

# Diversity and first record of Porifera (sponges) from Gujarat Coast, India

ZALAK SABAPARA, PARESH PORIYA\*

Department of Zoology, Bahauddin Science College, Junagadh 362002, Gujarat, India. Tel.: +91-285-2675731, \*email: pasheshporiya@gmail.com

Manuscript received: 7 September 2023. Revision accepted: 30 March 2024.

**Abstract.** Sabapara Z, Poriya P. 2024. Diversity and first record of Porifera (sponges) from Gujarat Coast, India. *Indo Pac J Ocean Life* 8: 24-38. The present study represents a significant milestone in understanding sponge diversity in the Gujarat Coastal area. This investigation identified 51 sponge species and classified them into 3 classes and 28 families. Amongst the reported species, 47 species belong to class Demospongiae, followed by Calcarea and Homoscleromorpha, with 2 species, respectively. Remarkably, 24 of these species were previously undocumented along the Gujarat Coastline, while two species, *Sycon grantioides* Dendy, 1916 and *Halichondria (Halichondria) tenuiramosa* Dendy, 1922 only reported from the Gujarat Coast in India. Our research involved exploring 11 sites along the coast, with the primary objective of documenting intertidal sponges and exploring valuable insights into their habitat preferences. The study also includes information on the distribution patterns of these species within the region. Except for a few bio-eroding boring sponges, most of the recorded sponge species exhibit an encrusting growth habit. They are typically found in habitats beneath the rocks, zoanthid beds, shallow rock pools, coralline beds, caves-crevices and in close association with other macrofauna and seaweeds. This diverse range of habitats suggests the adaptability and resilience of these sponges in various ecological niches along the Gujarat Coast. The finding of many new records highlights the necessity of ongoing study and conservation initiatives to protect the diverse marine biodiversity of the Gujarat Coastline.

**Keywords:** Diversity, first record, Gujarat, India, intertidal, Porifera, sponges

## INTRODUCTION

The world's biodiversity is estimated at 8.7 million species (Sweetlove 2011), and about 18,000 new species are described yearly (Chapman 2009). The World Register of Marine Species (WoRMS) database indicates 242,000 known marine species known to the science world (Bouchet et al. 2023). However, the discovery rate of new marine species has continuously increased (Costello et al. 2012). This may be due to increased taxonomic effort, technological advances, the exploration of new habitats and locations, the application of molecular approaches, or a combination of these things. With at least the numbers of species found worldwide, poriferans, commonly known as sponges, are designated the most primitive of the multicellular animals with a most ancient geological history and are among the most diverse forms of sessile marine taxa. Sponge communities dominate many marine filter-feeding groups; they may create extensive garden-like ecosystems with great biomass and variety. In such environments, sponges influence the water quality and substrate condition and provide habitat and nutrition for many other organisms (Bell 2008). As effective filter feeders, sponges are essential in establishing a nutrient cycle that connects the pelagic environment to the benthos. They are also becoming more recognized as important providers of ecosystem services (Maldonado et al. 2005). Despite their evolutionary and ecological importance, sponges are not as well studied as corals and other benthic taxa that form structural habitats, and their importance

within the global ecosystem is far less widely appreciated (Fromont et al. 2016).

The period from 1765 to 1892 is addressed as a remarkable era in the history of spongology, primarily attributable to the revolutionary contributions of scientists such as Carl Linnaeus, George Cuvier, Jean Lamarck, and other contemporary biologists; their pioneering efforts involved systematically categorizing various sponge groups, following in-depth studies on their physiology and phylogeny. In contrast, the exploration of the shallow water marine sponge fauna in peninsular India has been relatively limited. On the east coast, some investigations were conducted in Madras and Chilka Lake. Ali (1956) and Dendy (1887) dedicated their research to the sponge fauna of Madras, while Sivaramakrishnan (1951) delved into the development and regeneration of *Callyspongia diffusa* (Ridley, 1884) and *Tedania nigrescens* (Schmidt, 1862) from the Madras Coast. Further studies on the fauna of Chilka Lake in Orissa State were carried out by Annandale (1915). The major studies dealing with the deep-sea sponge fauna of the Bay of Bengal are those of Dendy and Burton (1926) based on the deep-sea sponges collected by R.I.M.S. "Investigator" and deposited in the Indian Museum, Calcutta. Kumar (1925) provided a comprehensive report on the sponges discovered during the exploration conducted by the Bengal Fisheries Steamer "Golden Crown." Burton and Rao (1932) studied shallow-water marine sponges from India, Burma, Sri Lanka, and the Andamans. Among the 82 species documented in their work, 12 species and 3 genera were identified as new.

