornata	Hyaline	Planispiral	Epifaunal	Oxic - Hypoxic	Detritivore
Lenticulina pliocaena	Hyaline	Planispiral	Epifaunal	Oxic - Hypoxic	Detritivore
Lenticulina rotulata	Hyaline	Planispiral	Epifaunal	Oxic - Hypoxic	Detritivore
Lenticulina sp	Hyaline	Planispiral	Epifaunal	Oxic - Hypoxic	Detritivore
Lenticulina thalmanni	Hyaline	Planispiral	Epifaunal	Hypoxic	Detritivore
Liebusella goesi	Agglutinated	Uniserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Lobatula lobatula	Hyaline	Trochospiral	Epifaunal	Oxic	Phytodetritivore
Lobatula ungeriana	Hyaline	Trochospiral	Shallow Infaunal	Oxic	Detritivore
Lobatula wuellerstorfi	Hyaline	Trochospiral	Epifaunal	Oxic	Phytodetritivore
Loxostomina limbata	Hyaline	Biserial	Intermedia Infaunal	Anoxic	Phytodetritivore
Lugdunum hantkenianum	Hyaline	Biserial	Intermedia Infaunal	Hypoxic - Anoxic	Phytodetritivore
Marsipella elongata	Agglutinated	Tubular	Shallow Infaunal	Oxic	Detritivore/ Bacterivore
Martinottiella communis	Agglutinated	Uniserial	Intermedia Infaunal	Hypoxic	Detritivore
Martinottiella nodulosa	Agglutinated	Uniserial	Intermedia Infaunal	Hypoxic	Detritivore
Melonis affinis	Hyaline	Planispiral	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Melonis pompilioides	Hyaline	Planispiral	SI/II	Oxic - Hypoxic	Detritivore
Miliolinella subrotunda	Porcellaneous	Miliolide	Epifaunal	Oxic	Herbivore
Nodosinum gaussicum	Agglutinated	Uniserial	Intermedia Infaunal	Oxic	Detritivore
Nodulina dentaliniformis	Agglutinated	Uniserial	Intermedia Infaunal	Oxic - Hypoxic	Detritivore
Nonion commune	Hyaline	Planispiral	Shallow Infaunal	Oxic - Anoxic	Detritivore
Nonion pacificum	Hyaline	Planispiral	Shallow Infaunal	Oxic	Detritivore
Nonionella astricta	Hyaline	Trochospiral	Epifaunal	Hypoxic	Detritivore
Nonionella auris	Hyaline	Trochospiral	Epifaunal	Hypoxic	Detritivore

Nonionella sp	Hyaline	Trochospiral	Epifaunal	Hypoxic	Detritivore
Nonionella stella	Hyaline	Trochospiral	Epifaunal	Oxic - Anoxic	Detritivore
Nonionoides grateloupii	Hyaline	Trochospiral	Shallow Infaunal	Oxic - Anoxic	Phytodetritivore
Nonionoides turgidus	Hyaline	Trochospiral	Shallow Infaunal	Oxic - Hypoxic	Phytodetritivore
Nubeculina sp.	Agglutinated	Uniserial	Intermedia Infaunal	Hypoxic - Anoxic	Detritivore
Nummoloculina sp	Porcellaneous	Miliolide	Shallow Infaunal	Oxic	Phytodetritivore
Nuttallides umbonifer	Hyaline	Trochospiral	Shallow Infaunal	Oxic	Detritivore
Obesopleurostomella brevis	Hyaline	Biserial	Shallow Infaunal	Hypoxic	Detritivore
Oolina globosa	Hyaline	Spheric unilocular and elongated spheric	Intermedia infaunal	Hypoxic	Detritivore
Oridorsalis pauciapertura	Hyaline	Trochospiral	Intermedia infaunal	Oxic - Hypoxic	Detritivore
Oridorsalis tenerus subsp. Profundus	Hyaline	Trochospiral	Intermedia infaunal	Oxic - Hypoxic	Detritivore
Oridorsalis umbonatus	Hyaline	Trochospiral	Intermedia infaunal	Oxic - Hypoxic	Detritivore
Palliolatella bradii	Hyaline	Trochospiral	Intermedia infaunal	Oxic	Detritivore
Paracassidulina minuta	Hyaline	Globose, subglobose, ovoid or streptospiral	Shallow Infaunal	Oxic	Detritivore
Parafissurina lateralis	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Hypoxic	Detritivore
Parafissurina ovata	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic	Detritivore
Parafissurina sp	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Hypoxic	Detritivore
Parafissurina ventricosa	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic	Detritivore
Paratrochammina challengeri	Agglutinated	Trochospiral	Epifaunal	Oxic - Hypoxic	Phytodetritivore / Bacterivore

Paratrochammina globorotaliformis	Agglutinated	Trochospiral	Epifaunal	Oxic	Phytodetritivore / Bacterivore
Planispirinoides bucculentus	Porcellaneous	Miliolide	Intermedia Infaunal	Oxic	Detritivore
Planulina ecuadorana	Hyaline	Trochospiral	Epifaunal	Oxic	Phytodetritivore
Polystomammina nitida	Agglutinated	Trochospiral	Shallow Infaunal	Oxic	Detritivore
Portatrochammina karica	Agglutinated	Trochospiral	Shallow Infaunal	Oxic	Phytodetritivore / Bacterivore
Portatrochammina murrayi	Agglutinated	Trochospiral	Epifaunal/SI	Oxic	Phytodetritivore /Bacterivore
Portatrochammina pacifica	Agglutinated	Trochospiral	Shallow Infaunal	Oxic	Phytodetritivore /Bacterivore
Praeglobobulimina primitiva	Hyaline	Triserial	Intermedia Infaunal	Hypoxic	Detritivore
Praeglobobulimina spinescens	Hyaline	Triserial	Intermedia Infaunal	Hypoxic	Detritivore
Procerolagena distoma	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Procerolagena gracilis	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Protoglobobulimina pupoides	Hyaline	Triserial	Shallow Infaunal	Anoxic	Detritivore
Psammatodendron arborescens	Agglutinated	Irregular	Shallow Infaunal	Oxic	Bacterivore
Psammosiphonella discreta	Agglutinated	Tubular	Epifaunal	Oxic	Bacterivore
Psammosphaera fusca	Agglutinated	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic	Bacterivore
Pseudobrizalina lobata	Hyaline	Biserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Pseudonodosinella nodulosa	Agglutinated	Uniserial	Intermedia Infaunal	Oxic	Detritivore
Pseudoparrella pacifica	Hyaline	Trochospiral	SI/II	Hypoxic - Anoxic	Omnivore
Pseudoparrella subperuviana	Hyaline	Trochospiral	SI/II	Hypoxic - Anoxic	Omnivore
Pullenia bulloides	Hyaline	Globose, subglobose, ovoid or streptospiral	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Pullenia elegans	Hyaline	Globose, subglobose,	Shallow Infaunal	Oxic	Detritivore

		ovoid or streptospiral			
Pullenia quinqueloba	Hyaline	Globose, subglobose, ovoid or streptospiral	Shallow Infaunal	Oxic	Detritivore
Pullenia sp	Hyaline	Globose, subglobose, ovoid or streptospiral	Shallow Infaunal	Oxic	Detritivore
Pullenia subcarinata	Hyaline	Globose, subglobose, ovoid or streptospiral	Shallow Infaunal	Oxic	Detritivore
Pulleniatina obliquiloculata	Hyaline	Globose, subglobose, ovoid or streptospiral	Shallow Infaunal	Oxic	Detritivore
Pulleniella asymmetrica	Hyaline	Globose, subglobose, ovoid or streptospiral	Shallow Infaunal	Oxic	Detritivore
Pyrgo depressa	Porcellaneous	Miliolide	Shallow Infaunal	Oxic	Herbivore
Pyrgo elongata	Porcellaneous	Miliolide	Shallow Infaunal	Oxic	Herbivore
Pyrgo murrhina	Porcellaneous	Miliolide	Shallow Infaunal	Oxic	Herbivore
Pyrgo sarsi	Porcellaneous	Miliolide	Shallow Infaunal	Oxic	Herbivore
Pyrgo sp	Porcellaneous	Miliolide	Shallow Infaunal	Oxic	Herbivore
Pyrgo subsphaerica	Porcellaneous	Miliolide	Shallow Infaunal	Oxic	Herbivore
Pyrgoella irregularis	Porcellaneous	Miliolide	Shallow Infaunal	Oxic	Herbivore
Pyrgoella sphaera	Porcellaneous	Miliolide	Shallow Infaunal	Oxic	Herbivore
Pyrulina	Hyaline	Biserial	Intermedia infaunal	Oxic	Detritivore
Pyrulina angusta	Hyaline	Biserial	Intermedia infaunal	Oxic	Detritivore
Quinqueloculina seminulum	Porcellaneous	Miliolide	Epifaunal/SI	Oxic - Hypoxic	Herbivore
Quinqueloculina sp	Porcellaneous	Miliolide	Epifaunal/SI	Oxic	Herbivore
Quinqueloculina weaveri	Porcellaneous	Miliolide	Epifaunal/SI	Oxic	Herbivore
Recurvoidella bradyi	Agglutinated	Planispiral	Intermedia Infaunal	Oxic	Phytodetritivore
Recurvoides contortus	Agglutinated	Trochospiral	Shallow Infaunal	Oxic - Anoxic	Detritivore
Recurvoides turbinatus	Agglutinated	Trochospiral	Intermedia infaunal	Oxic	Detritivore
Reophax apiculatus	Agglutinated	Uniserial	Shallow Infaunal	Oxic	Detritivore

Reophax bradyi	Agglutinated	Uniserial	Shallow Infaunal	Oxic	Detritivore
Reophax duplex	Agglutinated	Uniserial	Shallow Infaunal	Oxic	Detritivore
Reophax fusiformis	Agglutinated	Uniserial	Shallow Infaunal	Oxic	Detritivore
Reophax globosus	Agglutinated	Uniserial	Shallow Infaunal	Oxic	Detritivore
Reophax insectus	Agglutinated	Uniserial	Shallow Infaunal	Oxic	Detritivore
Reophax pilulifer	Agglutinated	Uniserial	Shallow Infaunal	Oxic	Detritivore
Reophax pisiformis	Agglutinated	Uniserial	Shallow Infaunal	Oxic	Detritivore
Reophax regularis	Agglutinated	Uniserial	Shallow Infaunal	Oxic	Detritivore
Reophax scorpiurus	Agglutinated	Uniserial	Shallow Infaunal	Oxic	Detritivore
Reophax sp	Agglutinated	Uniserial	Shallow Infaunal	Oxic	Detritivore
Reophax subdentaliniformis	Agglutinated	Uniserial	SI/II	Oxic	Detritivore
Reophax subfusiformis	Agglutinated	Uniserial	Shallow Infaunal	Oxic	Detritivore
Reussoolina apiculata	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic	Detritivore
Reussoolina laevis	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Rhabdammina abyssorum	Agglutinated	Tubular	Epifaunal	Oxic	Bacterivore
Rhabdammina pacifica	Agglutinated	Tubular	Epifaunal	Oxic	Bacterivore
Rhabdammina sp.	Agglutinated	Tubular	Epifaunal	Oxic	Bacterivore
Rhabdamminella cylindrica	Agglutinated	Tubular	Epifaunal	Oxic	Bacterivore
Rhizammina algaeformis	Agglutinated	Tubular	Epifaunal	Oxic	Bacterivore
Rhizammina sp	Agglutinated	Tubular	Epifaunal	Oxic	Bacterivore
Rhumblerella humboldti	Agglutinated	Triserial	Epifaunal	Oxic - Anoxic	Detritivore
Robertina sp	Hyaline	Trochospiral	Shallow Infaunal	Oxic - Hypoxic	Carnivore
Robertinoides bradyi	Hyaline	Trochospiral	Shallow Infaunal	Oxic - Hypoxic	Carnivore
Robertinoides oceanica	Hyaline	Trochospiral	Shallow Infaunal	Oxic - Hypoxic	Carnivore
Rosalina globularis	Hyaline	Trochospiral	Shallow Infaunal	Oxic	Omnivore
Rotalina pleurostomata	Hyaline	Trochospiral	Shallow Infaunal	Oxic	Detritivore
Rutherfordoides rotundatus	Hyaline	Biserial	Shallow Infaunal	Oxic - Anoxic	Detritivore
Saccammina sphaerica	Agglutinated	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic	Bacterivore
Saccorhiza ramosa	Agglutinated	Tubular	Intermedia infaunal	Oxic	Bacterivore

