

THE PORIFERA, CNIDARIA, BRYOZOA, AND ECHINODERMATA COLLECTIONS OF THE UNIVERSIDADE FEDERAL DO CEARÁ: CONTRIBUTIONS TO THE MARINE BIODIVERSITY KNOWLEDGE OF NORTHEASTERN BRAZIL

As coleções de Porifera, Cnidaria, Bryozoa e Echinodermata da Universidade Federal do Ceará: contribuições para o conhecimento da biodiversidade marinha do Nordeste do Brasil

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ABSTRACT

In the last years, in addition to recording the diversity, the biological collections have also been used as repositories for ecological data. In order to contribute to the knowledge of Brazilian biological collections and, consequently, Brazil's biodiversity, especially marine, the present study brings data from four regional collections (phyla Porifera, Cnidaria, Bryozoa, and Echinodermata) of the Departamento de Biologia, Universidade Federal do Ceará. The composition and geographic distribution data of each phylum were obtained by analyzing the digital spreadsheets containing the information about the deposited material. Together, the analyzed collections have 1,378 lots, being 303 of Porifera, 131 of Cnidaria, 414 of Bryozoa, and 530 of Echinodermata. Despite their regional nature, the collections of Porifera, Cnidaria, Bryozoa and Echinodermata of the Universidade Federal do Ceará represent, respectively, 6.5%, 6.9%, 10.7%, and 17.5% of the species so far recorded for the Brazilian coast. Although regional biological collections can help to better understand the diversity, there has never been a long-term policy formation and

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maintenance of scientific collections in Brazil. The preservation of these repositories, together with the sharing of their knowledge, will allow for more appropriate conservation decision-making in local, regional, and global scales.

Keywords: biological collections, sponges, cnidarians, bryozoans, echinoderms.

RESUMO

Nos últimos anos, além do registro da diversidade, as coleções biológicas têm também sido utilizadas como repositórios de dados ecológicos. Com o objetivo de contribuir para o conhecimento das coleções biológicas brasileiras e, conseqüentemente, da biodiversidade do Brasil, especialmente a marinha, o presente estudo traz dados de quatro coleções regionais (filos Porifera, Cnidaria, Bryozoa e Echinodermata) do Departamento de Biologia, da Universidade Federal do Ceará. Os dados de composição e distribuição geográfica de cada filo foram obtidos pela análise de planilhas digitais contendo as informações sobre o material depositado. Juntas, as coleções analisadas possuem 1.382 lotes, sendo 303 de Porifera, 131 de Cnidaria, 414 de Bryozoa e 530 de Echinodermata. Apesar da natureza regional das coleções de Porifera, Cnidaria, Bryozoa e Echinodermata da Universidade Federal do Ceará, elas representam, respectivamente, 6,5%, 6,9%, 10,7% e 17,5% das espécies até o momento registradas para a costa brasileira. Embora coleções biológicas regionais possam ajudar a compreender melhor a diversidade, nunca houve uma política de longo prazo de formação e manutenção de coleções científicas no Brasil. A preservação desses repositórios, juntamente com o compartilhamento de seus conhecimentos, permitirá uma tomada de decisão mais apropriada de medidas de conservação em escalas locais, regionais e globais.

Palavras-chave: coleções biológicas, esponjas, cnidários, bryozoários, equinodermos.

INTRODUCTION

Biodiversity can be defined as the variety of life, heterogeneously distributed, which encompasses all levels of organization, from genetic diversity within populations to the diversity of ecosystems in landscapes (Gaston, 2000; Chapin III *et al.*, 2000). The current period of Earth's history, called Anthropocene, is characterized by the various human actions on the environment, which have modified, on a global scale, the relations between society and nature (Lewis & Maslin, 2015). Studies have shown that the loss and redistribution of biodiversity, driven by climate change at local, regional and global scales, affects the functioning of ecosystems (e.g., carbon sequestration processes), human well-being (including food security and disease transmissions) and the dynamics of climate change (Pecl *et al.*, 2017).