Hozawa (1937) significantly contributed to the knowledge of calcareous sponges in the Bay of Bengal. Thorough research on the boring sponges of the Indian Seas has been conducted, with Thomas (1972) specifically examining coral-boring sponges in the Gulf of Mannar and the Palk Bay. Approximately 20 boring sponges have been identified infesting coral reefs in these areas. Notably, the fauna of the west coast of India has been studied less extensively than that of the east coast. Dendy (1915, 1916) contributed significantly to our understanding of the Gulf of Kutch's fauna, focusing on *Calcarea* and non-*Calcarea* collected by James Hornell in Okhamandal during 1905-1906.

However, after that, the study on the poriferan community is the least concerned on this coastline. Documenting local diversity is of the utmost importance in strengthening protection and management efforts in Gujarat, one of the country's key marine biodiversity areas. Therefore, the entire intertidal belt of this area has been thoroughly surveyed to assess intertidal sponges quantitatively.

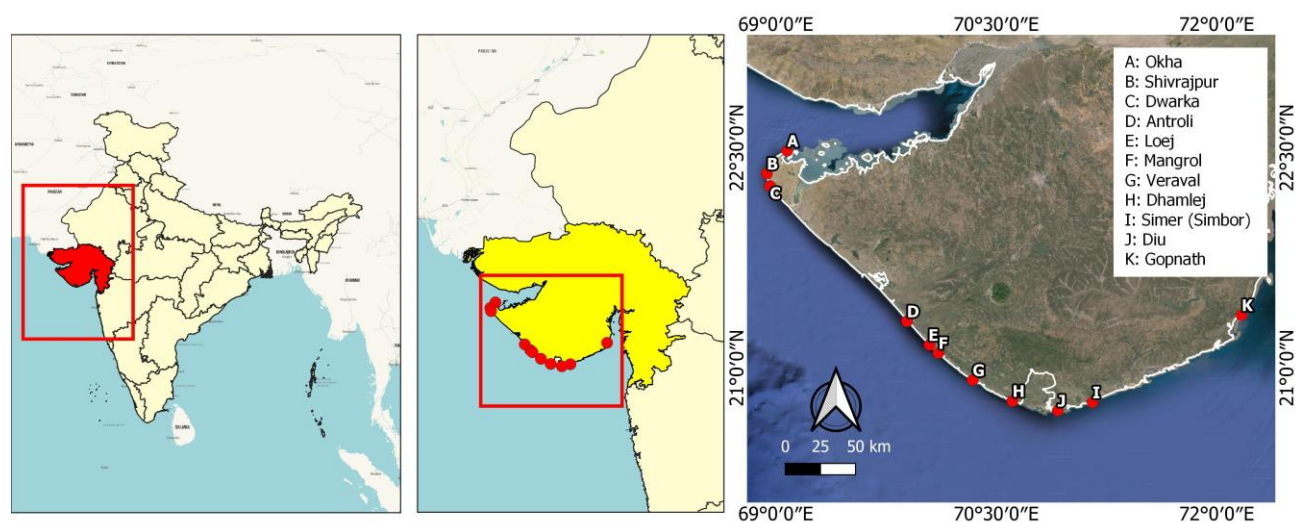
## MATERIALS AND METHODS

### Study area

In the present study, the entire Gujarat Coastline, India, except the Gulf of Kutch, was surveyed comprehensively from ecological and biological points of view for its coast characteristics. Therefore, 11 locations (Table 1, Figure 1) of Gujarat's coastline were selected, encompassing different intertidal habitats such as rocky, sandy, rocky-sandy, rocky-muddy, and muddy shores. The basis for selecting these 11 areas were the differences between locations, the positions of slope, substratum type, and the intertidal zone length. The assessment of intertidal Porifera species diversity was done from June 2020 to July 2023. During this period, sampling sites were surveyed at monthly intervals.

**Table 1.** Collection Sites among the Gujarat Coasts of West India

Collection stations	G.P.S. coordinates	Site description
Okha	22°28'45"N 69° 4'43"E	Located between the tip of the Saurashtra coast and the Gulf of Kutch region of Gujarat state (India), the 4 km-long flat intertidal zone is a unique rocky shore with sandy patches.
Shivrajpur	22°19'25"N 68°56'23"E	'Blue Flag Beach' is located between Dwarka and Okha. The intertidal zone is 1 km long and has many rocks.
Dwarka	22°14'18"N 68°57'37"E	South-west part of Saurashtra coastline. 800 m long, sandy-rocky coastal area.
Antroli	21°12'54"N 69°39'54"E	Near Mangrol, around 1.5 km long intertidal zone with sandy patches and tide pools covered with sands and gastropod shells.
Loej	21°09'25"N 70°02'50"E	Near Mangrol, 1 km long flat intertidal coast
Mangrol	21°06'07"N 70°06'25"E	The coastal stretch is 3 km long, with a flat rocky substratum and boring sponge patches.
Veraval	20°55'02"N 70°20'26"E	Largest fish landing site, 3 km long intertidal belt with tide pools, puddles, crevices, small channels, flat rocky surface, coral, zoanthids, and <i>cerethium</i> assemblages. Smooth rock type at the upper zone of the coast.
Dhamlej	20°46'30"N 70°36'40"E	Near the Sutrapada, around 2 km long rocky substratum. Flat emergent rocky habitat covered by <i>Zoanthus</i> .
Simer (Simbor)	20°45'56"N 71°09'20"E	A small islet is located at the mouth of the Sahil River at the Bay of Simbor. Sandy-rocky coast with tidepools.
Diu	20°42'34"N 70°55'10"E	An island is located on the outer rim of the Gulf of Kambhat, a 2 km long intertidal coast with big rock pools.
Gopnath	21°21'36"N 72°10'14"E	Located on the coast of the Gulf of Khambhat near Bhavnagar



