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REVIEW

Biodiversity and distribution of corals in Chile

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Abstract

The present review investigates our current knowledge of the richness and distribution of coral species inhabiting diverse habitats in Chilean coastal and marine waters, including the oceanic islands. Information, such as the spatial-temporal coverage, taxonomic resolution, and bathymetry of species, was extracted from published articles, geodatabases, and unpublished data. Our analyses of these data highlight major gaps in knowledge on corals in Chile, indicating this region remains poorly studied. The results show that the previous studies focused mostly on coastal and shallow-water habitats, with the continental slope, oceanic islands, and seamounts remaining mainly unexplored. Furthermore, high coral species richness was observed in the Magellanic Province compared with the northern Intermediate Area and Peruvian Province, and the temporal distribution of occurrence records was discontinuous, with peaks observed for the years 1876–1877, 1960–1967, and 2001–2016. We also report a new location and an extension of the known geographic distribution for *Bathycyathus chilensis*. Despite the progress in scientific knowledge achieved in the last decades, coral research still suffers from significant knowledge gaps, especially of the deep-sea benthic biodiversity in Chile. Further exploration of Chilean coastal and marine waters is therefore necessary to increase the knowledge of the coral biodiversity of this vast region.

Keywords Anthozoa · Hydrozoa · Review · New record · South-eastern Pacific

Introduction

Ever-increasing human pressures on the environment had led to a major decline in marine biodiversity by the end of the twentieth century (Duarte et al. 2020). This decline is mainly reflected in terms of common species as their biodiversity and distribution tend to be well documented, whereas those of rare species are often unknown. However, the proportion of undiscovered species has been estimated at between one-third and two-thirds of all described marine species (Appeltans et al. 2012), indicating there is a large gap in knowledge of the biodiversity and geographic range of marine species. Though this shortage of knowledge is general across all marine ecosystems, information is particularly scarce for deep-sea species and those in other remote areas due to undersampling and underexploration (see e.g., McClain and Hardy 2010). Having large gaps in knowledge affects conservation management efforts that aim to halt or reverse biodiversity and ecosystem loss in general. Therefore, it is important to overcome the current fragmented state of information on marine biodiversity in many geographic regions.

In this study, we review the occurrence records of coral species inhabiting diverse habitats in the marine and coastal waters of Chile to determine species richness and distribution (both geographic and bathymetric), and to identify spatial and temporal trends in the data. To do this, we complied the data reported by previous studies of corals in the region including those by Reyes-Bonilla (2002), Cairns et al.

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(2005), Alarcón Delgado (2009), and Häussermann and Försterra (2007b, 2009), as well as more recent studies that focus on habitats in coastal or shallow waters, on the continental slope or seamounts, and around oceanic islands (e.g., Zapata-Guardiola and López-González 2010; McFadden and van Ofwegen 2013; Breedy et al. 2015; Araya et al. 2017; Gorny et al. 2018; Hoeksema et al. 2019) or methane seeps (Sellanes et al. 2008; Zapata-Hernández et al. 2014a, 2014b). According to these data, and other resources on coral biodiversity and distribution around Chile, including the continental shelf and slope, oceanic islands (i.e., Juan Fernández Archipelago, Desventuradas Islands, Salas y Gómez islet, and Rapa Nui), and oceanic ridges (i.e., Juan Fernández, Nazca and Salas y Gómez), there are significant knowledge gaps in the data that need to be filled in order to support efficient conservation plans that protect and promote the marine biodiversity of Chile.

Materials and methods

In order to determine the state of knowledge of coral diversity and distribution in Chile, we gathered data available from peer-reviewed articles and biodiversity databases. We performed a literature search using the databases Scopus Preview (https://www.scopus.com) and Google Scholar (https://scholar.google.it) (both accessed on 18 Dec 2020) using the following search criteria:

– peer-reviewed scientific papers and academic theses
– from all years to present; keywords in English or Spanish in the "Article title, abstract or keywords": ["coral" AND "Cnidaria" OR "Anthozoa" AND "Hydrozoa" OR "Hexacorallia" AND "Octocorallia" AND "Anthoathecata" AND "Hydroidolina"] AND ["diversity"] AND ["distribution"] AND ["Chile" OR "Chilean"] AND ["marine"].

In this study, the term "coral" refers to "hard and soft coral species that secrete calcium carbonate to form calcareous or corneous skeletons, or supportive elements such as sclerites or other exogenous material (e.g. sand grains, spicules)" (see e.g. Fabricius & Alderslade 2001; Veron 2000). All species belonging to the classes Anthozoa and Hydrozoa (Stylasteridae and Milleporidae) fall under this definition and were therefore included in the study. Datasets on coral occurrence records were downloaded from the Ocean Biodiversity Information System—OBIS (https://www.obis.org, 2020) and the Global Biodiversity Information Facility–GBIF (https://www.gbif.org 2020) and cross-checked against the peer-reviewed literature and some unpublished data (e.g. those found in the not publicly available part of the Sala de Colecciones Biológicas Universidad Católica del Norte, SCBUCN, database; or those gathered from 43 expeditions led by the co-authors VH and GF and the Huinay Scientific Field Station, HSFS). The taxonomic classification of each record was checked and, when necessary, corrected according to the information found in the latest version of WoRMS Editorial Board, 2021 (http://www.marinespecies.org, 2021)

Linear regressions were performed to determine the latitudinal distribution of coral species richness for Anthozoa and Hydrozoa. For the biogeographic analyses, coral records were assigned to ecoregions and/or provinces of one of three different biogeographic classification frameworks:

1) Provinces and ecoregions of the Southeastern Pacific Ocean according to the Marine Ecoregions of the World (MEOW) framework proposed by Spalding et al. (2007). Provinces included:

– Easter Island, Indo-Pacific (MEOW 42),
– Warm Temperate Southeastern Pacific (MEOW 45),
– Juan Fernández and Desventuradas (MEOW 46),
– Magellanic (MEOW 48).

The marine ecoregions included: 42.163 = Easter Island, 45.176 = Humboldtian, 45.177 = Central Chile, 45.178 = Araucanian, 46.179 = Juan Fernández and Desventuradas, 48.188 = Chiloense, and 48.187 = Channels and Fjords of Southern Chile (Figure 1a).