In the last years, the biological collections, which have as primary function record the diversity, being reference for taxonomists, have also been used to characterize distribution and phenology of species, serving as repositories for ecological data (Ponder *et al.*, 2001; Rocha *et al.*, 2014; Meineke *et al.*, 2018). Since natural history collections house vast amounts of biodiversity data of centralized locations, they are now recognized as among the best resources for measuring and understanding the human impacts of global change during the past century (Ponder *et al.*, 2001; Meineke *et al.*, 2018).

In terms of biodiversity, Brazil occupies a prominent place, since it hosts about 15-20% of the planet's biological diversity, being part of a group comprising 17 megadiverse countries (Unep-WCMC, 2014). However, it holds only 1% of the world's scientific biological collections, having a great challenge ahead (Kury *et al.*, 2006). Added to this, over the past eleven years, fires have consumed science museums and research centers, including the scientific collections of the Butantan Institute of São Paulo and the National Museum of Rio de Janeiro (Sant'anna, 2010; Warrell; Theakston & Wuster, 2010; Mega, 2019).

In order to contribute to the knowledge of Brazilian biological collections and, consequently, Brazil's biodiversity, especially marine, the present study brings qualitative and quantitative data from four regional collections of the Departamento de Biologia, Universidade Federal do Ceará. The data presented here correspond to the phyla Porifera, Cnidaria, Bryozoa, and Echinodermata, being an important record of the marine biodiversity of northeastern Brazil.

MATERIAL AND METHODS

The Porifera, Cnidaria, Bryozoa, and Echinodermata scientific collections analyzed in this study are in the Laboratório de Invertebrados Marinhos LIMCE of the Departamento de Biologia, Universidade Federal do Ceará (Ceará State, NE Brazil).

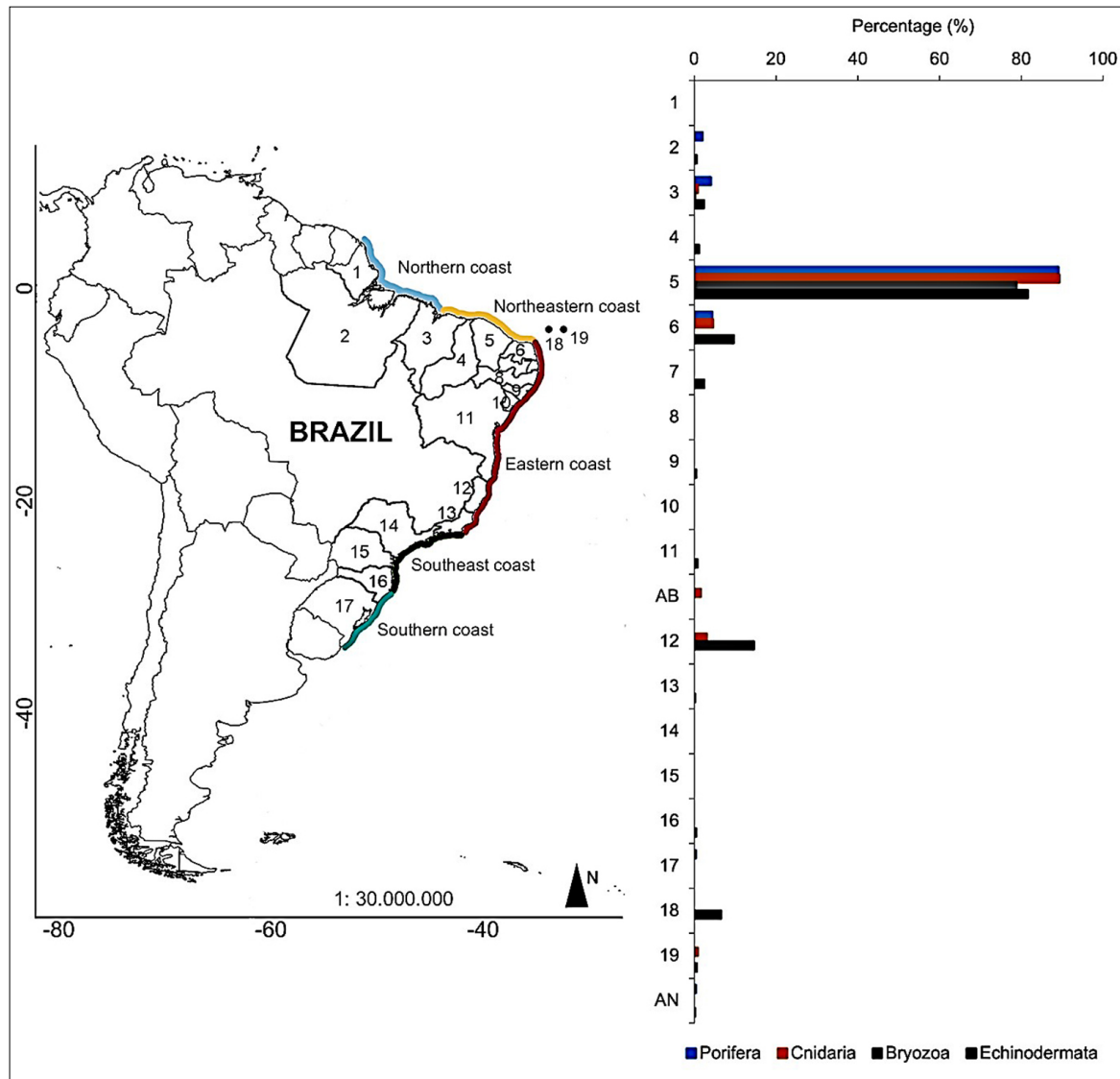
The composition and geographic distribution data of each phylum were obtained by analyzing the digital spreadsheets containing the information about the deposited material. For taxonomy, we used specialized literature (Hendler *et al.*, 1995; Hooper & van Soest, 2002; Morrow & Cárdenas, 2015; Cook *et al.*, 2018; Schwaha, 2020) and on-line resources, such as the World Register of Marine Species (WoRMS Editorial Board, 2021) and World Porifera Database (van Soest *et al.*, 2021). For the geographical distribution, we used the Brazilian coast classification proposed by Fernandez *et al.* (2019), which divided this region in: Northern coast (from Cape Orange to São Marcos Bay), Northeastern coast (landscapes between São Marcos Bay and Cape Calcanhar), Eastern coast (from south of Cape Calcanhar to Cape Frio), Southeast coast (landscapes between Cape Frio to Cape Santa Marta), and Southern coast (from Cape Santa Marta to Chuí). In addition, we also mentioned the Brazilian States where the specimens were collected (Figure 1).