Sahulia conica	Agglutinated	Biserial	Intermedia infaunal	Oxic - Hypoxic	Detritivore
Saracenaria stolidota	Hyaline	Planispiral	Intermedia infaunal	Hypoxic	Detritivore
Sigmoilina sp	Porcellaneous	Miliolide	Shallow Infaunal	Oxic	Herbivore
Siphouvigerina hispida	Hyaline	Triserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Siphouvigerina proboscidea	Hyaline	Triserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Sphaeroidina bulloides	Hyaline	Globose, subglobose, ovoid or streptospiral	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Sphaeroidina sp	Hyaline	Globose, subglobose, ovoid or streptospiral	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Spirillina sp	Hyaline	Planispiral	Epifaunal/Shallow Infaunal	Oxic - Hypoxic	Detritivore
Spiroloculina robusta	Porcellaneous	Miliolide	Shallow Infaunal	Oxic	Herbivore
Spiroloculina sp	Porcellaneous	Miliolide	Shallow Infaunal	Oxic	Herbivore
Spiroplectammina biformis	Agglutinated	Biserial	Intermedia infaunal	Oxic - Hypoxic	Detritivore
Spirosigmoilina tenuis	Porcellaneous	Miliolide	Shallow Infaunal	Oxic	Herbivore
Spirosigmoilinella sp.	Agglutinated	Miliolide	Shallow Infaunal	Oxic	Detritivore
Stainforthia fusiformes	Hyaline	Biserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Suggrunda eckisi	Hyaline	Biserial	Shallow Infaunal	Anoxic	Detritivore
Suggrunda kleinpelli	Hyaline	Biserial	Shallow Infaunal	Anoxic	Detritivore
Suggrunda porosa	Hyaline	Biserial	Shallow Infaunal	Anoxic	Detritivore
Takayanagia delicata	Hyaline	Biserial	Intermedia infaunal	Oxic - Hypoxic	Omnivore
Techitella melo	Agglutinated	Tubular	Shallow Infaunal	Oxic	Bacterivore
Technitella sp.	Agglutinated	Tubular	Shallow Infaunal	Oxic	Bacterivore
Textularia earlandi	Agglutinated	Biserial	SI/II	Oxic	Omnivore
Textularia gramen	Agglutinated	Biserial	SI/II	Oxic	Omnivore
Textularia lythostrota	Agglutinated	Biserial	SI/II	Oxic	Omnivore
Textularia porrecta	Agglutinated	Biserial	SI/II	Oxic	Omnivore
Thurammina albicans	Agglutinated	Spheric unilocular and elongated spheric	Shallow Infaunal	Oxic	Bacterivore
Tolypammina vagans	Agglutinated	Irregular	Shallow Infaunal	Oxic - Hypoxic	Bacterivore
Trifarina angulosa	Hyaline	Triserial	Shallow Infaunal	Oxic - anoxic	Detritivore
Triloculina tricarinata	Porcellaneous	Miliolide	Epifaunal/SI	Oxic	Phytodetritivore

Triloculina trigonula	Porcellaneous	Miliolide	Epifaunal/SI	Oxic	Herbivore
Trochammina inflata	Agglutinated	Planispiral	Shallow Infaunal	Oxic	Phytodetritivore
Trochammina intermedia	Agglutinated	Planispiral	Shallow Infaunal	Oxic	Phytodetritivore
Trochammina nana	Agglutinated	Planispiral	Shallow Infaunal	Oxic	Phytodetritivore
Trochammina sp	Agglutinated	Planispiral	Shallow Infaunal	Oxic	Phytodetritivore
Trochammina squamata	Agglutinated	Planispiral	Shallow Infaunal	Oxic	Phytodetritivore
Trochammina triloba	Agglutinated	Planispiral	Epifaunal/SI	Oxic	Phytodetritivore
Uvigerina auberiana	Hyaline	Triserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Uvigerina canariensis	Hyaline	Triserial	Shallow Infaunal	Hypoxic	Detritivore
Uvigerina dirupta	Hyaline	Triserial	Shallow Infaunal	Oxic - Hypoxic	Detritivore
Uvigerina peregrina	Hyaline	Triserial	Shallow Infaunal	Oxic - Anoxic	Omnivore
Uvigerina semiornata	Hyaline	Triserial	Shallow Infaunal	Hypoxic - Anoxic	Detritivore
Uvigerina senticosa	Hyaline	Triserial	Shallow Infaunal	Hypoxic	Detritivore
Uvigerina shiwoensis	Hyaline	Triserial	Shallow Infaunal	Hypoxic	Detritivore
Uvigerina sp	Hyaline	Triserial	Shallow Infaunal	Hypoxic	Detritivore
Uvigerina striata	Hyaline	Triserial	Shallow Infaunal	Hypoxic	Detritivore
Vaginulina americana	Hyaline	Uniserial	Shallow Infaunal	Oxic	Omnivore
Valvulineria araucana	Hyaline	Trochospiral	Epifaunal	Oxic - Hypoxic	Detritivore
Valvulineria bradyana	Hyaline	Trochospiral	Epifaunal	Oxic - Hypoxic	Detritivore
Valvulineria glabra	Hyaline	Trochospiral	Epifaunal	Oxic - Hypoxic	Detritivore
Valvulineria inaequalis	Hyaline	Trochospiral	Epifaunal	Oxic - Hypoxic	Detritivore
Valvulineria inflata	Hyaline	Trochospiral	Epifaunal	Oxic - Hypoxic	Detritivore
Vasicostella inflatiperforata	Hyaline	Spheric unilocular and elongated spheric	Shallow Infaunal	Hypoxic	Detritivore
Veleroninoides scitulus	Agglutinated	Planispiral	Shallow Infaunal	Oxic	Detritivore
Verneuilinulla propinqua	Agglutinated	Triserial	Intermedia infaunal	Hypoxic	Detritivore

Appendix 6. Spearman's correlation coefficients between taxonomic and functional diversity and their *p*-value. Variables that are not significantly correlated are marked in bold. Variable “Taxa” = Species richness.

Variable 1	**Variable 2**	**rho**	***p*-value**	**Variable 1**	**Variable 2**	**rho**	***p*-value**

Taxa	Simpson	0.639	$p < 0.01$	Pielou	Abundance	-0.682	$p < 0.01$
Taxa	Shannon	0.794	$p < 0.01$	**Pielou**	**FRic**	**0.158**	**$p \geq 0.05$**
Taxa	**Pielou**	**-0.040**	**$p \geq 0.05$**	Pielou	FDiv	-0.211	$p < 0.05$
Taxa	Fisher_a	0.631	$p < 0.01$	Pielou	FDis	0.532	$p < 0.01$
Taxa	Abundance	0.391	$p < 0.01$	Pielou	FEve	0.623	$p < 0.01$
Taxa	FRic	0.841	$p < 0.01$	Pielou	RaoQ	0.514	$p < 0.01$
Taxa	**FDiv**	**-0.057**	**$p \geq 0.05$**	Fisher_a	Abundance	-0.236	$p < 0.05$
Taxa	FDis	0.333	$p < 0.01$	Fisher_a	FRic	0.696	$p < 0.01$
Taxa	FEve	-0.257	$p < 0.01$	**Fisher_a**	**FDiv**	**-0.146**	**$p \geq 0.05$**
Taxa	RaoQ	0.349	$p < 0.01$	Fisher_a	FDis	0.569	$p < 0.01$
Simpson	Shannon	0.962	$p < 0.01$	Fisher_a	FEve	0.337	$p < 0.01$
Simpson	Pielou	0.672	$p < 0.01$	Fisher_a	RaoQ	0.591	$p < 0.01$
Simpson	Fisher_a	0.834	$p < 0.01$	**Abundance**	**FRic**	**0.140**	**$p \geq 0.05$**
Simpson	**Abundance**	**-0.179**	**$p \geq 0.05$**	Abundance	FDiv	0.197	$p < 0.05$
Simpson	FRic	0.683	$p < 0.01$	Abundance	FDis	-0.375	$p < 0.01$
Simpson	FDiv	-0.189	$p < 0.05$	Abundance	FEve	-0.667	$p < 0.01$
Simpson	FDis	0.627	$p < 0.01$	Abundance	RaoQ	-0.367	$p < 0.01$
Simpson	FEve	0.216	$p < 0.05$	**FRic**	**FDiv**	**-0.120**	**$p \geq 0.05$**
Simpson	RaoQ	0.625	$p < 0.01$	FRic	FDis	0.494	$p < 0.01$
Shannon	Pielou	0.506	$p < 0.01$	**FRic**	**FEve**	**-0.012**	**$p \geq 0.05$**
Shannon	Fisher_a	0.849	$p < 0.01$	FRic	RaoQ	0.526	$p < 0.01$
Shannon	**Abundance**	**-0.049**	**$p \geq 0.05$**	**FDiv**	**FDis**	**-0.087**	**$p \geq 0.05$**
Shannon	FRic	0.787	$p < 0.01$	**FDiv**	**FEve**	**0.080**	**$p \geq 0.05$**
Shannon	**FDiv**	**-0.164**	**$p \geq 0.05$**	**FDiv**	**RaoQ**	**-0.086**	**$p \geq 0.05$**
Shannon	FDis	0.593	$p < 0.01$	FDis	FEve	0.414	$p < 0.01$
Shannon	**FEve**	**0.108**	**$p \geq 0.05$**	FDis	RaoQ	0.990	$p < 0.01$
Shannon	RaoQ	0.602	$p < 0.01$	FEve	RaoQ	0.424	$p < 0.01$
Pielou	Fisher_a	0.586	$p < 0.01$				

Appendix 7. Niche parameters of all the species of benthic foraminifera in the marine surface sediments used in this study with a contribution > 0.05% in all the stations and their traits estimated by Outlying Mean Index (OMI). Inertia = total variability, OMI = Outlying Mean Index (i.e., marginality), Tol = Tolerance, RTol = Residual Tolerance, OMI% = percentage of variability given by OMI, Tol% = percentage of variability given by Tol, RTol% = percentage of variability given by RTol. Species in bold: *p*-value <0.05
*Abbreviations of the traits. Shell: Group agglutinated (GA), Group hyaline (GH); Morpho: Morphology planispiral (MP), morphology tubular (MTub), morphology biserial (MB), morphology triserial (MT), morphology trochospiral (MTroc), morphology globose/subglobose/ovoid or streptospiral (MG), morphology uniserial (MU), morphology spheric unilocular and elongated spheric (MS). Microhabitat (Habit): group epifaunal (GE), group shallow infaunal (GSI) and group intermedia infaunal (GII). Trophic behaviour (Trophy): Detritivore (Det), Phytodetritivore (PhDet), Bacterivore (Bact) and Omnivore (Omni).

Specie	Wall	Code	Morpho	Habit	Trophy	inertia	OMI	Tol	Rtol	omi %	tol%	rtol %	*p*-value
Ammobaculites agglutinans	GA	Aaggl	MP	GSI	Bact	17.12	2.05	1.09	13.98	12	6.40	81.70	0.54
Ammodiscus catinus	GA	Acati	MP	GE	Det	17.98	12.53	1.63	3.82	69.70	9	21.30	0.11
Astrorhizoides cornutus	GA	Acorn	MTub	GE	Bact	11.54	11.54	0	0	100	0	0	0.50
Astrononion echolsi	GH	Aecho	MP	GSI	PhDet	5.85	5.85	0	0	100	0	0	0.92
Ammoglobigerina globigeriniformis	GA	Aglobi	MTroc	GSI	Det	12.62	3.05	3.01	6.56	24.20	23.80	52.00	0.10
Ammoglobigerina globulosa	GA	Aglobu	MTroc	GSI	Det	5.99	3.29	0.04	2.65	54.90	0.70	44.30	0.93
Adercotryma glomeratum	GA	Aglom	MG	GE	Herb	11.87	1.53	1.22	9.12	12.90	10.30	76.90	0.88
Ammosphaeroidina grandis	GA	Agrand	MG	GII	Det	29.54	29.54	0	0	100	0	0	0.13
Astrorhiza granulosa	GA	Agranu	MI	GII	Bact	11.47	8.21	1.74	1.52	71.60	15.20	13.20	0.67
Ammodiscus incertus	**GA**	**Aince**	**MP**	**GE**	**Det**	**20.10**	**4.77**	**3.79**	**11.53**	**23.70**	**18.90**	**57.40**	**0.04**
Astacolus insolitus	GH	Ainso	MP	GSI	Det	8.38	5.67	0.04	2.66	67.70	0.50	31.80	0.72
Alveolophragmium orbiculatum	GA	Aorb	MP	GSI	Det	5.32	5.23	0.01	0.08	98.40	0.10	1.50	0.65
Ammodiscus planorbis	GA	Aplan	MP	GE	Det	10.08	8.37	0.37	1.34	83	3.70	13.30	0.09
Astrammina rara	GA	Arara	MI	GII	Car	17.34	8.14	2.80	6.41	46.90	16.10	36.90	0.38
Astrononion stellatum	GH	Astel	MP	GSI	PhDet	5.85	5.85	0	0	100	0	0	0.93
Ammodiscus tenuis	GA	Atenu	MP	GE	Det	7.58	2.21	0.62	4.76	29.20	8.10	62.70	0.95
Bolivina alata	GH	Balat	MB	GSI	PhDet	14.97	4.18	3.76	7.03	28	25.10	46.90	0.12
Bathysiphon sp.	GA	Bat	MTub	GSI	PhDet	18.02	18.02	0	0	100	0	0	0.25
Bolivina (Loxostomum) boltovskoyi	GH	Bbolt	MB	GE	PhDet	18.02	18.02	0	0	100	0	0	0.21
Bathysiphon capillare	**GA**	**Bcapi**	**MTub**	**GSI**	**PhDet**	**24.62**	**24.45**	**0**	**0.16**	**99.30**	**0**	**0.70**	**0.02**
Bolivina costata	**GH**	**Bcost**	**MB**	**GSI**	**PhDet**	**24.40**	**12.67**	**2.50**	**9.24**	**51.90**	**10.20**	**37.90**	**0.01**
Buliminella elegantissima limbosa	**GH**	**Belim**	**MTroc**	**GE**	**Det**	**31.44**	**31.02**	**0.03**	**0.40**	**98.60**	**0.10**	**1.30**	**0.01**