**Figure 1.** The map shows the sampling locations along Gujarat Coast, India

### Field methods

By flipping the rocks and seaweed over, the study areas were extensively studied for the occurrence of sponges. In situ, photography, color, shape, texture, substratum type, and other morphological characters were recorded to identify sponge species. The complete study was conducted non-destructively, and the organisms were not disturbed. A few species of sponges were collected when necessary for identification.

### Species identification methods

Collected sponges immediately fixed in 10% buffered formaldehyde for only a brief period. Back in the laboratory, preserved samples were examined under a Carl-Zeiss Stemi DV4 stereomicroscope fitted with a high-resolution CMOS camera, Lawrence & Mayo Image (Model: ISH300) microscope, and Magnus Plus Compound Microscope for morphological examinations and taxonomic analyses. Spicules slides were prepared by dissolving tissue in sodium hypochlorite and nitric acid solution. Identified specimen was transferred in 70-90 % alcohol and stored.

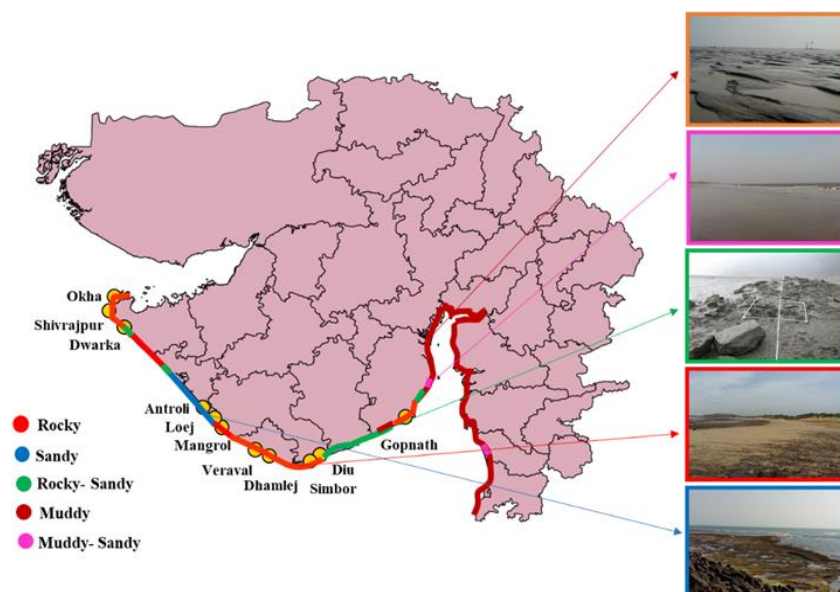
## RESULTS AND DISCUSSION

A total of 51 sponge species belonging to 28 families, 15 orders, and 3 classes were recorded from 11 intertidal habitats of the Gujarat Coast (Figures 3-6 and Table 3). Among 51 species, 24 species are new records for the Gujarat Coastline. Most of the sponge species encountered belonged to class Demospongiae, with 47 species, followed by Calcarea and Homoscleromorpha, with 2 species, respectively. The highest diversity was observed on the Okha coast, which is located between the tip of Saurashtra coast and the Gulf of Kutch region of Gujarat state and 4 km long flat intertidal zone is a unique rocky shore with 35 sponge species, followed by Shivrajpur (31 species), a blue flag beach with 1 km long rocky intertidal zone, Dwarka

(14 species) is south-west part of Saurashtra coastline with 800 m long, sandy-rocky coast, Antroli (11 species) has around 1.5 km long intertidal zone with sandy patches and tide pools covered with sands and gastropod shells, Loej (10 species) near Mangrol with 1 km long flat intertidal coast, Mangrol (13 species) coastal stretch 3 km long with flat rocky substratum and boring sponge patches, Veraval (18 species) largest fish landing site with 3 km long intertidal belt supported by coral, zoanths and *Cerethium* assemblages, Dhamlej (8 species) near Sutrapada and around 2 km long rocky substratum. Flat emergent rocky habitat covered by zoanthus, Simer (Simbor) (9 species) is a small islet with a sandy-rocky coast, Diu (8 species) island located on the outer rim of Gulf of Khambhat; 2 km long intertidal coast with big rock pools and Gopnath (2 species) located on the coast of Gulf of Khambhat near Bhavnagar, Gujarat. (Table 2). Two species, *Sycon tenuiramosa* Dendy, 1916 and *Halichondria (Halichondria) tenuiramosa* Dendy, 1922, were only reported from the Gujarat Coast in India. The present study has indicated that the intertidal areas of Okha and Shivrajpur are rich in diversity of sponges compared to the other coastal areas of the Gujarat Coastline. A variety of substrata influences the distribution patterns of sponges along intertidal habitats.