2) Provinces according to the biogeographic classification of the Chilean continental coast proposed by Camus (2001):

– Peruvian Province (18°S—30°S);
– Intermediate Area (30°S–41°S), which is divided into three districts (Northern, Mediterranean, and Southern: 30°S–33°S, 33°S–37°S, and 37°S–41°S, respectively);
– Magellanic Province (41°S–56°S), which is divided into two districts (Austral and Subantarctic: 41°S–52°S, and 52°S–56°S, respectively) (Figure 1b).

3) Provinces according to the biogeographic classification proposed by Häussermann (2006) and Häussermann et al. (2021), which is based on Pickard's (1971) subdivision of Chilean Patagonia:

– In this case, the Magellanic Province (sensu Camus 2001) is divided in three regions, Northern (41°S–47°S), Central (47°S–53°S), and Southern (53°S–56°S) Patagonia (Figure 1c).

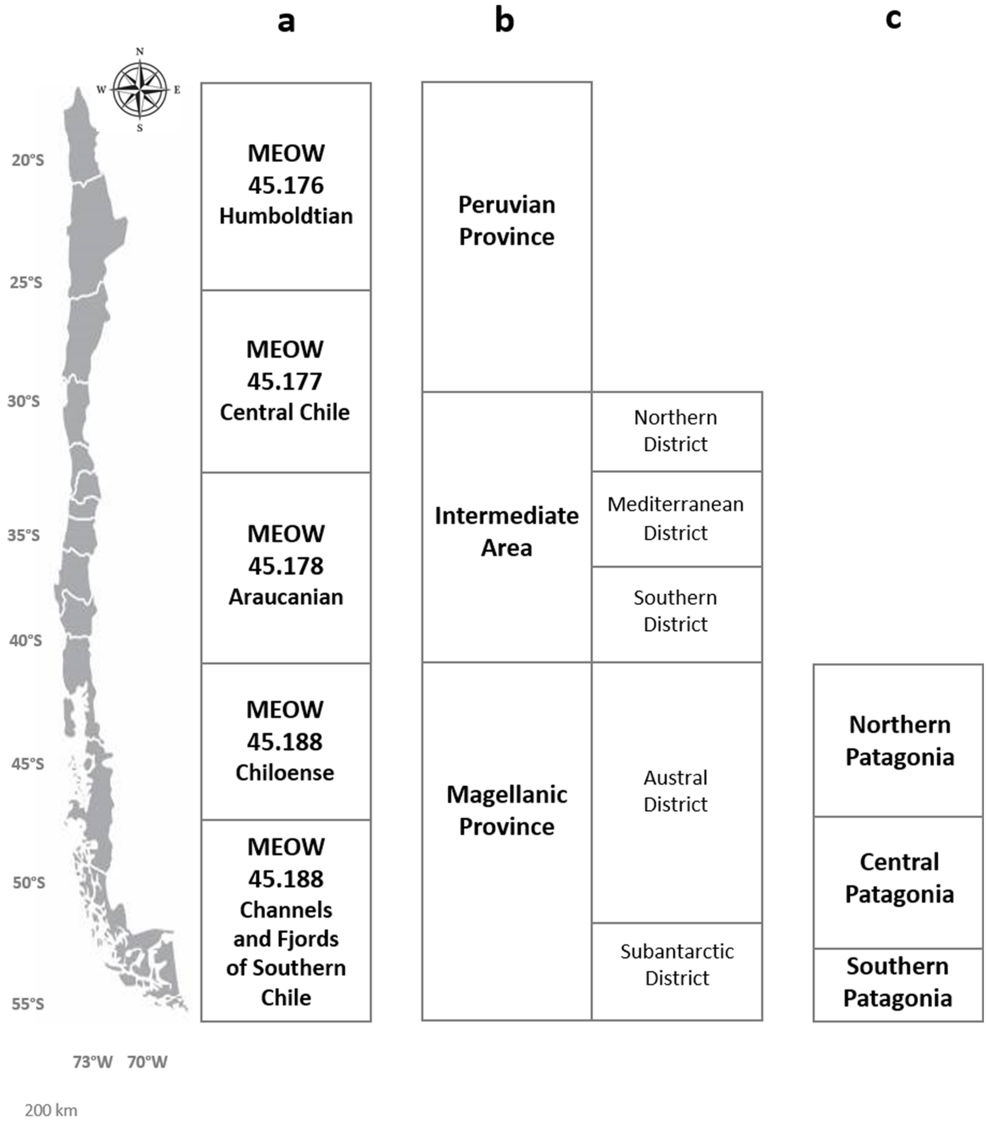

Fig. 1 Scheme of the biogeographic classifications of the Chilean continental coasts and shelves used in this study. Classification according to **a** Spalding et al. (2007) in the Marine Ecoregions of the World (MEOW); **b** Camus (2001); and **c** Häussermann et al. (2021)

Results

After excluding any non-applicable records (i.e., those for coral species without calcified skeletons or structures and duplicate, fossil and non-Chilean ones), we obtained a total of 74 publications and 2505 occurrence records from the literature and biodiversity databases. To these data, we added those found in studies not mentioned in these databases and unpublished data from scientific expeditions:

– 78 coral occurrence records from 13 studies: Reyes-Bonilla (2002), Glynn et al. (2003), Häussermann and Försterra (2007b, 2009), van Ofwegen et al. (2007), Alarcón Delgado (2009), Sinniger and Haüssermann (2009), Zapata-Guardiola and López-González (2010), McFadden and van Ofwegen (2013), Breedy et al. (2015), Araya et al. (2016, 2017), and Gorny et al. (2018);
– 67 coral occurrence records from recent expeditions reported in the SCBUCN collection database, and 1982 coral records registered from the 43 expeditions organized by the co-authors VH and GF between 1998 and 2003, and those organized by the HSFS (and also by VH and GF) between 2005 and 2019.