Bulimina elongata	GH	Belon	MT	GII	Det	10.63	10.63	0	0	100	0	0	0.69
Buliminella elegantissima tenuis	**GH**	**Belte**	**MTroc**	**GE**	**Det**	**30.96**	**30.50**	**0.02**	**0.45**	**98.50**	**0.1**	**1.4**	**0.01**
Bathysiphon fusca	GA	Bfusc	MTub	GSI	PhDet	10.12	10.12	0	0	100	0	0	0.65
Bolivina humilis	GH	Bhumi	MB	GSI	PhDet	8.31	8.31	0	0	100	0	0	0.81
Bolivina interjuncta	**GH**	**Binte**	**MB**	**GE**	**PhDet**	**18.74**	**5.64**	**1.92**	**11.18**	**30.1**	**10.3**	**59.7**	**0.02**
Bulimina marginata	GH	Bmarg	MT	GII	Det	7.46	6.40	0.01	1.04	85.9	0.1	14.0	0.51
Bolivinita minuta	**GH**	**Bminu**	**MB**	**GE**	**PhDet**	**15.21**	**9.00**	**0.33**	**5.88**	**59.2**	**2.2**	**38.7**	**0.01**
Bolivina pacifica	GH	Bpaci	MB	GE	PhDet	12.03	9.32	1.20	1.51	77.4	10	12.6	0.44
Bulimina pagoda	**GH**	**Bpago**	**MT**	**GSI**	**Det**	**20.44**	**17.99**	**0.49**	**1.95**	**88**	**2.4**	**9.6**	**0.05**
Buccella peruviana	GH	Bperu	MTroc	GSI	Det	20.24	14.59	1.1	4.55	72.1	5.4	22.5	0.10
Bolivina plicata	**GH**	**Bplic**	**MB**	**GE**	**PhDet**	**20.80**	**7.70**	**4.94**	**8.16**	**37**	**23.7**	**39.2**	**0.01**
Bolivina (Loxostomum) salvadorensis	GH	Bsalv	MB	GE	PhDet	18.02	18.02	0	0	100	0	0	0.32
Bolivina seminuda	**GH**	**Bsemi**	**MB**	**GE**	**PhDet**	**28.15**	**15.28**	**5.22**	**7.65**	**54.3**	**18.5**	**27.2**	**0.01**
Bolivina spissa	GH	Bspis	MB	GE	PhDet	11.53	2.20	1.69	7.65	19.1	14.6	66.3	0.10
Bulimina striata	GH	Bstri	MT	GSI	Det	7.58	3.93	0.03	3.62	51.9	0.4	47.8	0.19
Bolivina subadvena	GH	Bsuba	MB	GE	PhDet	23.42	23.42	0	0	100	0	0	0.15
Bolivina subadvena subsp. Acuminata	**GH**	**Bsubacu**	**MB**	**GE**	**PhDet**	**26.57**	**19.77**	**1.01**	**5.79**	**74.4**	**3.8**	**21.8**	**0.01**
Bolivina subaenariensis	GH	Bsubae	MB	GSI	PhDet	17.94	17.94	0	0	100	0	0	0.30
Bulimina sp.	GH	Bul	MT	GII	Det	7.71	7.71	0	0	100	0	0	0.90
Buzasina sp.	GA	Buz	MP	GII	Det	22.81	22.81	0	0	100	0	0	0.20
Bolivina variabilis	GH	Bvari	MB	GE	PhDet	10.63	10.63	0	0	100	0	0	0.63
Cancris sp	GH	Can	MTroc	GII	Det	9.73	9.73	0	0	100	0	0	0.78
Cassidulina auka	**GH**	**Cauka**	**MP**	**GII**	**PhDet**	**19.67**	**11.19**	**1.51**	**6.96**	**56.9**	**7.7**	**35.4**	**0.01**
Cancris auricula	GH	Cauri	MTroc	GII	Det	14.35	14.35	0	0	100	0	0	0.32
Cyclammina cancellata	GA	Ccanc	MP	GSI	Det	12.82	1.05	1.16	10.62	8.2	9	82.8	0.48
Cassidulina carinata	GH	Ccari	MP	GII	PhDet	9.94	2.20	1.48	6.27	22.1	14.9	63	0.15
Cancris carmenensis	**GH**	**Ccarm**	**MTroc**	**GII**	**Det**	**19.05**	**10.12**	**2.83**	**6.09**	**53.1**	**14.9**	**32**	**0.01**
Cibicidoides dispars	GH	Cdisp	MTroc	GE	PhDet	11.27	11.27	0	0	100	0	0	0.63
Cribrostomoides evolutus	GA	Cevol	MP	GII	PhDet	11.20	3.52	0.27	7.41	31.4	2.4	66.2	0.49
Chilostomella sp	GH	Chilo	MG	GII	Det	10.63	10.63	0	0	100	0	0	0.62
Cibicidoides sp	GH	Cibic	MTroc	GE	PhDet	8.95	8.95	0	0	100	0	0	0.71
Cornuspira involvens	GP	Cinvo	MP	GE	PhDet	7.88	6.99	0.02	0.87	88.7	0.2	11	0.74
Cribrostomoides jeffreysii	GA	Cjeff	MP	GSI	Det	5.85	5.85	0	0	100	0	0	0.95
Cassidulina laevigata	GH	Claev	MP	GII	PhDet	11.98	8.82	0.01	3.15	73.6	0.1	26.3	0.53
Cibicidoides mckannai	GH	Cmcka	MTroc	GE	PhDet	15.88	15.88	0	0	100	0	0	0.38
Cibicidoides mundulus	GH	Cmund	MTroc	GE	PhDet	10.27	5.74	1.06	3.47	55.9	10.3	33.8	0.07

Cancris oblongus	GH	Coblo	MTroc	GII	Det	12.14	3.91	0.03	8.2	32.2	0.2	67.6	0.17
Chilostomella oolina	GH	Cooli	MG	GII	Det	12.75	2.24	0.79	9.72	17.6	6.2	76.3	0.44
Chilostomella ovoidea	GH	Covoi	MG	GII	Det	14.01	8.14	1.11	4.76	58.1	7.9	34.0	0.09
Cibicides pachyderma	GH	Cpach	MTroc	GE	PhDet	8.79	7.47	0.22	1.1	84.9	2.5	12.6	0.23
Cribrogoesella pacifica	GA	Cpaci	MTroc	GII	Det	10.34	10.34	0	0	100	0	0	0.63
Cassidulinoides parkeriana	GH	Cpark	MP	GII	PhDet	8.64	5.60	0.01	3.03	64.8	0.1	35	0.66
Crithionina pisum	GA	Cpisu	MS	GSI	Bact	9.01	7.32	0.24	1.45	81.2	2.7	16.1	0.41
Cibicidoides robertsonianus	GH	Crobe	MTroc	GE	PhDet	10.63	10.63	0	0	100	0	0	0.63
Cribrostomoides sphaerilocula	GA	Cspha	MP	GSI	Det	14.45	5.19	1.18	8.08	35.9	8.2	55.9	0.49
Cribrostomoides subglobosus	GA	Csubg	MP	GSI	Det	11.48	9.31	0.01	2.15	81.2	0.1	18.8	0.36
Cyclammina trullissata	GA	Ctrul	MP	GSI	Det	9.73	9.73	0	0	100	0	0	0.77
Cibicidoides variabilis	GH	Cvari	MTroc	GE	PhDet	4.11	4.11	0	0	100	0	0	1.00
Discorbinella bertheloti	GH	Dbert	MTroc	GE	Herb	14.35	14.35	0	0	100	0	0	0.46
Dorothia bradyana	GA	Dbrad	MB	GII	Det	21.76	21.76	0	0	100	0	0	0.24
Discorbis sp	GH	Disc	MTroc	GE	Herb	10.31	9.53	0.15	0.64	92.4	1.4	6.2	0.43
Discorbis peruvianus	GH	Dperu	MTroc	GE	Herb	9.73	9.73	0	0	100	0	0	0.72
Dorothia pseudoturris	GA	Dpseu	MB	GII	Det	15.88	15.88	0	0	100	0	0	0.31
Dorothia scabra	**GA**	**Dscab**	**MB**	**GII**	**Det**	**22.26**	**20.27**	**0.01**	**1.98**	**91.1**	**0.0**	**8.9**	**0.02**
Eggerelloides advena	**GA**	**Eadve**	**MT**	**GSI**	**Det**	**31.91**	**23.27**	**2.70**	**5.93**	**72.9**	**8.5**	**18.6**	**0.02**
Eubuliminella basispinata	GH	Ebasi	MT	GSI	Det	16.40	7.31	3.12	5.97	44.5	19.0	36.4	0.07
Eggerella bradyi	**GA**	**Ebrad**	**MT**	**GSI**	**Det**	**16.31**	**6.72**	**0.31**	**9.28**	**41.2**	**1.9**	**56.9**	**0.02**
Ehrenbergina compressa	GH	Ecomp	MB	GSI	Det	13.19	8.68	0.17	4.34	65.8	1.3	32.9	0.09
Eubuliminella curta	**GH**	**Ecurt**	**MT**	**GSI**	**Det**	**32.05**	**31.67**	**0.03**	**0.35**	**98.8**	**0.1**	**1.1**	**0.02**
Epistominella exigua	GH	Eexig	MTroc	GSI	PhDet	18.26	2.7	3.4	12.16	14.8	18.6	66.6	0.41
Eubuliminella exilis	GH	Eexil	MT	GSI	Det	23.30	23.3	0	0	100	0	0	0.10
Eratidus foliaceus	GA	Efoli	MP	GSI	Bact	11.97	4.63	2.55	4.78	38.7	21.3	40	0.30
Epistominella obesa	**GH**	**Eobes**	**MTroc**	**GSI**	**PhDet**	**19.53**	**11.02**	**0.54**	**7.97**	**56.4**	**2.8**	**40.8**	**0.01**
Epistominella sp	GH	Epist	MTroc	GSI	PhDet	21.76	21.76	0	0	100	0	0	0.25
Eponides sp.	GH	Epon	MTroc	GE	PhDet	22.81	22.81	0	0	100	0	0	0.18
Epistominella pulchella	GH	Epulc	MTroc	GSI	PhDet	11.27	11.27	0	0	100	0	0	0.60
Evolutinella rotulata	GA	Erotu	MP	GII	Det	13.23	5.72	1.75	5.75	43.3	13.2	43.5	0.73
Eggerelloides scabrum	**GA**	**Escab**	**MT**	**GSI**	**Det**	**17.62**	**5.56**	**0.92**	**11.14**	**31.5**	**5.2**	**63.2**	**0.05**
Eggerella sp	GA	Esp	MT	GSI	Det	10.63	10.63	0	0	100	0	0	0.56
Ehrenbergina trigona	GH	Etrig	MB	GSI	Det	22.81	22.81	0	0	100	0	0	0.15
Fissurina annectens	**GH**	**Fanne**	**MS**	**GSI**	**Det**	**15.97**	**12.05**	**0.34**	**3.58**	**75.5**	**2.1**	**22.4**	**0.04**
Fursenkoina bradyi	GH	Fbrad	MB	GII	Det	18.02	18.02	0	0	100	0	0	0.25
Fissurina gravata	GH	Fgrav	MS	GSI	Det	7.71	7.71	0	0	100	0	0	0.86