RESULTS

Together, the analyzed collections have 1,378 lots, being 303 of Porifera, 131 of Cnidaria, 414 of Bryozoa, and 530 of Echinodermata (Table I). The specimens are from the intertidal and infralittoral zones, during punctual samplings and oceanographic expeditions (e.g., MAR XV, carried out by the German oceanographic ship Victor Hensen, in the years 1990 and 1991).

The Porifera collection, although a large part of its lots is still unidentified (40.6%), is currently represented by one class (Demospongiae), 13 orders, 23 families, 25 genera, and 39 species. The most representative order is Haplosclerida, with four families, five genera, and eight species, following by Tetractinellida (two families, two genera, and five species) and Verongiida (one family, one genus, and five species) (Table I). Except for two lots (0.7%) (from the Antarctica and the Rio Grande do Sul State, Southern Brazilian Coast), all lots analyzed are from Northern, Northeastern, and Eastern Brazilian coasts (2% from Pará, 4% from Maranhão, 89% from Ceará, and 4.3% from Rio Grande do Norte States) (Figure 1).

Figure 1 - The geographic distribution data of the Porifera, Cnidaria, Bryozoa, and Echinodermata scientific collections of the Departamento de Biologia, Universidade Federal do Ceará (Ceará State, NE Brazil). The regions along the Brazilian coast (Northern Coast, Northeastern coast, Eastern coast, Southeast coast, and Southern Coast) follow the classification proposed by Fernandez *et al.* (2019). The abbreviation AB (Abrolhos Archipelago) and numbers correspond to Brazilian States and insular areas: 1 - Amapá, 2 - Pará, 3 - Maranhão, 4 - Piauí, 5 - Ceará, 6 - Rio Grande do Norte, 7 - Paraíba, 8 - Pernambuco, 9 - Alagoas, 10 - Sergipe, 11 - Bahia, 12 - Espírito Santo, 13 - Rio de Janeiro, 14 - São Paulo, 15 - Paraná, 16 - Santa Catarina, 17 - Rio Grande do Sul, 18 - Rocas Atoll, and 19 - Fernando de Noronha Archipelago. The abbreviation AN correspond to Antarctica continent