Coral records identified only to the class level were excluded from further analyses, and scientific names were corrected for 302 records. The final dataset included 4117 coral records. Missing information was observed for some of these records at the family (136), genus (159), or species (517) level, representing 185 taxa (Table 1) from:

– two classes of Cnidaria (Anthozoa and Hydrozoa), and three subclasses (Hexacorallia, Octocorallia, Hydroidolina);

Table 1 Coral taxa distribution registered in Chilean marine and coastal waters. Number of genera and species by family in Anthozoa and Hydrozoa. (*) Taxa without information at species level

Class / Subclass / Order / Family	Number of genera	Number of species
Anthozoa		
Hexacorallia		
Antipatharia		
Antipathidae	3	6
Aphanipathidae	1	1
Cladopathidae	2	2
Leiopathidae	1*	1
Myriopathidae	1	1
Schizopathidae	3	3
Stylopathidae	1*	1
Scleractinia		
Acroporidae	1	1
Agariciidae	1	2
Caryophylliidae	9(1*)	17
Deltocyathidae	1	1
Dendrophylliidae	6(1*)	6
Faviidae	1	1
Flabellidae	4	4
Fungiacyathidae	1	4
Fungiidae	2	3
Merulinidae	1	1
Micrabaciidae	1	2
Mussidae	1	1
Oculinidae	3	3
Pocilloporidae	1	2
Poritidae	1	1
Psammocoridae	1	1
Rhizangiidae	3	3
Siderastreidae	1	1
Stenocyathidae	1	1
Turbinoliidae	1	2
Zoantharia		
Epizoanthidae	1	4
Hydrozoanthidae	1	1
Parazoanthidae	2	4
Octocorallia		
Alcyonacea		
Acanthogorgiidae	1	5
Alcyoniidae	2(1*)	11
Anthothelidae	2(1*)	2
Victorgorgiidae	1	1
Chrysogorgiidae	1*	1
Clavulariidae	3	4
Gorgoniidae	3(1*)	4
Isididae	5(1*)	6
Keroeididae	1*	1
Paragorgiidae	2(1*)	2
Plexauridae	9(3*)	16
Primnoidae	11	23
Pennatulacea		
Anthoptilidae	1	1
Halipteridae	1	1
Kophobelemnidae	1*	1
Protoptilidae	2	2
Renillidae	1	4
Stachyptilidae	1	1
Umbellulidae	1*	1
Virgulariidae	2(1*)	2
Hydrozoa		
Hydroidolina		
Anthoathecata		
Milleporidae	1	1
Stylasteridae	9	14

- six orders (Antipatharia, Scleractinia, Zoantharia, Alcyonacea, Pennatulacea, Anthoathecata);
- 52 families (50 for Anthozoa and 2 for Hydrozoa, by order: Antipathidae, Aphanipathidae, Cladopathidae, Leiopathidae, Myriopathidae, Schizopathidae, Stylopathidae; Acroporidae, Agariciidae, Caryophylliidae, Deltocyathidae, Dendrophylliidae, Faviidae, Flabellidae, Fungiacyathidae, Fungiidae, Merulinidae, Micrabaciidae, Mussidae, Oculinidae, Pocilloporidae, Poritidae, Psammocoridae, Rhizangiidae, Siderastreidae, Stenocyathidae, Turbinoliidae; Epizoanthidae, Hydrozoanthidae, Parazoanthidae; Acanthogorgiidae, Alcyoniidae, Anthothelidae, Chrysogorgiidae, Clavulariidae, Gorgoniidae, Isididae, Keroeididae, Paragorgiidae, Plexauridae, Primnoidae, Victorgorgiidae; Anthoptilidae, Halipteridae, Kophobelemnidae, Protoptilidae, Renillidae, Stachyptilidae, Umbellulidae, Virgulariidae; Milleporidae, Stylasteridae);
- 118 genera (108 for Anthozoa, 10 for Hydrozoa) and 185 species (170 for Anthozoa, 15 for Hydrozoa) (Table 1, SI Table 3).

Occurrence records

According to the occurrence records, corals in Chilean marine and coastal waters occur at a latitudinal range from 18°S to 59°S (SI Table 2). The distribution of coral records by degree of latitude (Figure 2a) and by sampling year (Figure 2b) was highly variable. The majority of the records were for the southern regions of Chile, from 41°S to 56°S of latitude, corresponding to Chilean Patagonia. The highest number of records was observed for latitudes 42°S (806 records) and 48°S (629 records). For latitudes north of 41°S, the number of records generally ranged between two and 67, with the exception of 33°S, which had 250 records. Regarding sampling year, a higher number of records (and an increasing trend) were registered for the years 1876 to 1877 and 1960 to 1967, and since 2000, from 2001 to 2016.

With respect to the bathymetric data, coral occurrences decreased markedly as depth increased, with most of the corals (92%) found at depths above 2000 m (Figure 3a). By zones, around 54.5% of the records were for the littoral-euphotic (0–50 m), 6.8% for the littoral-oligophotic (50–200 m), 30.7% for the archibenthic (200–1000 m), 7.3% for the bathybenthic (1000–4000 m), and only 0.6% (27 records) for the abyssobenthic (4000–6000 m) and just 0.1% (one record) for the hadobenthic (>6000 m) (Figure 3b). The orders Anthoathecata, Antipatharia, Pennatulacea, and Zoantharia presented the lowest numbers of registered records, and the