Fissurina marginata	GH	Fmarg	MS	GSI	Det	10.54	1.03	1.05	8.46	9.8	9.9	80.3	0.98
Fissurina orbignyana	GH	Forbi	MS	GSI	Det	11.22	9.27	0	1.95	82.6	0.0	17.4	0.28
Fissurina (Fissurina) ovata	GH	Fovat	MS	GSI	Det	6.58	6.58	0	0	100	0	0	0.91
Fissurina piriformis	GH	Fpiri	MS	GSI	Det	8.95	8.95	0	0	100	0	0	0.88
Fursenkoina schreibersiana	GH	Fschr	MB	GII	Det	12.86	12.86	0	0	100	0	0	0.49
Fissurina sp.	GH	Fsp	MS	GSI	Det	23.42	23.42	0	0	100	0	0	0.14
Fissurina submarginata	GH	Fsubm	MS	GSI	Det	15.42	11.03	0.47	3.92	71.5	3	25.4	0.16
Globobulimina affinis	**GH**	**Gaffi**	**MT**	**GII**	**Det**	**14.33**	**5.96**	**2.9**	**5.46**	**41.6**	**20.3**	**38.1**	**0.04**
Gyroidina altiformis	GH	Galti	MTroc	GE	Det	10.89	6.51	1.55	2.83	59.8	14.3	26	0.06
Glaphyrammina americana	GA	Gamer	MP	GSI	Det	11.34	1.86	1.00	8.47	16.40	8.90	74.70	0.22
Globobulimina auriculata	GH	Gauri	MT	GII	Car	7.42	5.01	0.12	2.29	67.60	1.60	30.80	0.70
Globocassidulina crassa	**GH**	**Gcras**	**MG**	**GSI**	**Det**	**17.38**	**8.65**	**1.70**	**7.04**	**49.80**	**9.80**	**40.50**	**0.01**
Gyroidina gemma	GH	Ggemm	MTroc	GE	Det	6.55	6.05	0.04	0.46	92.40	0.50	7.10	0.58
Glomospira gordialis	GA	Ggord	MI	GE	PhDet	14.47	10.93	0.00	3.54	75.50	0.00	24.50	0.23
Globobulimina hoeglundi	GH	Ghoeg	MT	GII	Det	14.46	14.46	0	0	100	0	0	0.29
Glandulina laevigata	GH	Glaev	MU	GII	Det	7.93	7.12	0.04	0.77	89.80	0.60	9.70	0.50
Gyroidina polia	GH	Gorbi	MTroc	GE	Det	7.17	4.62	0.19	2.37	64.40	2.60	33.00	0.81
Glandulina ovula	GH	Govul	MU	GII	Det	6.58	6.58	0	0	100	0	0	0.87
Globobulimina pacifica	GH	Gpaci	MT	GII	Det	16.07	6.13	4.80	5.15	38.10	29.80	32.00	0.16
Gyroidina orbicularis	GH	Gpoli	MTroc	GE	Det	7.71	7.71	0	0	100	0	0	0.75
Gyroidina rothwelli	GH	Groth	MTroc	GE	Det	21.76	21.76	0	0	100	0	0	0.18
Gyroidina soldanii var multilocula	**GH**	**Gsoldm**	**MTroc**	**GE**	**Det**	**17.58**	**10.11**	**0.54**	**6.93**	**57.5**	**3.1**	**39.4**	**0.01**
Globobulimina subaffinis	GH	Gsuba	MT	GII	Det	7.95	4.33	0.75	2.86	54.5	9.5	36	0.63
Globocassidulina subglobosa	GH	Gsubg	MG	GE	Det	10.33	2.84	2.83	4.65	27.5	27.4	45	0.44
Galwayella trigonoornata	GH	Gtrig	MS	GII	Det	7.71	7.71	0	0	100	0	0	0.88
Globobulimina turgida	GH	Gturg	MT	GII	Car	8.14	3.76	0.07	4.31	46.2	0.8	53	0.86
Hanzawaia mexicana	**GH**	**Hamex**	**MTroc**	**GSI**	**PhDet**	**29.86**	**21.20**	**3.09**	**5.56**	**71**	**10.3**	**18.6**	**0.05**
Hanzawaia boueana	GH	Hboue	MTroc	GSI	PhDet	17.94	17.94	0	0	100	0	0	0.26
Haplophragmoides bulloides	GA	Hbull	MP	GII	PhDet	5.85	5.85	0	0	100	0	0	0.90
Hyalinonetrion clavatum	GH	Hclav	MS	GII	Det	23.30	23.30	0	0	100	0	0	0.16
Hormosinella distans	GA	Hdist	MU	GSI	Det	11.96	5.86	1.19	4.91	49	10	41	0.08
Heterolepa bradyi	GH	Hebrad	MTroc	GSI	Det	8.94	4.33	0.20	4.41	48.4	2.3	49.3	0.29
Hyperammina echinata	GA	Hechi	MTub	GSI	Bact	13.42	13.42	0	0	100	0	0	0.44
Hoeglundina elegans	**GH**	**Heleg**	**MTroc**	**GE**	**Omni**	**11.83**	**1.65**	**1.42**	**8.76**	**13.9**	**12.0**	**74.1**	**0.03**
Hyperammina elongata	GA	Helon	MTub	GSI	Bact	9.64	9.23	0.07	0.34	95.7	0.8	3.5	0.23
Hyperammina friabilis	GA	Hfria	MTub	GSI	Bact	15.88	15.88	0	0	100	0	0	0.36
Hormosina globulifera	**GA**	**Hglob**	**MU**	**GSI**	**Det**	**13.68**	**6.88**	**0.45**	**6.35**	**50.3**	**3.3**	**46.4**	**0.05**

Hyalinonetrion gracillimum	**GH**	**Hgrac**	**MS**	**GII**	**Det**	**17.23**	**8.28**	**3.87**	**5.08**	**48.1**	**22.5**	**29.5**	**0.04**
Hormosinelloides guttifer	GA	Hgutt	MU	GSI	Det	9.97	8.22	0.88	0.87	82.5	8.8	8.7	0.41
Haplophragmoides mexicanus	GA	Hmexi	MP	GII	PhDet	14.62	9.82	0.05	4.75	67.2	0.3	32.5	0.31
Haplophragmoides planissima	GA	Hplan	MP	GII	PhDet	14.26	9.85	0.06	4.36	69	0.4	30.6	0.33
Haplophragmoides pusillus	**GA**	**Hpusi**	**MP**	**GII**	**PhDet**	**15.21**	**6.44**	**3.16**	**5.6**	**42.4**	**20.8**	**36.8**	**0.04**
Hansenisca soldanii	GH	Hsold	MTroc	GSI	Det	15.00	1.43	4.67	8.9	9.5	31.1	59.3	0.19
Haplophragmoides sp	GA	Hsp	MP	GII	PhDet	11.88	11.88	0	0	100	0	0	0.50
Haplophragmoides subsphaeroides	GA	Hsubs	MP	GII	PhDet	10.83	10.83	0	0	100	0	0	0.60
Haplophragmoides wilberti	GA	Hwilb	MP	GII	PhDet	11.54	11.54	0	0	100	0	0	0.58
Hyperammina	GA	Hyp	MTub	GSI	Bact	20.38	10.29	3.8	6.29	50.5	18.7	30.9	0.08
Karreriella baccata	GA	Kbacc	MB	GSI	Det	22.68	13.71	0.73	8.24	60.5	3.2	36.3	0.16
Karreriella bradyi	GA	Kbrad	MB	GSI	Det	17.34	17.34	0	0	100	0	0	0.27
Lagena aspera	GH	Laspe	MS	GII	Det	23.30	23.30	0	0	100	0	0	0.24
Lagena substriata	GH	Lasub	MS	GII	Det	13.42	13.42	0	0	100	0	0	0.36
Laevidentalina baggi	GH	Lbagg	MU	GSI	Det	21.76	21.76	0	0	100	0	0	0.25
Laevidentalina communis	GH	Lcomm	MU	GSI	Det	7.69	5.82	0	1.9	75.8	0.1	24.2	0.53
Lenticulina convergens	GH	Lconv	MP	GE	Det	21.77	14.50	2.22	5.05	66.60	10.20	23.20	0.07
Labrospira crassimargo	GA	Lcras	MP	GSI	Det	11.25	8.07	0.33	2.86	71.70	2.90	25.40	0.50
Lagenammina difflugiformis	GA	Ldiff	MS	GE	Bact	14.28	4.20	1.26	8.82	29.40	8.80	61.80	0.06
Laevidentalina filiformis	GH	Lfili	MU	GSI	Det	35.27	35.27	0	0	100	0	0	0.07
Lenticulina gibba	GH	Lgibb	MP	GE	Det	23.42	23.42	0	0	100	0	0	0.16
Liebusella goesi	GA	Lgoes	MU	GSI	Det	12.36	10.22	0.01	2.13	82.70	0.10	17.20	0.43
Lugdunum hantkenianum	GH	Lhant	MB	GII	PhDet	15.88	15.88	0	0	100	0	0	0.32
Lagena hispidula	GH	Lhisp	MS	GII	Det	11.86	2.95	1.18	7.73	24.90	9.90	65.20	0.69
Lenticulina inornata	GH	Linorn	MP	GE	Det	23.30	23.30	0	0	100	0	0	0.19
Lobatula lobatula	GH	Lloba	MTroc	GE	PhDet	11.31	5.14	1.31	4.85	45.40	11.60	42.90	0.47
Lagena parvulipora	GH	Lparv	MS	GII	Det	8.95	8.95	0	0	100	0	0	0.76
Lenticulina pliocaena	**GH**	**Lplio**	**MP**	**GE**	**Det**	**30.78**	**21.77**	**1.25**	**7.76**	**70.70**	**4.00**	**25.20**	**0.02**
Labrospira robusta	**GA**	**Lrobu**	**MP**	**GSI**	**Det**	**17.14**	**10.56**	**0.06**	**6.52**	**61.60**	**0.30**	**38.10**	**0.04**
Lenticulina rotulata	GH	Lrotu	MP	GE	Det	14.47	7.23	2.58	4.67	49.90	17.80	32.30	0.08
Lenticulina sp	GH	Lsp	MP	GE	Det	23.30	23.30	0	0	100	0	0	0.20
Laevidentalina subsoluta	GH	Lsubs	MU	GSI	Det	10.63	10.63	0	0	100	0	0	0.59
Lagena sulcata	GH	Lsulc	MS	GII	Det	13.42	13.42	0	0	100	0	0	0.48
Lobatula ungeriana	GH	Lunge	MTroc	GSI	Det	10.10	7.03	0.02	3.05	69.6	0.2	30.2	0.46
Lobatula wuellerstorfi	GH	Lwuel	MTroc	GE	PhDet	14.13	2.37	1.96	9.79	16.8	13.9	69.3	0.12
Melonis affinis	**GH**	**Maffi**	**MP**	**GSI**	**Det**	**11.82**	**2.25**	**1.17**	**8.40**	**19.1**	**9.9**	**71.1**	**0.02**

Martinottiella communis	**GA**	**Mcomm**	**MU**	**GII**	**Det**	**24.47**	**22.03**	**0.03**	**2.40**	**90.1**	**0.1**	**9.8**	**0.02**
Marsipella elongata	**GA**	**Melon**	**MTub**	**GSI**	**Bact**	**9.23**	**7.00**	**0.77**	**1.45**	**75.9**	**8.4**	**15.7**	**0.04**
Martinottiella nodulosa	GA	Mnodu	MU	GII	Det	14.59	8.70	1.25	4.64	59.7	8.6	31.8	0.57
Melonis pompilioides	GH	Mpomp	MP	GII	Det	13.17	10.33	1.19	1.64	78.5	9.1	12.5	0.19
Miliolinella subrotunda	GP	Msubr	MM	GE	Herb	12.63	11.52	0.11	1	91.3	0.8	7.9	0.17
Nonionella astricta	GH	Nastr	MTroc	GE	Det	31.30	31.30	0	0	100	0	0	0.11
Nonion commune	GH	Ncomm	MP	GSI	Det	12.47	1.62	1.48	9.37	13	11.9	75.1	0.56
Nodulina dentaliniformis	GA	Ndent	MU	GII	Det	13.83	1.77	1.81	10.26	12.8	13.1	74.1	0.17
Nodosinum gaussicum	GA	Ngaus	MU	GII	Det	6.58	6.58	0	0	100	0	0	0.92
Nonionoides grateloupii	**GH**	**Ngrat**	**MTroc**	**GSI**	**PhDet**	**16.02**	**5.63**	**4.26**	**6.13**	**35.2**	**26.6**	**38.2**	**0.05**
Laevidentalina subsoluta	GH	Nsubs	MU	GSI	PhDet	6.58	6.58	0	0	100	0	0	0.94
Nonionoides turgidus	GH	Nturg	MTroc	GSI	PhDet	9.73	9.73	0	0	100	0	0	0.65
Obesopleurostomella brevis	GH	Obrev	MB	GSI	Det	15.76	15.76	0	0	100	0	0	0.37
Oridorsalis pauciapertura	GH	Opauc	MTroc	GII	Det	13.42	13.42	0	0	100	0	0	0.43
Oridorsalis tenerus subsp. Profundus	GH	Otene	MTroc	GII	Det	11.88	11.88	0	0	100	0	0	0.52
Oridorsalis umbonatus	GH	Oumbo	MTroc	GII	Det	17.10	3.81	0.40	12.89	22.30	2.30	75.40	0.31
Parafissurina sp	GH	Paraf	MS	GSI	Det	13.57	13.57	0	0	100	0	0	0.38
Psammatodendron arborescens	GA	Parbo	MI	GSI	Bact	21.76	21.76	0	0	100	0	0	0.23
Planispirinoides bucculentus	GP	Pbucc	MM	GII	Det	22.81	22.81	0	0	100	0	0	0.18
Pullenia bulloides	GH	Pbull	MG	GSI	Det	12.24	3.58	0.51	8.15	29.20	4.20	66.60	0.25
Paratrochammina challengeri	GA	Pchal	MTroc	GE	Bact	10.01	6.10	0.65	3.26	60.90	6.50	32.50	0.41
Pyrgo depressa	GP	Pdepr	MM	GSI	Herb	7.71	7.71	0	0	100	0	0	0.90
Psammosiphonella discreta	GA	Pdisc	MTub	GE	Bact	11.83	5.53	0.54	5.76	46.70	4.60	48.70	0.24
Planulina ecuadorana	GH	Pecua	MTroc	GE	PhDet	21.63	21.63	0	0	100	0	0	0.26
Pullenia elegans	**GH**	**Peleg**	**MG**	**GSI**	**Det**	**18.52**	**10.67**	**0.31**	**7.54**	**57.60**	**1.70**	**40.70**	**0.01**
Pyrgo elongata	GP	Pelon	MM	GSI	Herb	11.54	11.54	0	0	100	0	0	0.55
Procerolagena gracilis	GH	Pgrac	MS	GSI	Det	23.30	23.30	0	0	100	0	0	0.17
Pyrgoella irregularis	GP	Pirre	MM	GSI	Herb	11.54	11.54	0	0	100	0	0	0.57
Portatrochammina karica	GA	Pkari	MTroc	GSI	Bact	13.57	13.57	0	0	100	0	0	0.46
Pseudobrizalina lobata	**GH**	**Ploba**	**MB**	**GSI**	**Det**	**22.02**	**13.24**	**0.33**	**8.45**	**60.10**	**1.50**	**38.40**	**0.03**
Paracassidulina minuta	GH	Pminu	MG	GSI	Det	6.58	6.58	0	0	100	0	0	0.90
Pyrgo murrhina	GP	Pmurr	MM	GSI	Herb	13.41	3.31	3.32	6.78	24.70	24.80	50.60	0.16
Polystomammina nitida	GA	Pniti	MTroc	GSI	Det	9.66	5.89	0.02	3.76	61.00	0.20	38.90	0.61
Pseudonodosinella nodulosa	GA	Pnodu	MU	GII	Det	11.09	10.31	0.20	0.58	93.00	1.80	5.20	0.35
Pulleniatina obliquiloculata	GH	Pobli	MG	GSI	Det	8.95	8.95	0	0	100	0	0	0.76
Portatrochammina murrayi	GA	Pomur	MTroc	GE	Bact	10.63	10.63	0	0	100	0	0	0.66