The Cnidaria collection, despite the small number of lots, is represented by five classes, 12 orders, 30 families, 38 genera, and 47 species. The anthozoan Alcyonacea is the most representative order, with five families, eight genera, and 11 species. Both the anthozoan Scleractinia and the hydrozoan Leptothecata orders are represented by seven species (Table I). Except for four lots (3%) from the Doce River mouth, Espírito Santo State, Eastern Brazilian coast, all lots analyzed are from Northeastern and Eastern Brazilian coasts (0.8% from Maranhão, 89.3% from Ceará, and 4.6% from Rio Grande do Norte States), including one lot (0.8%) from Fernando de Noronha Archipelago and two lots (1.5%) from Abrolhos Archipelago (Figure 1).

A little more than Porifera in terms of number of lots, Bryozoa collection is represented by two classes (Gymnolaemata and Stenolaemata), three orders (Cheilostomata, Ctenostomata and Cyclostomata), 45 families, 61 genera, and 51 species. Cheilostomata represents 92% of the deposited material, with 40 families, 55 genera, and 47 species (Table I). The specimens are collected along the Northeastern (0.2% from Maranhão and 78.8% from Ceará) and Eastern (14.5% from Espírito Santo) Brazilian coasts, in addition to lots of Rocas Atoll (6.5%) (Figure 1).

In terms of number of lots, Echinodermata is the most representative collection analysed here, with five classes, 14 orders, 27 families, 40 genera, and 59 species. Thirty-four lots (6.4%) are identified only at class level. The order Amphilepidida (Ophiuroidea) is the most representative, with five families, 10 genera, and 15 species, following by the order Dendrochirotida (Holothuroidea), which comprising three families, seven genera, and 10 species (Table I). Except for one lot (0.2%) from Antarctica, all specimens are from Northern, Northeastern, Eastern, and Southeast Brazilian coasts (0.6% from Pará, 2.3% from Maranhão, 1.1% from Piauí, 81.5% from Ceará, 9.6% from Rio Grande do Norte, 2.4% from Paraíba, 0.4% from Alagoas, 0.7% from Bahia, 0.2% from Rio de Janeiro, and 0.4% from Santa Catarina), including three lots (0.6%) from Fernando de Noronha Archipelago (Figure 1). The Echinodermata collection is the most representative in terms of specimens collected in different regions.

Table I - The diversity of Porifera, Cnidaria, Bryozoa, and Echinodermata biological collections of the Departamento de Biologia, Universidade Federal do Ceará (NE Brazil), in terms of classes, orders, families, genera, and species

| Phylum/class/order | Number of | | |
|------------------------|--------------|--------------|--------------|
| | families | Genera | Species |
| Phylum Porifera | 23 | 25 | 39 |
| Class Demospongiae | | | |
| Order Agelasida | 1 | 1 | 1 |
| Order Axinellida | 2 | 3 | 3 |
| Order Chondrillida | 1 | 1 | 1 |
| Order Clionaida | 2 | 2 | 2 |
| Order Dendroceratida | unidentified | unidentified | unidentified |
| Order Dictyoceratida | 3 | 3 | 4 |
| Order Haplosclerida | 4 | 5 | 8 |
| Order Poecilosclerida | 2 | 2 | 4 |
| Order Scopalinida | 1 | 1 | 1 |
| Order Suberitida | 1 | 1 | 2 |
| Order Tethyida | 2 | 2 | 2 |
| Order Tetractinellida | 3 | 3 | 6 |
| Order Verongiida | 1 | 1 | 5 |
| Phylum Cnidaria | 30 | 38 | 47 |
| Class Anthozoa | | | |
| Order Actiniaria | 1 | 1 | 1 |
| Order Alcyonacea | 5 | 8 | 11 |
| Order Pennatulacea | 1 | 1 | 3 |
| Order Scleractinia | 4 | 6 | 7 |
| Order Zoantharia | 2 | 3 | 6 |
| Class Cubozoa | | | |
| Order Chirodropida | 1 | 1 | 1 |
| Class Hydrozoa | | | |
| Order Anthoathecata | 4 | 4 | 4 |
| Order Leptothecata | 5 | 7 | 7 |
| Order Siphonophorae | 1 | 1 | 1 |
| Class Scyphozoa | | | |