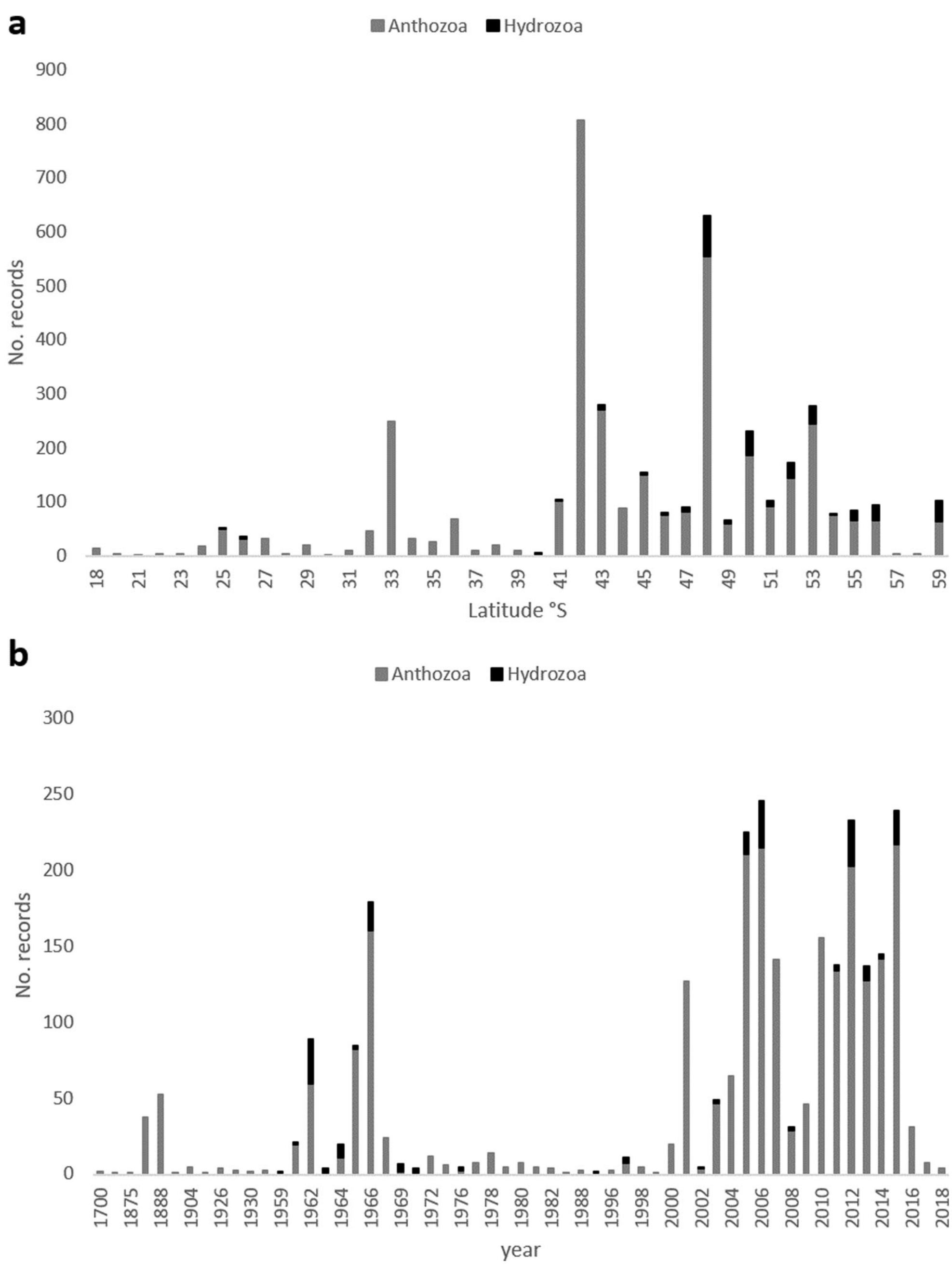

Fig. 2 Number of occurrence records for the classes Anthozoa and Hydrozoa by **a** latitude and **b** sampling year