Pseudoparrella pacifica	**GH**	**Ppaci**	**MTroc**	**GII**	**Omni**	**12.40**	**5.53**	**1.64**	**5.23**	**44.60**	**13.20**	**42.10**	**0.03**
Protoglobobulimina pupoides	**GH**	**Ppupo**	**MT**	**GSI**	**Det**	**23.23**	**13.40**	**4.35**	**5.48**	**57.70**	**18.70**	**23.60**	**0.01**
Pullenia quinqueloba	GH	Pquin	MG	GSI	Det	12.26	4.85	0.79	6.61	39.60	6.50	53.90	0.13
Praeglobobulimina spinescens	GH	Pspin	MT	GII	Det	8.06	6.60	0.40	1.06	81.90	4.90	13.20	0.73
Pullenia subcarinata	GH	Psubc	MG	GSI	Det	8.27	1.82	1.29	5.16	22.10	15.60	62.40	0.49
Pseudoparrella subperuviana	GH	Psubp	MTroc	GII	Omni	19.15	14.16	1.56	3.43	73.90	8.20	17.90	0.07
Pullenia sp	GH	Pulle	MG	GSI	Det	8.00	8.00	0	0	100	0	0	0.80
Pyrgo sp	GP	Pyrgo	MM	GSI	Herb	11.66	9.91	0.21	1.54	85.00	1.80	13.20	0.26
Quinqueloculina seminulum	GP	Qsemi	MM	GE	Herb	20.02	15.93	0.98	3.11	79.60	4.90	15.50	0.06
Quinqueloculina sp	GP	Qsp	MM	GE	Herb	11.54	11.54	0	0	100	0	0	0.56
Rhabdammina abyssorum	**GA**	**Rabys**	**MTub**	**GE**	**Bact**	**9.80**	**8.81**	**0.15**	**0.83**	**89.9**	**1.6**	**8.5**	**0.05**
Rhizammina algaeformis	GA	Ralga	MTub	GE	Bact	5.58	4.73	0.00	0.85	84.8	0	15.2	0.79
Reophax apiculatus	GA	Rapic	MU	GSI	Det	12.86	12.86	0	0	100	0	0	0.47
Reophax bradyi	**GA**	**Rbrad**	**MU**	**GSI**	**Det**	**11.35**	**7.24**	**0.42**	**3.69**	**63.80**	**3.70**	**32.50**	**0.05**
Recurvoides contortus	GA	Rcont	MTroc	GSI	Det	15.71	3.12	3.86	8.74	19.80	24.60	55.60	0.15
Rhabdamminella cylindrica	GA	Rcyli	MTub	GE	Bact	12.09	12.09	0	0	100	0	0	0.50
Reophax duplex	GA	Rdupl	MU	GSI	Det	11.91	9.65	0.09	2.17	81.00	0.70	18.20	0.19
Reussoolina apiculata	GH	Reapi	MS	GSI	Det	13.57	13.57	0	0	100	0	0	0.38
Recurvoidella bradyi	GA	Recbrad	MP	GII	PhDet	10.83	10.83	0	0	100	0	0	0.67
Reophax sp	GA	Reoph	MU	GSI	Det	12.35	4.73	0.43	7.19	38.30	3.50	58.20	0.50
Reophax fusiformis	GA	Rfusi	MU	GSI	Det	9.61	6.04	0.53	3.05	62.80	5.50	31.70	0.31
Rhabdammina sp.	GA	Rhabda	MTub	GE	Bact	10.62	5.29	0.48	4.85	49.80	4.50	45.70	0.12
Rhizammina sp	GA	Rhiza	MTub	GE	Bact	9.37	7.40	0.08	1.89	79.00	0.90	20.20	0.13
Rhumblerella humboldti	GA	Rhumb	MT	GE	Det	32.47	29.35	0.68	2.45	90.40	2.10	7.50	0.09
Reussoolina laevis	**GH**	**Rlaev**	**MS**	**GSI**	**Det**	**17.84**	**10.48**	**1.42**	**5.94**	**58.70**	**8.00**	**33.30**	**0.05**
Robertinoides oceanica	GH	Rocea	MTroc	GSI	Car	15.88	15.88	0	0	100	0	0	0.33
Rosalina globularis	GH	Roglo	MTroc	GSI	Omni	12.90	12.90	0	0	100	0	0	0.48
Rhabdammina pacifica	GA	Rpaci	MTub	GE	Bact	11.22	7.94	0.7	2.58	70.8	6.3	23.0	0.06
Reophax pilulifer	GA	Rpilu	MU	GSI	Det	22.81	22.81	0	0	100	0	0	0.25
Reophax pisiformis	GA	Rpisi	MU	GSI	Det	22.81	22.81	0	0	100	0	0	0.15
Rotalina pleurostomata	GH	Rpleu	MTroc	GSI	Det	12.26	12.26	0	0	100	0	0	0.53
Rutherfordoides rotundatus	GH	Rrotu	MB	GSI	Det	4.53	4.53	0	0	100	0	0	0.97
Reophax scorpiurus	**GA**	**Rscor**	**MU**	**GSI**	**Det**	**13.80**	**3.27**	**2.89**	**7.64**	**23.70**	**20.90**	**55.40**	**0.01**
Reophax subdentaliniformis	GA	Rsubd	MU	GII	Det	8.00	8.00	0	0	100	0	0	0.83
Reophax subfusiformis	GA	Rsubf	MU	GSI	Det	13.57	13.57	0	0	100	0	0	0.36
Recurvoides turbinatus	GA	Rturb	MTroc	GII	Det	15.88	15.88	0	0	100	0	0	0.34

Sphaeroidina bulloides	GH	Sbull	MG	GSI	Det	9.39	5.26	0.58	3.55	56	6	38	0.09
Sahulia conica	GA	Sconi	MB	GII	Det	22.67	11.75	0.62	10.3	51.8	2.7	45.4	0.06
Suggrunda eckisi	GH	Secki	MB	GSI	Det	18.02	18.02	0	0	100	0	0	0.27
Stainforthia fusiformis	**GH**	**Sfusi**	**MB**	**GSI**	**Det**	**19.69**	**10.91**	**0.84**	**7.94**	**55.40**	**4.30**	**40.30**	**0.01**
Siphouvigerina hispida	GH	Shisp	MT	GSI	Det	12.26	12.26	0	0	100	0	0	0.53
Suggrunda kleinpelli	GH	Sklei	MB	GSI	Det	29.54	29.54	0	0	100	0	0	0.13
Siphouvigerina proboscidea	GH	Sprob	MT	GSI	Det	9.15	8.69	0.06	0.40	95	0.70	4.40	0.28
Saccorhiza ramosa	**GA**	**Sramo**	**MTub**	**GII**	**Bact**	**12.91**	**4.28**	**1.51**	**7.12**	**33.2**	**11.7**	**55.1**	**0.02**
Saccammina sphaerica	GA	Sspha	MS	GSI	Bact	7.94	3.05	1.14	3.74	38.5	14.4	47.1	0.60
Saracenaria stolidota	GH	Sstol	MP	GII	Det	12.86	12.86	0	0	100	0	0	0.46
Spirosigmoilina tenuis	GP	Stenu	MM	GSI	Herb	7.71	7.71	0	0	100	0	0	0.87
Thurammina albicans	GA	Talbi	MS	GSI	Bact	22.81	22.81	0	0	100	0	0	0.18
Trifarina angulosa	**GH**	**Tangu**	**MT**	**GSI**	**Det**	**19.17**	**5.75**	**1.07**	**12.36**	**30.0**	**5.6**	**64.5**	**0.01**
Takayanagia delicata	**GH**	**Tdeli**	**MB**	**GII**	**Omni**	**16.29**	**6.82**	**2.9**	**6.57**	**41.9**	**17.8**	**40.3**	**0.02**
Textularia earlandi	GA	Tearl	MB	GII	Omni	13.42	13.42	0	0	100	0	0	0.47
Trochammina inflata	GA	Tinfl	MP	GSI	PhDet	12.20	8.31	1.8	2.09	68.1	14.8	17.1	0.43
Techitella melo	GA	Tmelo	MTub	GSI	Bact	11.18	9.97	0.28	0.93	89.2	2.5	8.3	0.25
Trochammina nana	GA	Tnana	MP	GSI	PhDet	7.71	7.71	0	0	100	0	0	0.86
Textularia porrecta	GA	Tporr	MB	GII	Omni	22.81	22.81	0	0	100	0	0	0.25
Trochammina sp	GA	Troch	MP	GSI	PhDet	7.71	7.71	0	0	100	0	0	0.80
Technitella sp.	GA	Tsp	MTub	GSI	Bact	15.05	8.11	2.86	4.08	53.9	19	27.1	0.31
Trochammina squamata	GA	Tsqua	MP	GSI	PhDet	22.16	4.57	4.19	13.39	20.6	18.9	60.5	0.22
Triloculina tricarinata	GP	Ttric	MM	GE	PhDet	8.63	8.15	0.04	0.45	94.4	0.4	5.2	0.44
Triloculina trigonula	GP	Ttrig	MM	GE	Herb	11.54	11.54	0	0	100	0	0	0.58
Trochammina triloba	GA	Ttril	MP	GE	PhDet	18.75	15.68	0.09	2.98	83.6	0.5	15.9	0.09
Tolypammina vagans	GA	Tvaga	MI	GSI	Bact	10.12	10.12	0	0	100	0	0	0.68
Uvigerina auberiana	**GH**	**Uaube**	**MT**	**GSI**	**Det**	**9.42**	**3.90**	**0.96**	**4.56**	**41.4**	**10.2**	**48.4**	**0.01**
Uvigerina canariensis	**GH**	**Ucana**	**MT**	**GSI**	**Det**	**16.16**	**13.38**	**0.12**	**2.66**	**82.8**	**0.8**	**16.5**	**0.03**
Uvigerina peregrina	GH	Upere	MT	GSI	Omni	12.34	0.50	2.70	9.15	4	21.8	74.1	0.09
Uvigerina semiornata	**GH**	**Usemi**	**MT**	**GSI**	**Det**	**10.85**	**9.84**	**0.12**	**0.89**	**90.7**	**1.1**	**8.2**	**0.05**
Uvigerina senticosa	GH	Usent	MT	GSI	Det	9.63	9.44	0.01	0.17	98.1	0.2	1.8	0.22
Uvigerina sp	GH	Usp	MT	GSI	Det	9.44	9.44	0	0	100	0	0	0.81
Uvigerina striata	**GH**	**Ustri**	**MT**	**GSI**	**Det**	**16.35**	**10.96**	**0.55**	**4.84**	**67.0**	**3.4**	**29.6**	**0.01**
Vaginulina americana	**GH**	**Vamer**	**MU**	**GSI**	**Omni**	**35.27**	**35.27**	**0**	**0**	**100**	**0**	**0**	**0.03**
Valvulineria araucana	GH	Varau	MTroc	GE	Det	11.54	11.54	0	0	100	0	0	0.60
Vasicostella inflatiperforata	GH	Vasin	MS	GSI	Det	14.46	14.46	0	0	100	0	0	0.41
Valvulineria bradyana	GH	Vbrad	MTroc	GE	Det	9.73	9.73	0	0	100	0	0	0.72