(continuation Table 1)

| Phylum/class/order | Number of | | |
|-----------------------------|-----------|-----------|-----------|
| | families | Genera | Species |
| Order Rhizostomeae | 3 | 3 | 3 |
| Order Semaestomeae | 2 | 2 | 2 |
| Class Staurozoa | | | |
| Order Stauromedusae | 1 | 1 | 1 |
| Phylum Bryozoa | 45 | 61 | 51 |
| Class Gymnolaemata | | | |
| Order Cheilostomata | 39 | 55 | 47 |
| Order Ctenostomata | 3 | 3 | 3 |
| Class Stenolaemata | | | |
| Order Cyclostomata | 3 | 3 | 1 |
| Phylum Echinodermata | 27 | 40 | 59 |
| Class Asterozoa | | | |
| Order Paxillosida | 2 | 2 | 4 |
| Order Spinulosida | 1 | 1 | 1 |
| Order Valvatida | 2 | 2 | 3 |
| Class Crinozoa | | | |
| Order Comatulida | 1 | 1 | 1 |
| Class Echinozoa | | | |
| Order Camarodonta | 2 | 3 | 3 |
| Order Cidaroida | 1 | 1 | 2 |
| Order Clypeasteroida | 2 | 4 | 5 |
| Order Spatangoida | 1 | 1 | 1 |
| Class Holothurozoa | | | |
| Order Apodida | 2 | 2 | 2 |
| Order Dendrochirotrida | 3 | 7 | 10 |
| Order Holothuriida | 1 | 1 | 4 |
| Class Ophiurozoa | | | |
| Order Amphilepidida | 5 | 10 | 15 |
| Order Euryalida | 1 | 1 | 1 |
| Order Ophiacanthida | 3 | 4 | 7 |

DISCUSSION

Despite their regional nature, the collections of Porifera, Cnidaria, Bryozoa and Echinodermata of the Universidade Federal do Ceará represent, respectively, 6.5%, 6.9%, 10.7%, and 17.5% of the species so far recorded for the Brazilian coast by the Brazilian Fauna Taxonomic Catalog (Moura, 2021; Muricy, 2021; Oliveira, 2021; Vieira; Nascimento & Almeida, 2021). These collections are composed mainly of specimens collected in the Ceará State, being important sources for the biodiversity knowledge of the Northeastern Brazilian coast, which is still little known.

In Ceará State, the pioneer in the study of Zoology was Professor Francisco Dias da Rocha (1869-1960), who published the work "*Subsídio para o estudo da fauna cearense (Catálogo das espécies por mim coligadas e notadas)*" in 1948. In this article, Rocha reported species belonging to Cnidaria, Mollusca, Crustacea, Echinodermata, and Tunicata taxa, in addition to species of fishes.

In the study of Rocha (1948), sponges were not addressed, being the first work with this phylum in Ceará carried out by Schulze (1899), who described a species of Hexactinellida. Later, in the early 1970s, Johnson (1971) published the first inventory of marine sponges for the Ceará coast. In recent years, studies with Porifera are being carried out in Ceará,

including the description of new species (Salani; Lotufo & Hajdu, 2006), extraction of compounds (e.g., Carneiro *et al.*, 2013; Santos *et al.*, 2015; Carneiro *et al.*, 2017), synthesis of knowledge (Soares *et al.*, 2016b), and new sponges records (Azevedo *et al.*, 2017; Klautau *et al.*, 2020; Fortunato; Perez & Lobo-Hajdu, 2020).