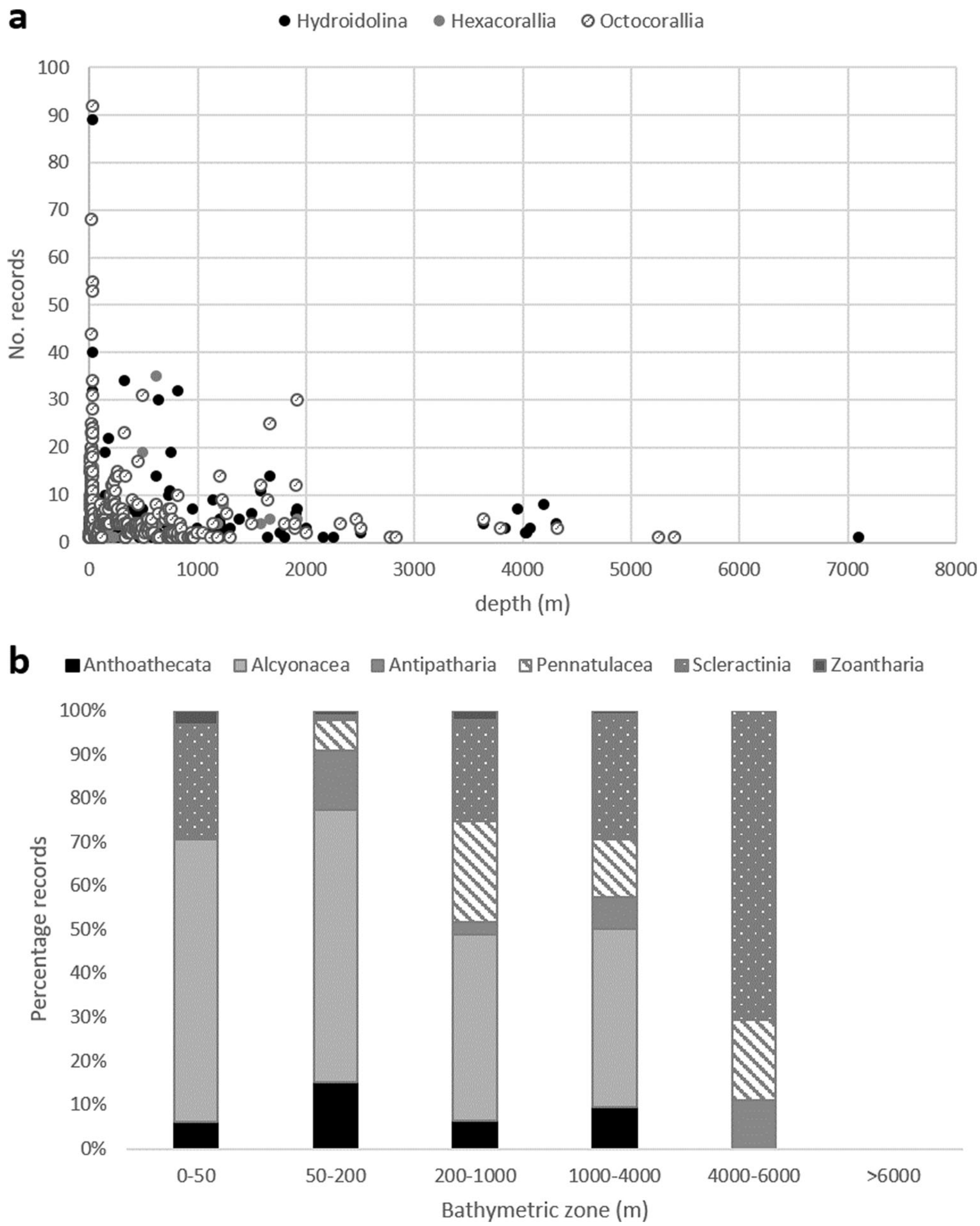

Fig. 3 Number of occurrence records for the **a** subclasses Hydroidolina, Hexacorallia, and Octocorallia by depth (m) and **b** orders Alcyonacea, Anthoathecata, Antipatharia, Pennatulcaea, Scleractinia, and Zoantharia by bathymetric zone

orders Alcyonacea and Scleractinia generally had the highest numbers for each bathymetric zone (Figure 3b).

Diversity

Coral richness, which included tropical and cold-water species, was higher for Anthozoa (92% of the occurrence records, Figure 4a) than for Hydrozoa (8% of the records, Figure 4b) at the family, genus, and species level. Similar to the distribution pattern of the coral records (Figure 2), the highest levels of alpha diversity were observed at latitudes 33°S (22 species), 48°S (27 species), 50°S (23 species), 53°S (31 species), and 56°S (26 species) for Anthozoa; and 55°S (6 species) and 56°S (11 species) for Hydrozoa. A pattern of increasing species richness from the equator to 56°S was observed for both anthozoan (Figure 5a, $r = 0.58$) and hydrozoan species (Figure 5b, r=0.51); however, there was a significant lack of hydroid coral occurrences at lower latitudes (i.e., from 18°S to 24°S and from 27°S to 39°S, Figure 4b).

In general, a pattern of increasing gamma diversity towards higher latitudes was also observed when diversity was considered in terms of MEOW biogeographic provinces and ecoregions. Higher coral species richness was observed in the southern provinces compared with the northern ones (from south to north, the Magellanic province had 131 species; Juan Fernández and Desventuradas, 73 species; Central Chile, 64 species; and Easter Island, 11 species) (Figure 5c). The highest

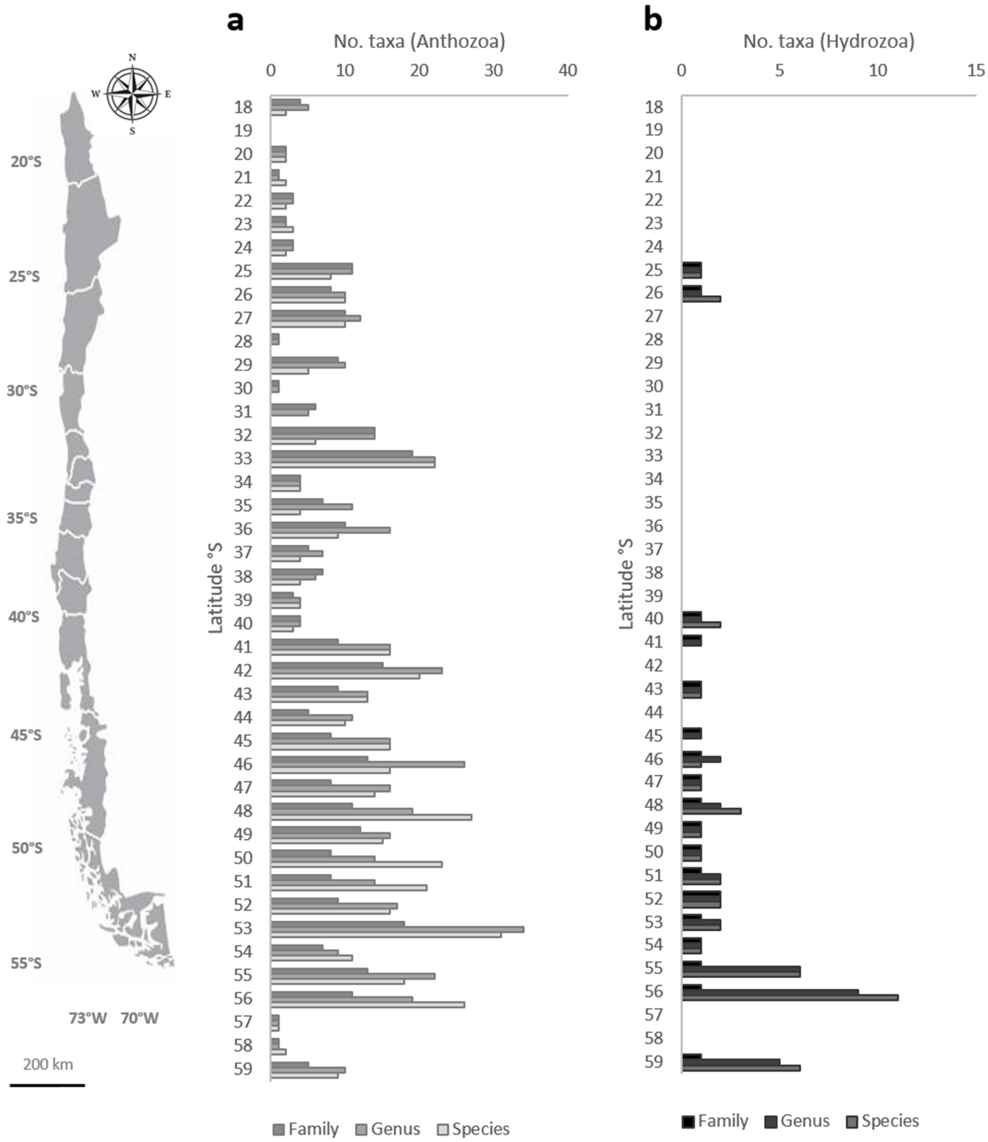

Fig. 4 Coral diversity by family, genus, and species at each degree of latitude for **a** Anthozoa and **b** Hydrozoa

species richness was consistently observed in the ecoregion Channels and Fjords of Southern Chile, with 123 coral species, and the lowest was in Easter Island with 11 species (Figure 5d). The oceanic ecoregion Juan Fernández and Desventuradas (with 73 species) also presented remarkably high coral species richness (Figure 5d). Similar species distribution patterns were obtained when considering the biogeographic regions proposed by Camus (2001), at both the province and the district level (Peruvian Province with 40 species; Intermediate Area with 43 species: Northern District (26), Mediterranean District (15), and Southern District (12); and Magellanic Province with 132 species: Austral District (91) and Subantarctic District (83)) (Figure 6a, b). For the biogeographic regions of the Magellanic Province proposed by Häussermann (2006) and Häussermann et al. (2021), the highest species richness was found in Central Patagonia (74 species) followed by Southern (68 species) and Northern (53 species) Patagonia (Figure 6c).