Valvulineria glabra	GH	Vglab	MTroc	GE	Det	14.06	1.15	4.41	8.51	8.2	31.3	60.5	0.44
Valvulineria inaequalis	GH	Vinae	MTroc	GE	Det	12.89	12.28	0.14	0.47	95.3	1.1	3.6	0.16
Valvulineria inflata	GH	Vinfl	MTroc	GE	Det	16.14	6.44	3.52	6.19	39.9	21.8	38.3	0.06
Verneuilinulla propinqua	GA	Vprop	MT	GII	Det	23.30	23.30	0	0	100	0	0	0.14
Veleroninoides scitulus	GA	Vscit	MP	GSI	Det	23.42	23.42	0	0	100	0	0	0.19

Supplementary Figures

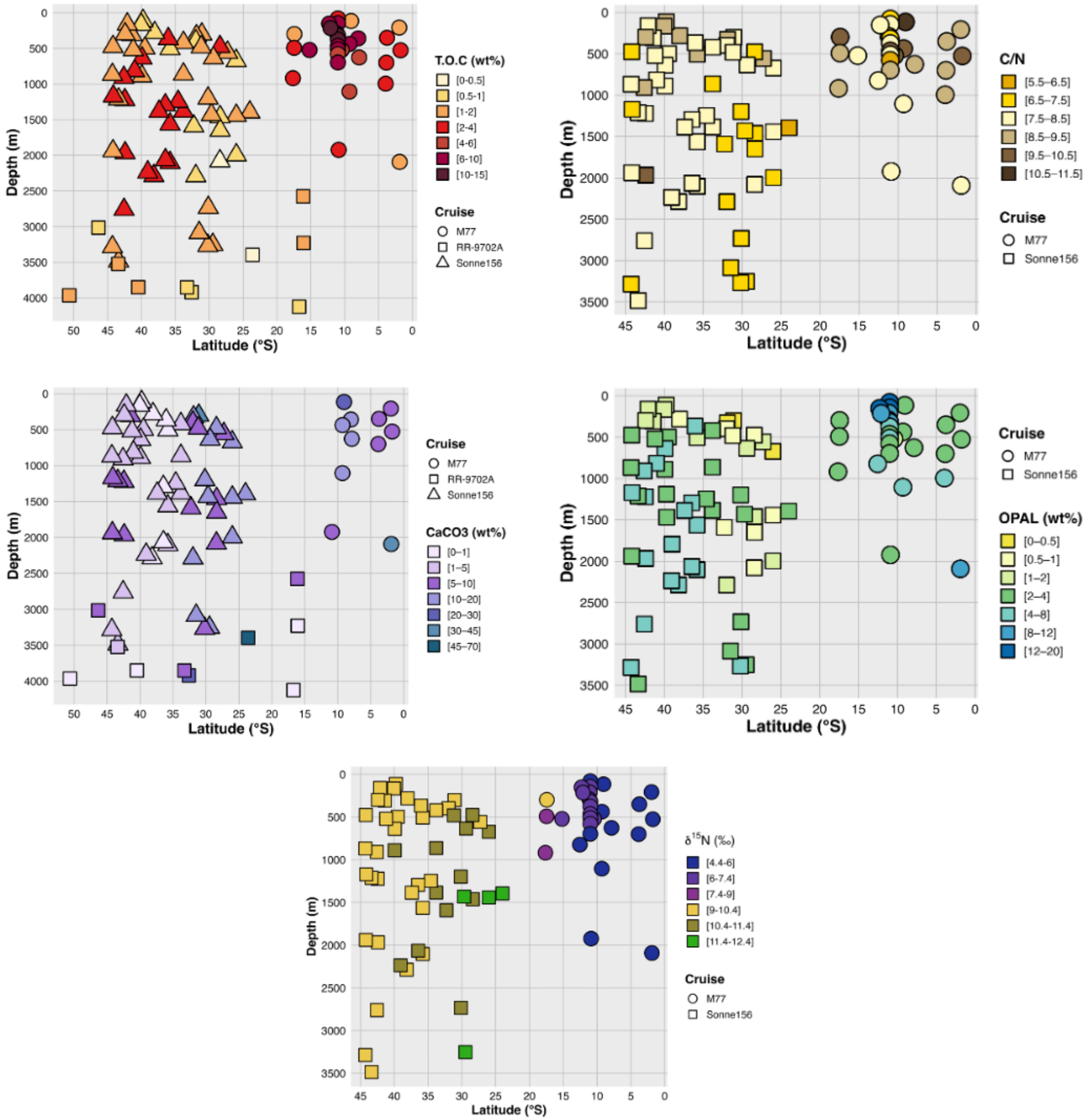


Figure S1. Distribution of bulk sediment composition across the Southeastern Pacific. **a)** Total organic carbon (TOC, wt %), **b)** ratio between organic carbon and total nitrogen content (C/N), **c)** calcium carbonate (CaCO3, wt %), **d)** biogenic opal (Opal, wt %), and nitrogen isotope (δ15N). The symbols refer to the expeditions of M77, SO161, and RR-9702A.

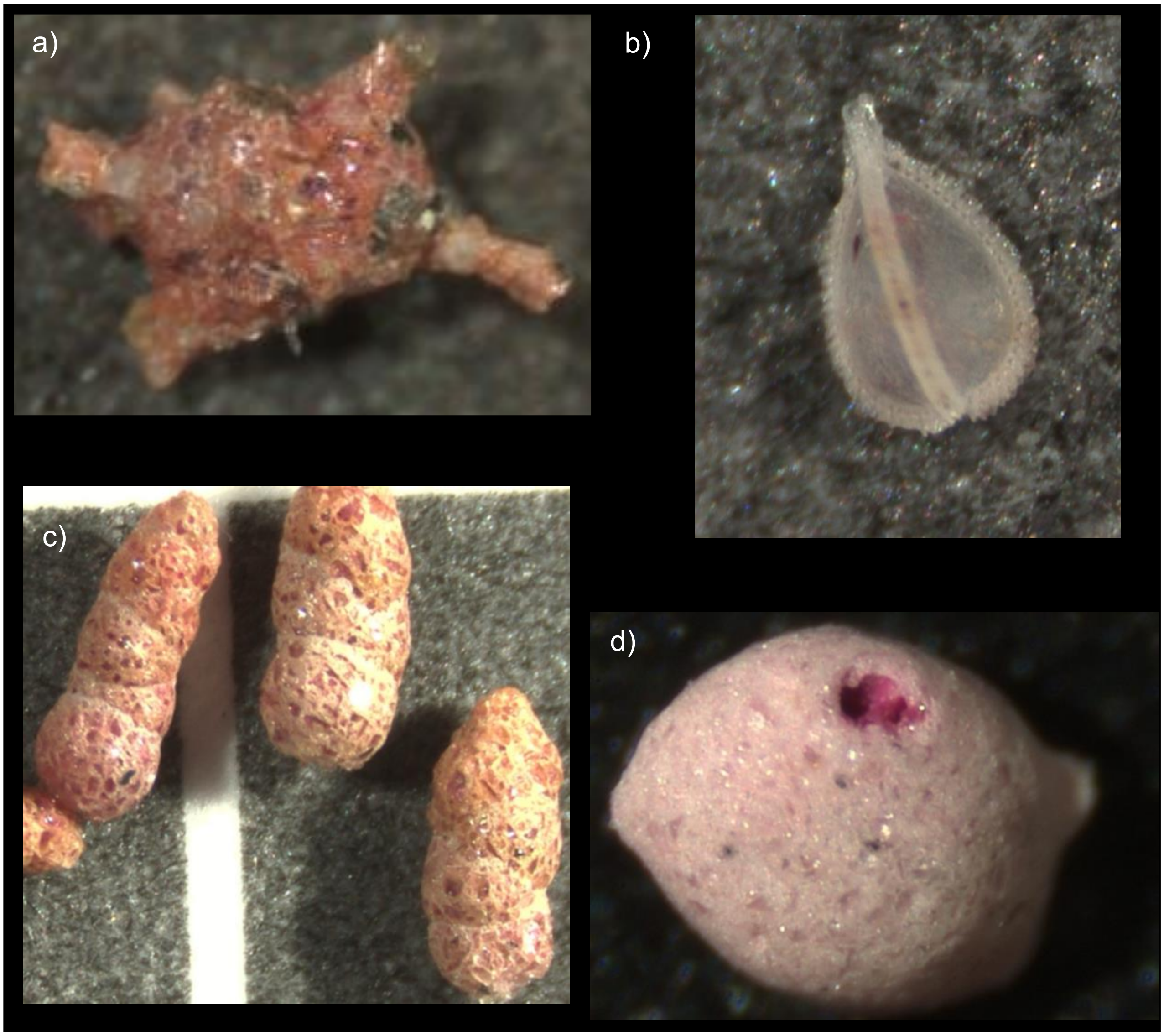


Figure S2. New records of living benthic foraminifera from the Southeastern Pacific. a) *Astrorhizoides cornutus,* b) *Galwayella trigonoornata,* c) *Liebusella goesi, and* d) *Crithionina pisum.*

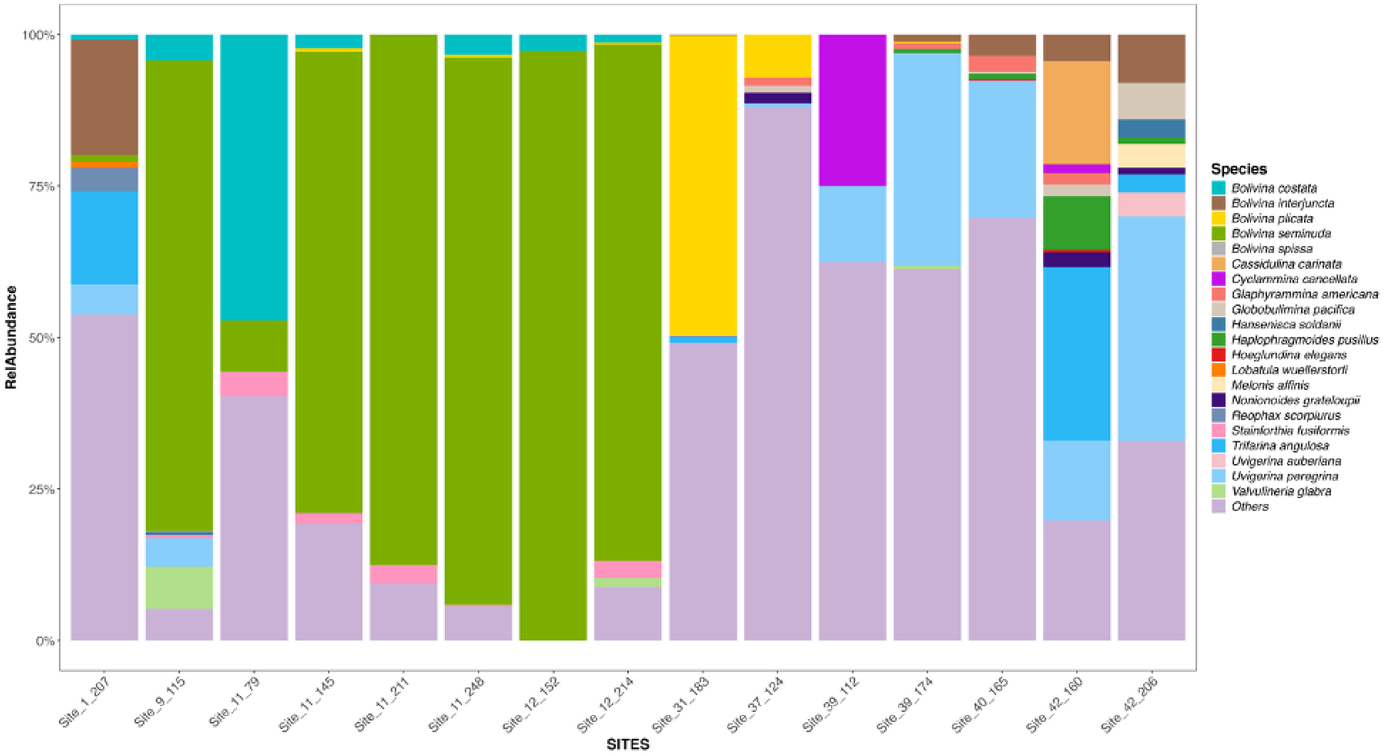


Figure S2. Relative abundance of the species with more than 20% of contribution in all marine surface sediment samples < 250 m along the Southeastern Pacific. *Nodulina dentaliniformis* and *Pullenia bulloides* were removed from the graph because they have no presence in the sites.