### Habitat preference

The Gujarat Coastline is categorized into various types, including rocky, sandy, rocky-sandy, muddy, and muddy-sandy areas, as illustrated in Figure 2. Coastal regions exhibit diverse features such as platforms, crevices, caves, rock pools, coral pools, boulder areas, and sandy stretches. Vertical zonation is recognizable throughout the coasts. According to the specific ecological requirements, sponges dwell in various intertidal habitats, such as rocks, coral, shells, and other marine organisms. Existing macrofaunal assemblages also affect sponges' distribution patterns (Sabapara and Poriya 2023). As a result, a high richness of species is notable from the Okha to Dwarka coast, mainly because they have rocky and rocky-sandy coasts.



**Figure 2.** Coastal habitats of Gujarat, India

**Table 2.** Taxonomic account of sponge species reported from the Gujarat coast, India

Species	Gujarat											Previous report from India	
	A	B	C	D	E	F	G	H	I	J	K		
Class: Calcarea													
Order: Clathrinida													
Family: Clathrinidae Minchin, 1900													
(1) <i>Clathrina coriacea</i> (Montagu, 1814)^	•	•				•							AD
Order: Leucosolenida													
Family: Syconidae Poléjaeff, 1883													
(2) <i>Sycon grantioides</i> Dendy, 1916									•	•			GU, MH
Class: Demospongiae													
Order: Dictyoceratida													
Family: Dysideidae Gray, 1867													
(3) <i>Dysidea avara</i> (Schmidt, 1862)	•						•						GU, MH
(4) <i>Dysidea fragilis</i> (Montagu, 1814)^	•	•											GoM, LD
(5) <i>Dysidea granulosa</i> Bergquist, 1965	•							•					LD
Family: Spongiidae Gray, 1867													
(6) <i>Hyattella tubaria</i> Lendenfeld, 1889^				•	•								GoM, LD
(7) <i>Hippospongia</i> sp.	•	•	•				•						GU, MH, GoM & TN, AD, LD
Order: Chondrillida													
Family: Chondrillidae Gray, 1872													
(8) <i>Chondrilla australiensis</i> Carter, 1873	•	•					•	•					GU, MH, GoM & TN, AD, LD
Order: Verongiida													
Family: Aplysinidae Carter, 1875													
(9) <i>Aiolochoxia crassa</i> (Hyatt, 1875) ^	•												MH
(10) <i>Aplysina lacunosa</i> (Lamarck, 1814) ^	•												GoM
Family: Pseudoceratinidae Carter, 1885													
(11) <i>Pseudoceratina purpurea</i> (Carter, 1880)^		•											GoM, LD
Order: Haplosclerida													
Family: Niphatidae van Soest, 1980													
(12) <i>Amphimedon viridis</i> Duchassaing & Michelotti, 1864^	•	•	•	•			•						MH
Family: Callyspongiidae Laubenfels, 1936													
(13) <i>Callyspongia (Cladochalina) aculeata</i> (Linnaeus, 1759) ^	•												LD
(14) <i>Callyspongia (Cladochalina) diffusa</i> (Ridley, 1884)	•	•	•	•	•	•	•						GU, MH, GoM & TN, AD, LD
Family: Chalinidae Gray, 1867													
(15) <i>Haliclona (Gellius) cymaeiformis</i> (Esper, 1806)						•		•	•				GU, MH
(16) <i>Haliclona (Gellius) fibulata</i> (Schmidt, 1862)	•	•											GU, MH, GoM & TN, AD, LD
(17) <i>Haliclona (Haliclona) oculata</i> (Linnaeus, 1759) ^	•												GoM
(18) <i>Haliclona (Reniera) cinerea</i> (Grant, 1826)	•	•	•				•						GU, MH
(19) <i>Haliclona (Reniera) tubifera</i> (George & Wilson, 1919)	•	•					•	•					GU, MH
Family: Petrosiidae van Soest, 1980													
(20) <i>Neopetrosia chaliniformis</i> (Thiele, 1899)^		•		•									GoM
(21) <i>Neopetrosia similis</i> (Ridley & Dendy, 1886)^	•												GoM
Order: Axinellida													
Family: Raspailiidae Nardo, 1833													
(22) <i>Raspailia (Clathriodendron) arbuscula</i> (Lendenfeld, 1888) ^	•	•	•				•						GoM
Order: Bubarida													
Family: Dictyonellidae van Soest, Diaz & Pomponi, 1990													
(23) <i>Acanthella cavernosa</i> Dendy, 1922^									•	•			GoM, LD
(24) <i>Acanthella ramosa</i> Kumar, 1925	•												GU, MH, GoM & TN, AD, LD
Order: Biemnida													
Family: Biemnidae Hentschel, 1923													
(25) <i>Biemna fortis</i> (Topsent, 1897)				•	•	•							GU, MH, GoM & TN, AD, LD