New record

Finally, we report a new location and an extension of the known geographic range for *Bathycyathus chilensis* (Order: Scleractinia; Family: Caryophylliidae). The distribution range of each coral family, genus, and species are available in SI Table 3.

Bathycyathus chilensis Milne Edwards & Haime, 1848
Bathycyathus chilensis Milne Edwards & Haime, 1848.—*Bathycyathus indicus* Milne Edwards and Haime, 1848: 294–295, pl. 9, Fig. 5.—Gay, 1854: 454–455.—Milne Edwards and Haime, 1848: 294–295, pl. 9, Fig. 4; 1857:

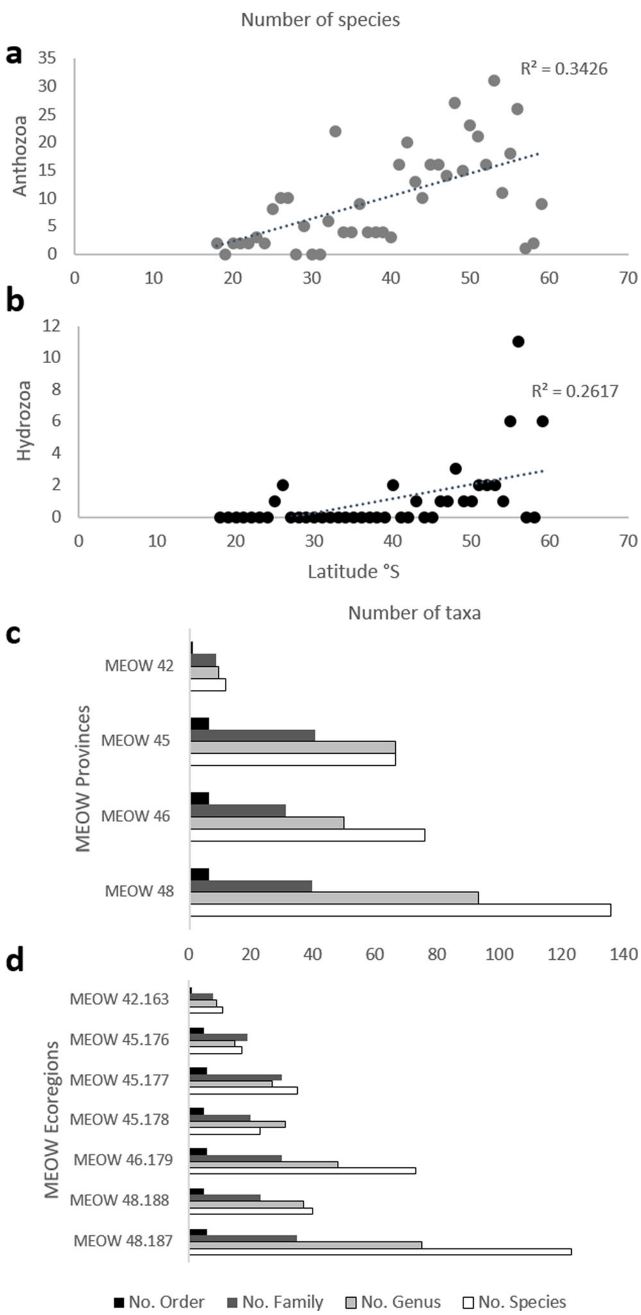

Fig. 5 Linear regression plots showing the latitudinal distribution of **a** anthozoan species and **b** hydrozoan species. Variables were statistically significant (*p* value = 0.0005). Number of taxa (by order, family, genus, and species) for the **c** four provinces and **d** seven ecoregions suggested for Chile, according to the Marine Ecoregions of the World (MEOW) classification proposed by Spalding et al. (2007). The province and ecoregion codes are as follows: *Provinces*: 42 = Easter Island, 45 = Warm Temperate Southeastern Pacific, 46 = Juan Fernández and Desventuradas, 48 = Magellanic; *Ecoregions*: 45.176 = Humboldtian, 45.177 = Central Chile, 45.178 = Araucanian, 46.179 = Juan Fernández and Desventuradas, 48.188 = Chiloense, 48.187 = Channels and Fjords of Southern Chile]

23.—Verrill, 1870: 539 (English translation of the description of Milne Edwards and Haime, 1848).—Philippi, 1892: 8–9, pl. 2, Figs. 3a–c.—Wells, 1936: 102–103 (type species of genus, synonymy *Bathycyathus indicus*).—Andrade, 1987: 78 (listed).—Piñón, 1999: 20, 80 (listed). Reyes-Bonilla, 285 2002: 7 (listed).—Cairns et al. 2005: 23, 24 (new records).

New distribution record and specimen examined.—Chile: Comau, Punta Gruesa, 238 m of depth, 42.400 72.410°W, 2014, 1 dead corallite, hard bottom (USNM 1283873, Figure 7);

Remarks.—*Bathycyathus chilensis* is an endemic species of Chile. The original description is based on a single specimen collected near Robinson Crusoe Island in the Juan Fernández Archipelago at a depth of 146 m (Milne Edwards and Haime, 1857; syn. *Bathycyathus indicus*). One and a half centuries later, Cairns et al. (2005) recorded *B. chilensis* from Papudo (Valparaíso) off the coast of Chile at 420 m of depth, extending the depth range of the species to from 26 m to 420 m. Based on the specimen of *B. chilensis* collected from Comau Fjord and reported here (Figure 7), the latitudinal distribution of *B. chilensis* is now from 26°S to 47°S.