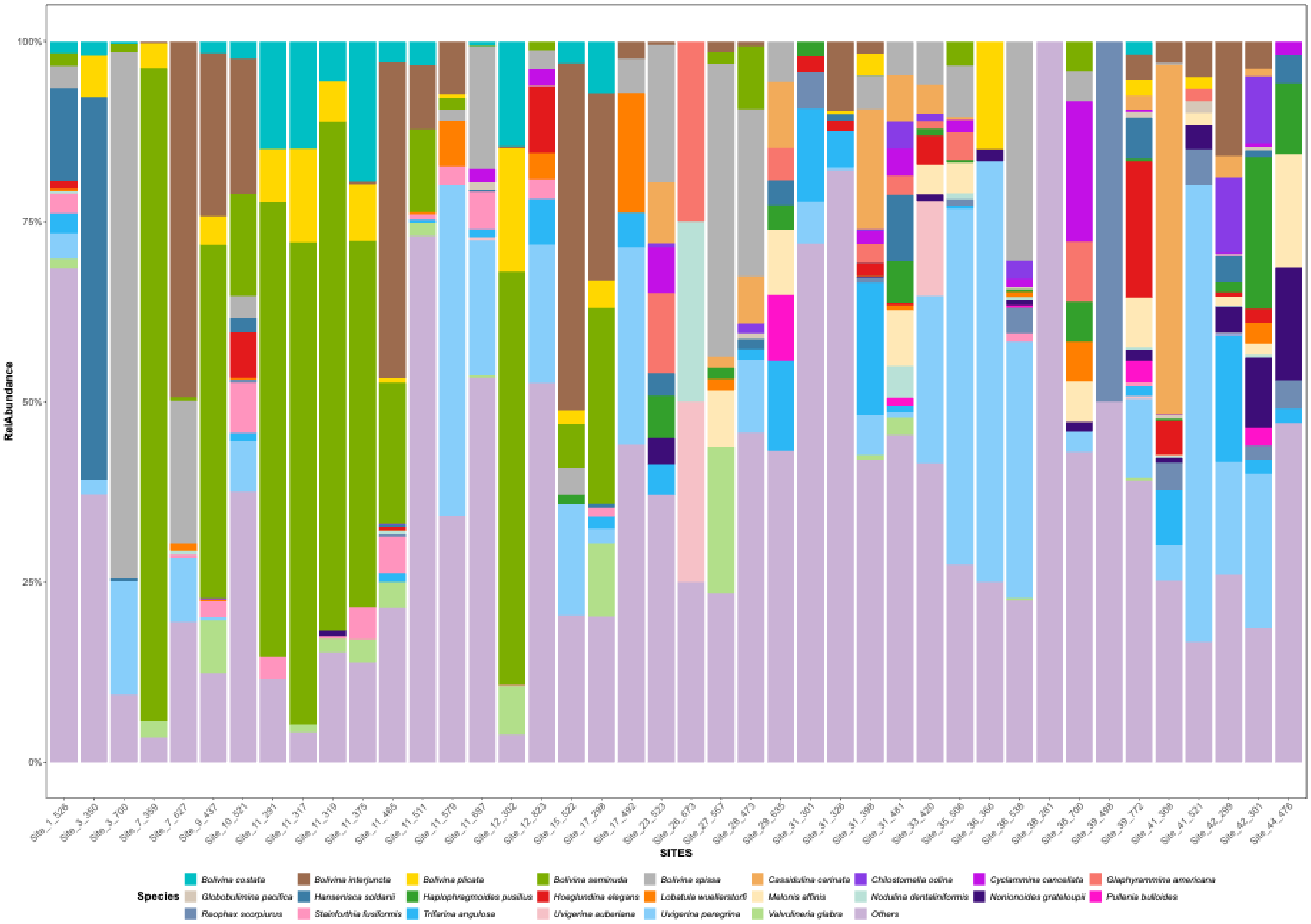


Figure S3. Relative abundance of the species with more than 20% of presence in the in all marine surface sediment samples >250 to 850 m along the Southeastern Pacific.

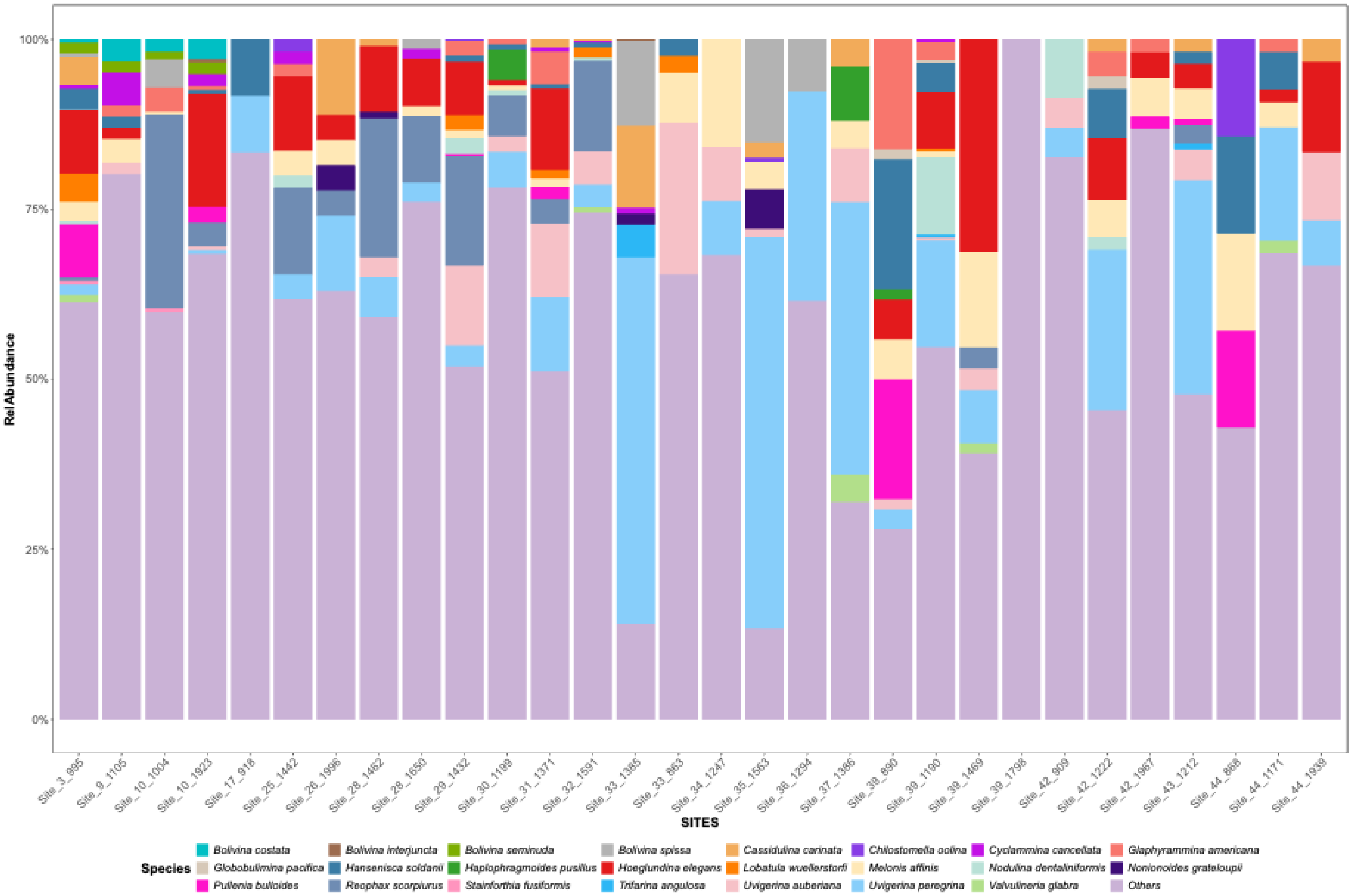
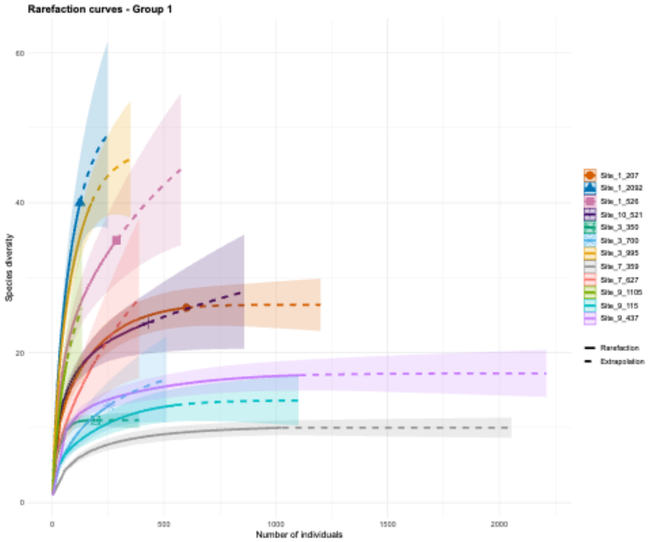
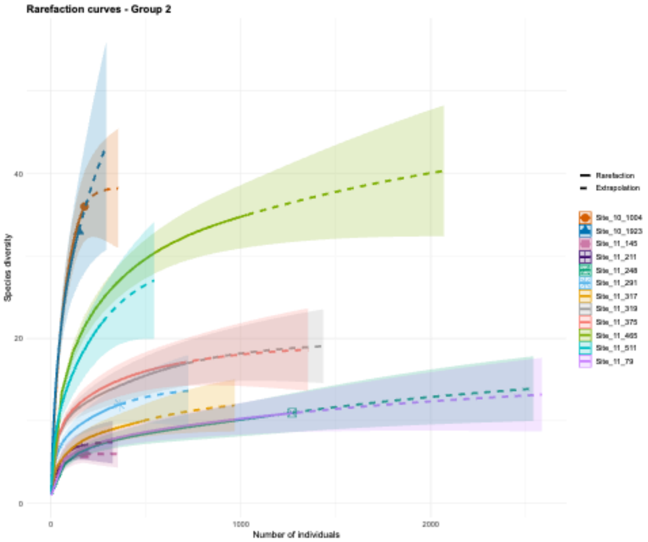
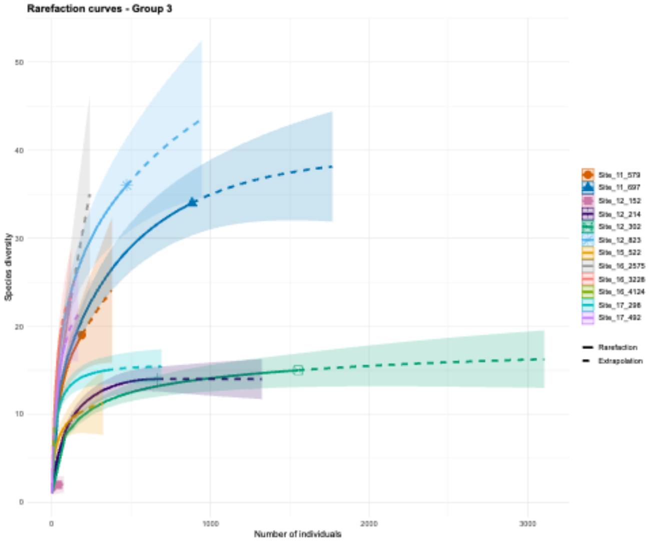


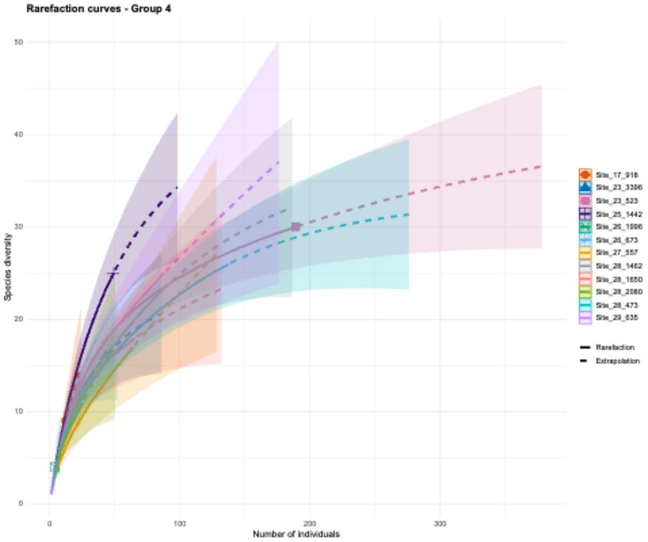
Figure S4. Relative abundance of the species with more than 20% of presence in the marine surface sediment samples >850 to 2000 m along the Southeastern Pacific. *Bolivina plicata* was removed from the graph due to its presence at any sample.

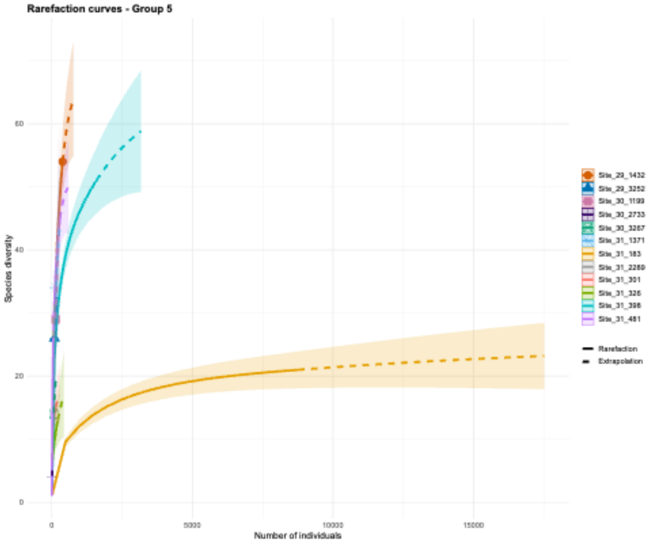
Figure S5. Relative abundance of the species with more than 20% of presence in the marine surface sediment samples > 2000 m along the Southeastern Pacific. *Bolivina costata*, *B. plicata*, *C. carinata, Haplophragmoides pusillus, Nonionoides grateloupii, Stainforthia fusiformis* and *Trifarina angulosa* were removed from the graph due they showed no presence in the samples.