Order: Tetractinellida												
Family: Tetillidae Sollas, 1886												
(26) <i>Cinachyrella australiensis</i> (Carter, 1886) <sup>^</sup>	•	•	•	•	•	•	•	•	•	•	•	AM
(27) <i>Cinachyrella hirsuta</i> (Dendy, 1889)	•	•	•					•				GU, MH, GoM
Family: Geodiidae Gray, 1867												
(28) <i>Geodia</i> sp.		•										GoM
Order: Poecilosclerida												
Family: Isodictyidae Dendy, 1924												
(29) <i>Coelocarteria singaporensis</i> (Carter, 1883) <sup>^</sup>	•								•			GoM
Family: Desmacididae Schmidt, 1870												
(30) <i>Desmapsamma anchorata</i> (Carter, 1882)	•	•					•					GU, MH, GoM & TN, AD, LD
Family: Iotrochotidae Dendy, 1922												
(31) <i>Iotrochota baculifera</i> Ridley, 1884		•										GU, MH, GoM & TN, AD, LD
Family: Mycalidae Lundbeck, 1905												
(32) <i>Mycale (Mycale) grandis</i> Gray, 1867 <sup>^</sup>		•									•	GoM, AM
(33) <i>Mycale (Zygomycale) parishii</i> (Bowerbank, 1875)	•	•	•					•	•	•	•	GU, MH, GoM & TN, AD, LD
Family: Microcionidae Carter, 1875												
(34) <i>Clathria (Microcionia) atrasanguinea</i> (Bowerbank, 1862) <sup>^</sup>											•	GU, MH, GoM & TN, AD, LD
Order: Clionaida												
Family: Clionaidae d'Orbigny, 1851												
(35) <i>Cliona celata</i> Grant, 1826	•	•	•			•	•	•				GU, MH, GoM & TN, AD, LD
(36) <i>Cliona viridis</i> (Schmidt, 1862)	•	•		•	•	•	•					GoM & TN
(37) <i>Sphaciospongia vagabunda</i> (Ridley, 1884)	•	•	•									GU, MH, GoM & TN, AD, LD
Family: Placospongiidae Gray, 1867												
(38) <i>Placospongia carinata</i> (Bowerbank, 1858)	•	•	•					•				GU, MH, GoM & TN, AD, LD
(39) <i>Placospongia melobesioides</i> Gray, 1867 <sup>^</sup>			•	•	•							GoM
Order: Tethyida												
Family: Tethyidae Gray, 1848												
(40) <i>Tethya robusta</i> (Bowerbank, 1873)	•	•			•	•	•					GU, MH, GoM & TN, AD, LD
Family: Timeidae Topsent, 1928												
(41) <i>Timea</i> sp.	•	•										MH, GoM
Order: Suberitida												
Family: Halichondriidae Gray, 1867												
(42) <i>Halichondria (Halichondria) bowerbanki</i> Burton, 1930 <sup>^</sup>	•	•	•	•	•	•	•	•				MH
(43) <i>Halichondria (Halichondria) tenuiramosa</i> Dendy, 1922		•										GU
(44) <i>Halichondria (Halichondria) panicea</i> (Pallas, 1766)	•	•	•	•	•	•	•	•	•	•	•	GU, MH, GoM & TN, AD, LD
(45) <i>Halichondria (Eumastia) sitiens</i> (Schmidt, 1870) <sup>^</sup>											•	MH
(46) <i>Hymeniacion perlevis</i> (Montagu, 1814) <sup>^</sup>									•	•		MH
(47) <i>Amorphinopsis excavans</i> Carter, 1887	•	•										GU, GoM
Family: Suberitidae Schmidt, 1870												
(48) <i>Pseudosuberites andrewsi</i> Kirkpatrick, 1900 <sup>^</sup>	•	•										GoM
(49) <i>Suberites carnosus</i> (Johnston, 1842)	•											GU, MH, GoM, LD
Class: Homoscleromorpha												
Order: Homosclerophorida												
Family: Plakinidae Schulze, 1880												
(50) <i>Plakortis simplex</i> Schulze, 1880 <sup>^</sup>	•					•	•					GoM
(51) <i>Plakina monolopha</i> Schulze, 1880 <sup>^</sup>		•		•	•							GoM
Total number of species	35	31	14	11	10	13	18	8	9	8	2	