Discussion

Although biodiversity databases such as OBIS and GBIF are extremely useful, the information registered is not always correct, and/or relevant data are sometimes missing. For this reason, the input data need to be carefully curated before they can be used for comprehensive analyses. A minimum standard of information should also be required for the input data. We strongly recommend that links to taxonomic and molecular databases (e.g., WoRMS for marine organisms or GenBank) and the taxonomic status of species be included in the entries of the biodiversity databases.

Variation in research intensity and disparity in sampling efforts may explain the differences in the number of coral occurrences observed at both the spatial and temporal scales. Indeed, locations comprising a concentration of records correspond to major cities or landmarks that have been suggested as limits between biogeographic ecoregions, for example:

- Coquimbo (30°S) in the Central Chile ecoregion (or Peruvian Province (*sensu* Camus 2001)),
- Puerto Montt (41°30′S) in the Chiloense ecoregion (or Magellanic Province—Austral District (*sensu* Camus 2001), or Northern Patagonia (sensu Häussermann et al. 2021)),
- Taitao Peninsula (48°S) in the Chiloense ecoregion (or Magellanic Province—Austral District (sensu Camus 2001) or Central Patagonia (sensu Häussermann et al. 2021)), and the Straights of Magellan (~53°S) in the Channels and Fjords of Southern Chile ecoregion (or Magellanic Province—Austral District (sensu Camus 2001), or Southern Patagonia (sensu Häussermann et al. 2021)),

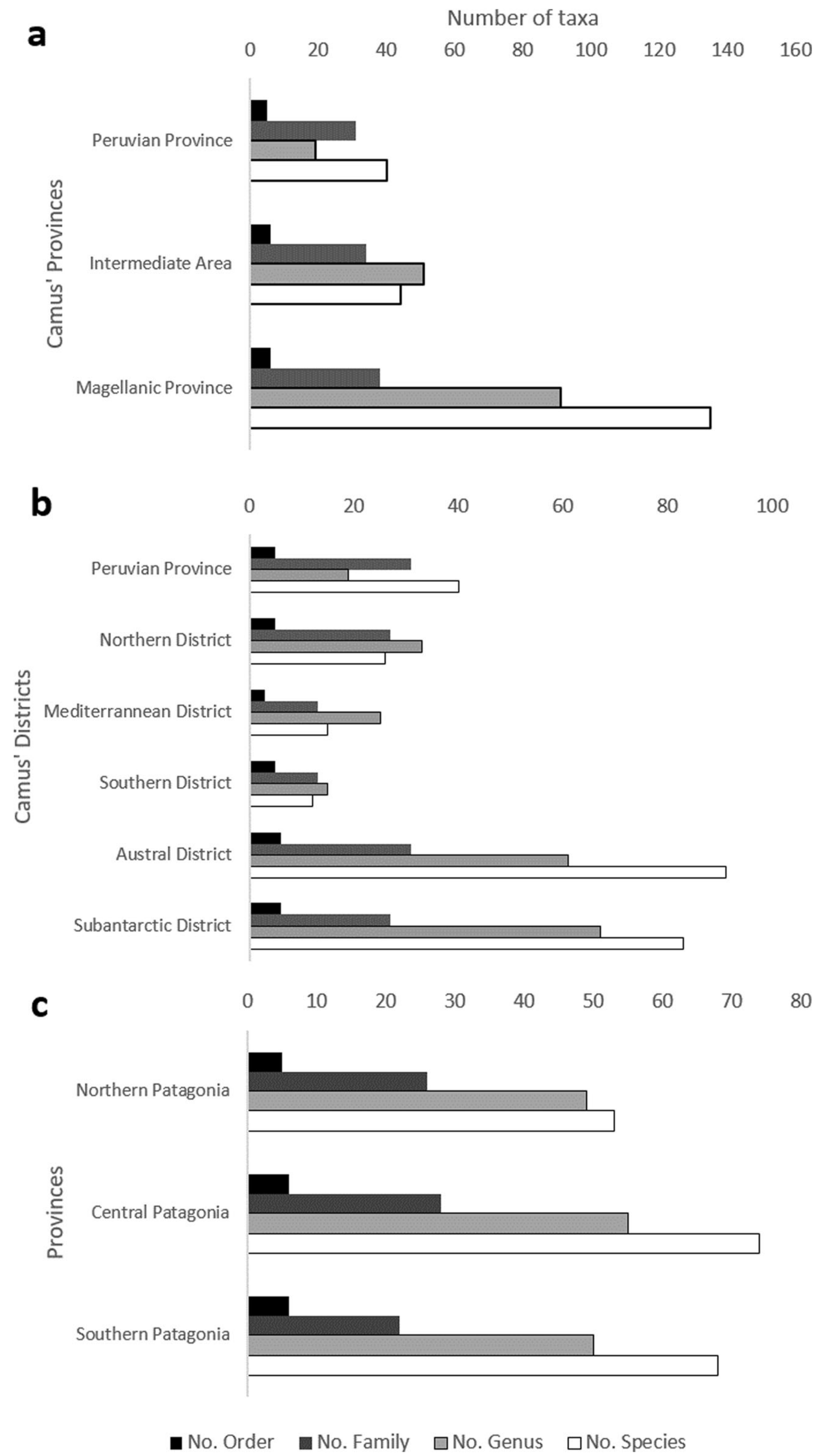

Fig. 6 Number of taxa (by order, family, genus, and species) for biogeographic classification proposed by **a** Camus (2001) for the Chilean continental coast and **b** Häussermann et al. (2021) for the Chilean Patagonia coast

– Cape Horn (56°S).