Rarefaction curves - Group 1
Species diversity
Number of individuals
0
20
40
60
0
500
1000
1500
2000
Site_1_207
Site_1_2092
Site_1_526
Site_10_521
Site_3_350
Site_3_700
Site_3_995
Site_7_359
Site_7_627
Site_9_1105
Site_9_115
Site_9_437
Rarefaction
Extrapolation


Rarefaction curves - Group 2
Species diversity
Number of individuals
0
20
40
0
1000
2000
Rarefaction
Extrapolation
Site_10_1004
Site_10_1923
Site_11_145
Site_11_211
Site_11_248
Site_11_291
Site_11_317
Site_11_319
Site_11_375
Site_11_465
Site_11_511
Site_11_79


Rarefaction curves - Group 3
Species diversity
Number of individuals
0
10
20
30
40
50
0
1000
2000
3000
Site_11_579
Site_11_697
Site_12_152
Site_12_214
Site_12_302
Site_12_823
Site_15_522
Site_16_2575
Site_16_3228
Site_16_4124
Site_17_298
Site_17_492
Rarefaction
Extrapolation


Rarefaction curves - Group 4
Species diversity
Number of individuals
0
10
20
30
40
50
0
100
200
300
Site_17_918
Site_23_3396
Site_23_523
Site_25_1442
Site_26_1996
Site_26_673
Site_27_557
Site_28_1462
Site_28_1650
Site_28_2080
Site_28_473
Site_29_635
Rarefaction
Extrapolation


Rarefaction curves - Group 5
Species diversity
Number of individuals
0
20
40
60
0
5000
10000
15000
Site_29_1432
Site_29_3252
Site_30_1199
Site_30_2733
Site_30_3267
Site_31_1371
Site_31_183
Site_31_2289
Site_31_301
Site_31_326
Site_31_398
Site_31_481
Rarefaction
Extrapolation

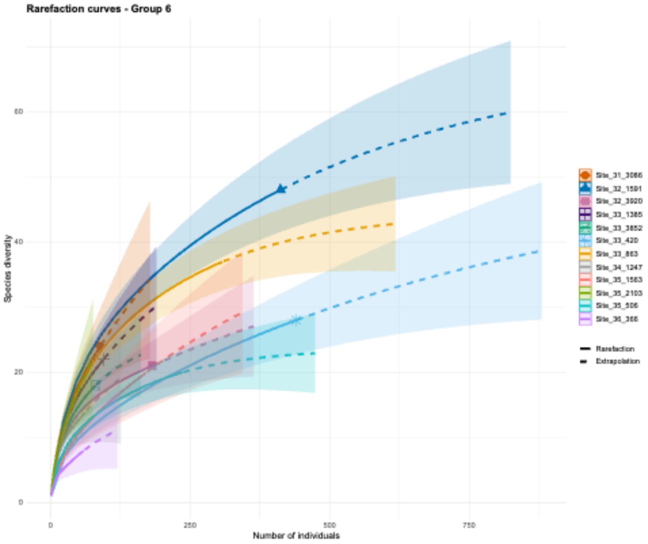

Rarefaction curves - Group 6
Species diversity
Number of individuals
0
20
40
60
0
250
500
750
Site_31_3086
Site_32_1591
Site_32_3920
Site_33_1385
Site_33_3852
Site_33_420
Site_33_863
Site_34_1247
Site_35_1563
Site_35_2103
Site_35_506
Site_36_366
Rarefaction
Extrapolation

Figure S6. Rarefaction curves of site groups along the western South American margin: a) 1º - 9ºS. b) 10º - 11ºS. c) 11º - 17ºS. d) 17ºS – 29ºS. e) 29º - 31ºS. f) 31º - 36ºS. g) 36º - 39ºS. h) 39º - 42ºS. i) 42º - 44ºS. j) 44º - 50ºS.

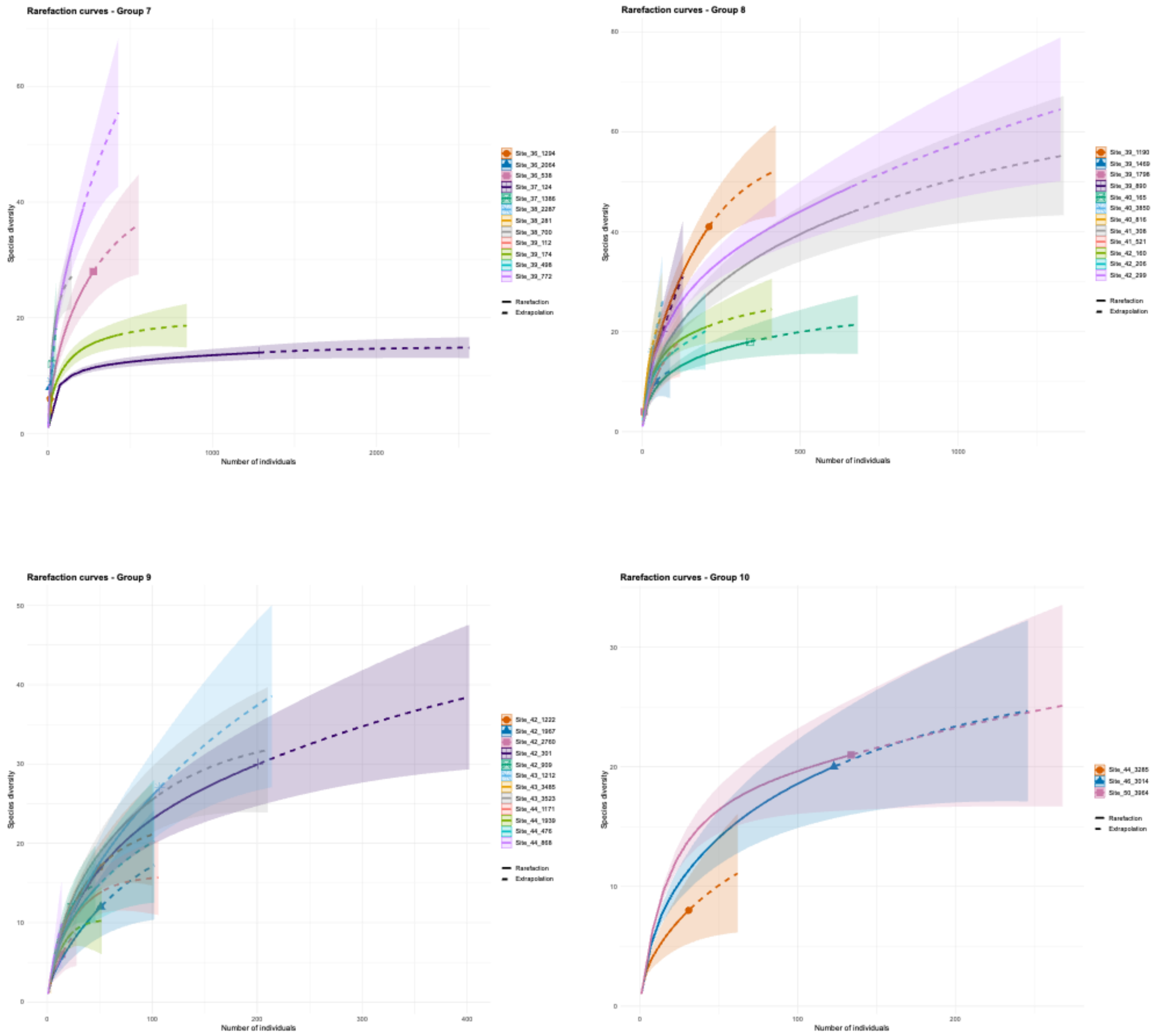


Figure S7. Rarefaction curves of site groups along the western South American margin: a) 36º - 39ºS. b) 39º - 42ºS. c) 42º - 44ºS. d) 44º - 50ºS.

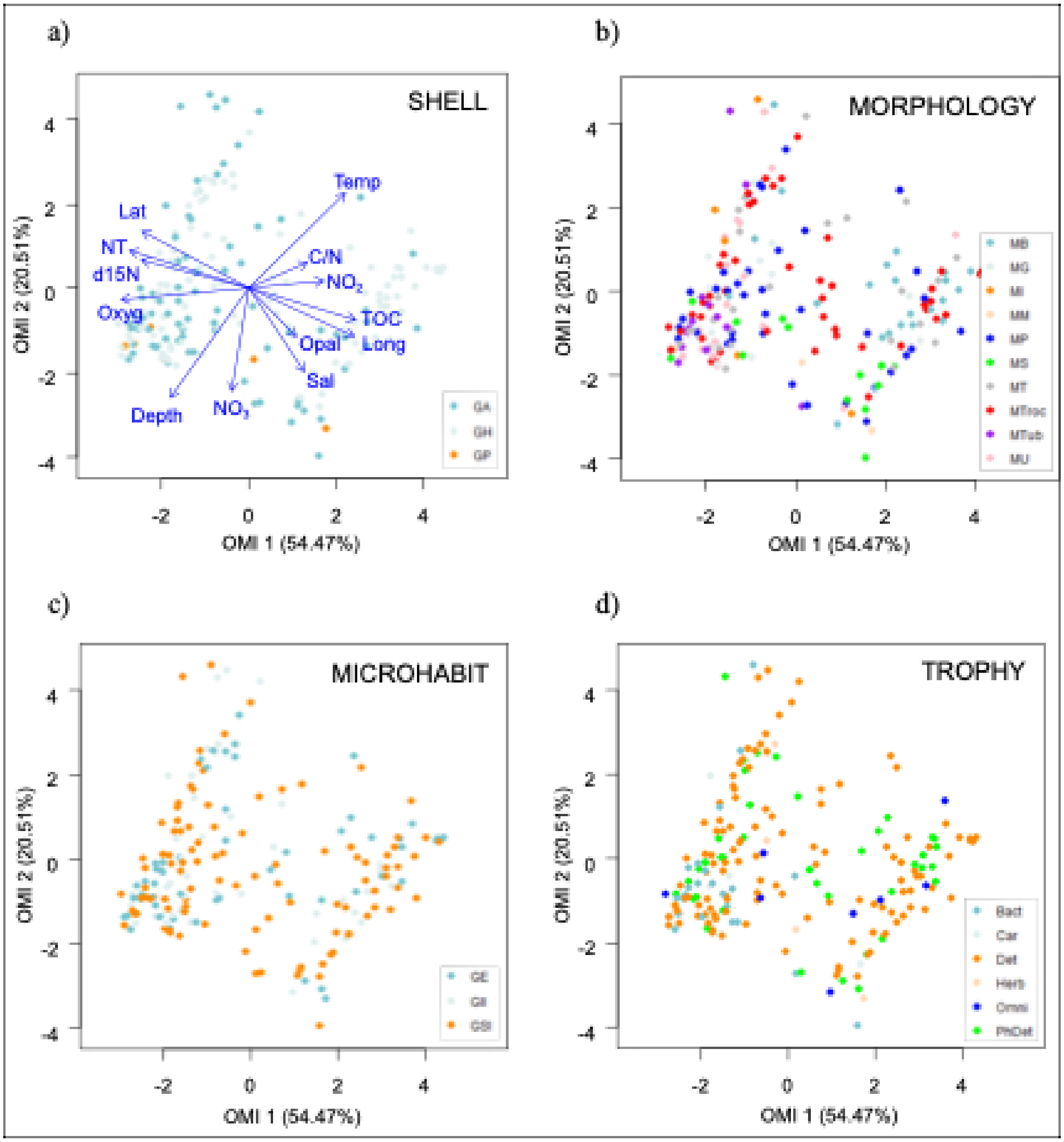


Figure S8. Outlying mean index (OMI) of the influence of the environmental variables on the functional traits of the benthic foraminifera species. **a)** Influence of the environmental variables on the type of test, GA: group agglutinated, GH: group Hyaline, GP: group porcellanaceous. **b)** Influence of the environmental variables on the morphology, MB: Morphology biserial, MG: Morphology globular, MI: Morphology irregular, MM: Morphology miliolide, MP: Morphology planispiral, MSp: Morphology spheric, unilocular and elongated spheric. MT: Morphology triserial, MTroc: Morphology trochospiral, MTub: Morphology tubular, MU: Morphology uniserial. **c)** Influence of the environmental variables on the microhabitat, GE: group epifaunal, GII: Group intermedia infaunal and GSI: Group shallow infaunal. **d)** Influence of the environmental variables on the trophic behaviour, Bact: bacterivore, Car: carnivore, Det: detritivore, Herb: Herbivore, Ommni: omnivore and PhDet: phytodetritivore. Letters and arrows in blue refer to the environmental variables, Temp: Temperature, Oxyg: oxygen, Sal: salinity, Lat: Latitude, Long: Longitude, NO3: Nitrate, NO2: Nitrite, TOC: Total Organic Carbon, NT: nitrogen total and d15N: $^{15}\delta$N).