A long gap of studies on the cnidarians of Ceará occurred after the publication of Rocha (1948). Only in the last decades, studies have been carried out with this group on the state, comprising inventories (e.g., Matthews-Cascon & Lotufo, 2006; Morandini *et al.*, 2006; Soares; Morandini & Matthews-Cascon, 2009; Soares & Souza, 2011; Soares *et al.*, 2016a) and ecological surveys (e.g., Rabelo & Matthews-Cascon, 2007; Soares & Sousa, 2011; Rabelo *et al.*, 2013; Rabelo *et al.*, 2014; Rabelo *et al.*, 2015; Soares *et al.*, 2017), which also include studies with exotic species (Soares; Davis & Carneiro, 2016; Soares *et al.*, 2020; Thé *et al.*, 2020; Braga *et al.*, 2021; Thé *et al.*, 2021), and consequences of climate change (Soares & Rabelo, 2014; Soares *et al.*, 2019).

In relation to Bryozoa, Marcus (1942) was the first to cite species of Bryozoa for Ceará, recording freshwater species. Like Cnidaria, after a long gap of studies, between the years 1996 and 1998, Dr. José Gerardo Ferreira Gomes-Filho, currently a professor at the Universidade Federal do Piauí (UFPI), carried out a study on the intertidal bryozoans found on some beaches of Ceará coast. Unfortunately, this data was never published. In 2020, a part of the specimens collected by Gomes-Filho was recovered and incorporated into Bryozoa collection. Vieira, Migotto and Winston (2010) recorded the first marine bryozoan – *Beania klugei* Cook, 1968 – for the coast of Ceará. During the decade of 2010, more species of bryozoans were recorded for the coast of Ceará (Vieira & Gordon, 2010; Vieira & Migotto, 2014; Vieira; Migotto & Winston, 2014; Almeida *et al.*, 2015; Xavier; Almeida & Vieira, 2021). Recently, between the years 2017 and 2018, through a large project involving the geodiversity and marine biodiversity of the coast of Ceará (Support Program for Centers of Excellence – Pronex), it was possible to obtain samples of bryozoans from the continental shelf, exclusively from the west coast of the state (unpublished data).

After Rocha (1948), at the end of the 1960s, the first articles on the ecology of echinoderms found on the coast of Ceará were published (Matthews & Lima-Verde, 1968; Lima-Verde & Matthews, 1969), as well as an inventory of this taxon for the northeastern region (Lima-Verde, 1969). In recent years, studies of diversity (Mathews-Cascon & Lotufo, 2006), population ecology (Martins & Matthews-Cascon, 2010) and records of new species for the Ceará coast, including an invasive species, have been published (Monteiro & Matthews-Cascon, 2017; Araújo *et al.*, 2018; Manso; Prata & Cerqueira, 2020). Recent taxonomic revision studies, including very common echinoderm taxa on the coast of Ceará, have been performed, changing nomenclature and discovering new species and genera [Santana *et al.* (2020), Martins & Souto (2020), and Cunha *et al.* (2021) reviewed the genus *Ophiothrix* (Ophiuroidea), the order Apodida (Holothuroidea), and the genus *Echinaster* (*Othilia*) (Asteroidea) from the Brazilian coast, respectively].

CONCLUSION

Although regional biological collections can help to better understand the diversity (recent and fossil) (e.g., D'Ávila, 2016; Heydrich, 2016; Santos & Mello, 2016; Alves *et al.*, 2018; Gondim; Christoffersen & Pereira-Dias, 2020; Bezerra, 2021; Franklin Jr., 2021; Faria; Xavier & Freitas, 2021; Garcia *et al.*, 2021; Rocha-Barreira *et al.*, 2021), except for a few sporadic financial supports (Marinoni & Peixoto, 2010), there has never been a long-term

policy formation and maintenance of scientific collections in Brazil (Zaher & Young, 2003). Many Brazilian zoological collections are in institutions, where researchers have difficulty in obtaining the necessary resources to keep them (Zaher & Young, 2003). In addition to the lack of funding and staffing, Salvador and Cunha (2020) argued that the collections are threatened by the non-deposit of specimens (voucher specimens) by the researchers, mainly in ecological studies, which makes the reproducibility of studies impossible and erodes the legacy for the future researchers. Rocha *et al.* (2014) highlighted the importance of voucher specimens and their associated date for making decisions about conservation and management, given climate changes and increasing rates of habitat loss.

Finally, the preservation of scientific collections, together with the sharing of their knowledge, will allow for more appropriate conservation decision-making in local, regional, and global scales.

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