Note: X: All recorded stations; <sup>^</sup>First record from Gujarat coast. Station Code and Names: A: Okha, B: Shivrajpur, C: Dwarka, D: Antroli, E: Loej, F: Mangrol, G: Veraval, H: Dhamlej, I: Simbor, J: Diu, K: Gopnath (Bhavnagar). GU: Gujarat, MH: Maharashtra, TN: Tamilnadu, GoM: Gulf of Mannar, AD: Andaman, LD: Lakshadweep

**Table 3.** Sponge diversity from Intertidal zones of Gujarat Coast, India

Species	Description
Family: Clathrinidae	
(1) <i>Clathrina coriacea</i> (Montagu, 1814)	Soft and delicate networks like a white color sponge were preferred. Several tubes join to share one common oscule. Habitat: Rock surfaces. Spicules are triradiates only with equal angles. Distribution: India, Britain and Northern Ireland, Norway, Spain, U.S.A., France, South Africa, Portugal, Jersey, Isle of Man
Family: Syconidae	
(2) <i>Sycon grantioides</i> Dendy, 1916	A tubular vase is like a white color sponge. Habitat: Zoanthid beds and shallow pools Spicules are triradiate mostly and oxea. Distribution: India
Family: Dysideidae	
(3) <i>Dysidea avara</i> (Schmidt, 1862)	Growth form encrusting with light rose-violet color. The surface looks like a three-dimensional network. Habitat: Underneath rocks The skeleton is made up of fibers. There are no mineral elements in the skeleton. Distribution: India, France, Spain, Italy, U.S.A., Australia, Turkey, Algeria, Papua New Guinea
(4) <i>Dysidea fragilis</i> (Montagu, 1814)	The growth form is irregular, 3-5 cm in diameter. The species is soft and fragile, with a brown-yellow color. The surface consists of an irregular network of dense collagen fibers. Habitat: Underneath rocks The skeleton is made up of spongin fibers. Distribution: India, UK and Northern Ireland, France, Spain, Jersey, Guernsey, U.S.A., Isle of Man, Portugal, Australia
(5) <i>Dysidea granulosa</i> Bergquist, 1965	Whitish-colored species are covered with fine conules, and their appearance is granular. Oscules are arranged in interval patterns and are 2-3.5 mm in diameter. Habitat: Caves and crevices on intertidal surfaces. The skeleton is made up of spongin fibers. Distribution: India, Australia, Indonesia, Palau, Papua New Guinea, Chinese Taipei, Thailand, China, Micronesia
Family: Spongiidae	
(6) <i>Hyattella tubaria</i> Lendenfeld, 1889	It is massive, with interconnecting tubular and brown-colored sponges. The surface is conulose. The consistency is firm, slightly elastic, and compressible. Habitat: Tide pools and puddles on the intertidal coast. The skeleton is made up of interconnecting Polygonal mesh fiber. Distribution: India, Singapore, Egypt, Indonesia, Seychelles, Vietnam, Yemen
(7) <i>Hippospongia</i> sp.	Black-brownish sponge with numerous oscules about 10-15 mm in diameter and irregularly distributed on the surface. Habitat: Attached to the hard substrates.
Family: Chondrillidae	
(8) <i>Chondrilla australiensis</i> Carter, 1873	Encrusting, glossy, and smooth brown sponge. Oscules are barely visible when the sponge is in water and look like tunicate. Habitat: Underneath rocks The skeleton comprises fibrillary collagen and a spheraster embedded in collagen. Distribution: India, Australia, Indonesia, Vietnam, South Africa, New Caledonia, Iran, Seychelles, American Samoa
Family: Aplysinidae	
(9) <i>Aiolochoira crassa</i> (Hyatt, 1875)	Purplish black color sponge with conulose surface. There is no visible opening. Habitat: Rock pools The skeleton is made up of spongin fiber. Distribution: India, Puerto Rico, Mexico, USA, Guadeloupe, Bonaire, Sint Eustatius and Saba, Martinique, Cuba, Cayman Island, Bermuda
(10) <i>Aplysina lacunosa</i> (Lamarck, 1814)	Tubular sponge with pinkish-purple color. The surface has irregular grooves. Habitat: Craves of intertidal flat The skeleton comprises a delicate and irregular network of spongin fiber. Distribution: India, Puerto Rico, Mexico, U.S.A., Cuba, Jamaica, Martinique, Brazil, Cayman Islands, Virgin Islands