Following the latitudinal diversity gradient (the tendency for species richness to increase from the poles to the tropics) (see Chown et al. 2004 and Kinlock et al. 2018), major coral occurrences in Chile would be expected at latitudes with the richest tropical marine areas, as has been observed for other marine organisms, such as fishes, molluscs, and polychaetes (e.g., Miloslavich et al. 2011), or other localities such as the Tropical Eastern Pacific (e.g., Núñez-Flores et al. 2019). This trend is observed along the Chilean coasts, though it is reversed in the Patagonian region: the data analysed here show

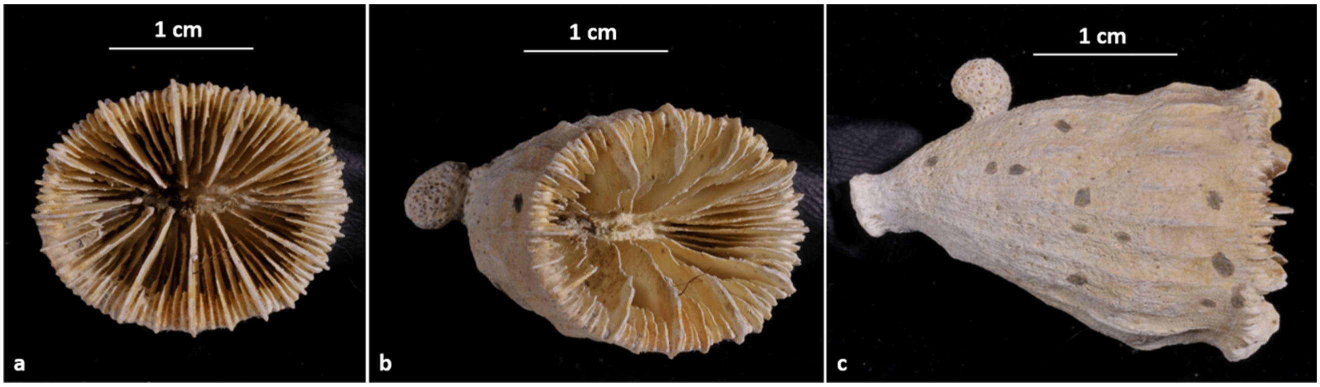

Fig. 7 Specimen of *Bathycyathus chilensis* collected in Comau, Punta Gruesa, 238 m, 42.400 72.410°W, 2014. (USNM 1283873). **a** = calicular view; **b**= calicular oblique view; **c**= lateral view of corallum. Scale bar = 1 cm

that the highest species diversity occurs in the Magellanic Province (i.e., Chilean Patagonia) rather than further north (see Figure 5). Häussermann et al. (2021), who have led numerous SCUBA diving expeditions of this province over the past two decades, reported that Northern Patagonia harbours the highest diversity of shallow-water anthozoans, followed closely by Central Patagonia; by comparison, Southern Patagonia harbours a lower level of biodiversity (Häussermann et al. 2021). It is worth mentioning that the results reported here may be mainly reflecting the asymmetrical sampling effort of past research expeditions of Chilean coastal and marine waters and not the real pattern of coral distribution and biodiversity in this vast area. Indeed, recent local-scale studies of the slopes of the ecoregions comprising oceanic islands and the seamounts of Nazca and Desventuradas (Friedlander et al. 2016; Asorey et al. 2021; Tapia-Guerra et al. 2021a) and of Easter Island (Tapia-Guerra et al. 2021b) have highlighted the still incipient taxonomic knowledge of benthic assemblages in these areas, particularly of corals, among other poorly studied organisms.

Many of the analysed occurrence records originated from large-scale expeditions such as the Challenger Expedition (1872–1876) and the Lund University Chile Expedition (1948–1949), and the publications resulting from these expeditions.

The results obtained here show that most of the analysed studies were conducted in coastal and shallow water habitats, and that the sampling effort was most intense in waters near main cities or landmarks and the shallow waters of Chilean Patagonia. The continental slope, oceanic islands, seamounts, and regions between cities remain mostly unexplored. Our findings are consistent with other studies showing, for instance, tropical areas as well-studied, but others such as oceanic ecosystems (e.g., deep-sea habitats) as also largely unexplored (Webb et al. 2010; Snelgrove et al. 2016; Oliver et al. 2021). This is in line with conclusions drawn at the global level in which coastal species show maximum diversity, whereas oceanic groups consistently peaked across broad mid-latitudinal bands in all oceans (Tittensor et al. 2010). Areas with high species richness were disproportionately concentrated in regions with a medium to high level of human impact (Tittensor et al. 2010). Strong geographic and taxonomic biases persist (Oliver et al. 2021), and many species remain unknown or unstudied, while others (e.g., charismatic megafauna) attract most of the public, scientific, and government attention (Troudet et al. 2017; Heathcote 2021).

As highlighted by our study of coral species occurrence, the coastal and marine waters of Chile, a vast area comprised several biogeographic provinces and ecoregions, remain poorly explored. This area includes relevant endemic biodiversity hotspots and fragile habitats (see e.g., Häussermann et al. 2021 for the continental shelf, slope, and fjord areas, and Wagner et al. 2021 for the Nazca and Salas y Gómez ridges), for which biodiversity estimates are especially important. Our study also demonstrates that the largest efforts to inventory coral species of this region were made by the Challenger (1872–1876), the Lund University Chile (1948–1949), and the Huinay Fjord (2005–2019) expeditions. Our findings establish a knowledge base to guide future coral diversity research and assessments, which can then be used to support coral conservation in Chilean coastal and oceanic waters. Having an accurate assessment of the status of our current knowledge on marine biodiversity is pivotal for protecting the marine realm. As indicated by our analysis, further studies of corals in Chilean coastal and oceanic waters are needed to increase the current knowledge of coral biodiversity and distribution at the geographic and the bathymetric scale. Filling the knowledge gaps on coral biodiversity in general is extremely important in the context of the Convention on Biological Diversity: as fragile calcified bioengineering species, corals can be used as indicators for monitoring biodiversity. Their conservation is therefore key for maintaining ecosystem services linked to marine biodiversity.

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Declarations

Conflict of interest The authors declare no competing interests.

Ethical approval No animal testing was performed during this study.

Sampling and field studies The study does not contain sampling material or data from field studies.

Data availability All the data analysed in this study are provided in the main article or in supplementary information.

Author contribution AMA conceived and designed the study. Sample collection was performed by AMA, AM, VH, GF, JS. Data collection and analysis were performed by AMA. The manuscript was written by AMA with contributions from all authors, VH, JS, GF, and AM.

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