---

Family: Pseudoceratinidae	
(11) <i>Pseudoceratina purpurea</i> (Carter, 1880)	Massive encrusting yellow-colored sponge with an uneven surface, scattered small, sharp conules, and prominent oscula. Habitat: Underneath rock and tide pools Spongin fibers scarcely develop, and the choanosome is collagenous. Distribution: India, Indonesia, Palau, Marshall Island, Seychelles, Singapore, Australia, Malaysia, Thailand, Mexico, U.S.A.
Family: Niphatidae	
(12) <i>Amphimedon viridis</i> (Duchassaing & Michelotti, 1864)	Dull green color sponge with repent branch and volcano-like oscules. Habitat: embedded in rocks on rock pools and growing between zoanthids polyps. Spicules oxea were slightly curved and robust type embedded in spongin fibers. Distribution: India, Puerto Rico, Mexico, U.S.A., Colombia, Jamaica, Venezuela, Brazil, Bermuda, Bahamas
Family: Callyspongiidae	
(13) <i>Callyspongia (Cladochalina) aculeata</i> (Linnaeus, 1759)	Violet colour sponge. Hollow tubular and rough irregular surface with a wide base. 6-8 tubes arising from a single wide base. Habitat: Underneath side of rocks in pools Spicules oxea type. Distribution: India, Atlantic Ocean, Caribbean sea, Pacific ocean
(14) <i>Callyspongia (Cladochalina) diffusa</i> (Ridley, 1884)	Pale yellow sponge with a soft, velvety texture. Surface reticulated and hispid. A branching sponge with tubes rises from a common base. Habitat: Crevices, Caves, tide pools, underneath rocks Spicules oxea, smooth, curved, and sharply pointed. Distribution: India, Australia, Indonesia, New Zealand, U.S.A., Sri Lanka, Myanmar, New Caledonia, Philippines, Palau
Family: Chalinidae	
(15) <i>Haliclona (Gellius) cymaeformis</i> (Esper, 1806)	Dark olive green color. Habitat: Crevices of rocks underneath rocks Spicules oxea type. Distribution: India, Australia, Indonesia, Hong Kong, China, Vietnam, New Caledonia, Papua New Guinea, Singapore, Malaysia
(16) <i>Haliclona (Gellius) fibulata</i> (Schmidt, 1862)	Light-pink color with a cushion like a sponge. Reticulation is showing through the surface. Habitat: Underneath rocks Spicules Straight and slightly curved oxea and sigma type. Distribution: India, France, Britain and Northern Ireland, Italy, Mayotte, New Caledonia, Portugal, Falkland Islands, Egypt
(17) <i>Haliclona (Haliclona) oculata</i> (Linnaeus, 1759)	Stalked and branching sponge with lilac color. Not hairy, neat oscules arranged serially along the edges of branches. Habitat: Vertical rock faces and fast-moving water areas. Spicules thick oxea type. Distribution: India, Britain and Northern Ireland, U.S.A., Canada, France, Netherlands, Guernsey, Sweden, Jersey, Germany
(18) <i>Haliclona (Reniera) cinerea</i> (Grant, 1826)	A purple-colored, soft, and flexible sponge with chimney-like growth of oscules. Slime appears when the sponge is pulled apart from the substratum. Habitat: Shallow pools and under rocks Spicules oxea type. Distribution: India, Canada, Britain and Northern Ireland, France, Korea, U.S.A., New Zealand, Japan, Egypt, Sweden
(19) <i>Haliclona (Reniera) tubifera</i> (George & Wilson, 1919)	Violet color sponge with oscular chimneys. Thin, long branching of the main body appears. Habitat: Tide pools, shallow pools with algae Spicules oxea type. Distribution: India, Venezuela, Belize, Mexico, U.S.A., Jamaica, Philippines, Panama, Martinique, Guadeloupe
Family: Petrosiidae	
(20) <i>Neopetrosia chaliniformis</i> (Thiele, 1899)	Chocolate yellowish brown color sponge. Hard and crumbly consistency. Habitat: Surface of substratum. Spicules are all oxea type with the same size. Distribution: India, Australia, Indonesia, Papua New Guinea, Thailand, Micronesia, Solomon Islands, Vanuatu, Palau, Seychelles, New Caledonia
(21) <i>Neopetrosia similis</i> (Ridley & Dendy, 1886)	Greyish blue color sponge. Habitat: Caves of rocks Spicules oxea slightly curved. Distribution: India, South Africa, Argentina, Australia, Heard Island and McDonald Islands, Tanzania, Indonesia

---

---

Family: Raspailiidae	
(22) <i>Raspailia (Clathriodendron) arbuscula</i> (Lendenfeld, 1888)	Bluish black arborescent and massive sponge. Branches of species conulated and evenly thick. Ostia scattered all over the body. Habitat: Underneath rocks mostly. Spicules mainly oxeas. Style, tylostyle, and acanthostyle are also present. Distribution: India, New Zealand, Australia
Family: Dictyonellidae	
(23) <i>Acanthella cavernosa</i> Dendy, 1922	A yellow sponge, its surface consists of blunt succulation forms. The species is attached to the substratum by a small base. Habitat: Caves of rocks Spicules style, slightly curved style, strongyles type. Distribution: India, Australia, Indonesia, Seychelles, Papua New Guinea, Malaysia, China, New Caledonia, Thailand, Palau
(24) <i>Acanthella ramosa</i> Kumar, 1925	Orange color sponge with braches. Branches are thick at the base, and oscules are visible all over the body—small pointed conuli present. Habitat: found in flooded water Spicules oxea, style, vermiculoid, strongyle type. Distribution: India
Family: Biemnidae	
(25) <i>Biemna fortis</i> (Topsent, 1897)	Pale brown sponge. The surface is uneven and covered with sand. Habitat: Shallow sandy tidepools and rockpools Spicule style, sigma and rhapsides types. Distribution: India, Indonesia, Malaysia, Micronesia, Seychelles, Thailand, Palau, Myanmar, Papua New Guinea, Singapore, China
Family: Tetillidae	
(26) <i>Cinachyrella australiensis</i> (Carter, 1886)	Bright yellow globular sponge. The surface has 1-4 porocalices covered with sand. Habitat: Mostly found in long periods of exposure to the flat surface of intertidal coast Spicule thin and long oxeas, acanthose, microxeas, sigmaspires. Distribution: India, Australia, Indonesia, Seychelles, Malaysia, Papua New Guinea, Mauritius, China, Egypt, Micronesia, Palau
(27) <i>Cinachyrella hirsuta</i> (Dendy, 1889)	Yellow globular sponge. Surface numerous porocalices with long spicules projecting outwards. Habitat: Flat surface and crevices of intertidal coast. Spicules are very long, straight oxea, very small, slender sigmaspires. Distribution: India, Philippines, Indonesia, Sri Lanka
Family: Geodiidae	
(28) <i>Geodia</i> sp.	White encrusting sponge with hispid surface. The surface is hard when touched. Habitat: Underneath rocks Skeletons possess crust of sterrasters
Family: Isodictyidae	
(29) <i>Coelocartheria singaporensis</i> (Carter, 1883)	Dark yellow-brown color. The surface is smooth, firm, and less compressible. Habitat: Flat surface of intertidal area covered with sand. Spicules Oxeas, strongyles, palmate isochela, toxa. Distribution: India, Australia, Indonesia, Papua New Guinea, Palau, Singapore, Thailand, Vanuatu, Marshall Islands, Malaysia, Solomon Islands
Family: Desmacididae	
(30) <i>Desmapsamma anchorata</i> (Carter, 1882)	Pale, slimy color. Oscules on elevation volcano-type tubes. Habitat: Shallow pools with sands underneath rocks Spicules oxeas sharply pointed type, anchorate chelae, sigmas. Distribution: India, Puerto Rico, USA, Mexico, Virgin Islands, Bonaire, Sint Eustatius and Saba, Guadeloupe, Martinique, Venezuela, Curacao
Family: Iotrochotidae	
(31) <i>Iotrochota baculifera</i> Ridley, 1884	Blackish, thin, encrusting sponge with a network-like appearance. Habitat: Underneath big rocks of intertidal area Spicules megascleres are absent; microscleres are birotulas. Network of heavy spongin fibre present. Distribution: India, Australia, Indonesia, Seychelles, Papua New Guinea, Micronesia, New Caledonia, Palau, Marshall Islands, Philippines
Family: Mycalidae	
(32) <i>Mycale (Mycale) grandis</i> Gray, 1867	Dark orange encrusting sponge. The surface is irregular, barely compressible, and brittle. Habitat: Crevices of rocks Spicules mycalostyle straight and slightly curved, anisochela, sigma 'C' and 'S' shaped and raphides types. Distribution: India, Indonesia, Thailand, U.S.A., Seychelles, Singapore, Australia, Marshall Islands, Netherlands, American Samoa, French Polynesia

---

(33) <i>Mycale (Zygomycale) parishii</i> (Bowerbank, 1875)	Dark orange color. The surface is membranous and uneven with spines; firm and slightly compressible. Habitat: Caves, flat algal substrates of intertidal area. Spicules mycalostyle, palmate anisochela, toxa, isochela, sigmas, microxea. Distribution: India, Australia, U.S.A., Thailand, Indonesia, Singapore, Madagascar, Brazil, Jamaica, Vietnam
Family: Microcionidae	
(34) <i>Clathria (Microcionia) atrasanguinea</i> (Bowerbank, 1862)	Orange color encrusting and very thin sponge. Oscula is very minute. Habitat: Underneath rocks Spicules subtylostyle, acanthostyle, palmate isochelae, toxa. Distribution: India, Britain and Northern Ireland, France, Isle of Man, Egypt, Guernsey, Norway
Family: Clionaidae	
(35) <i>Cliona celata</i> Grant, 1826	Yellow color boring sponge. Large oscules with sieve-like openings. Habitat: On rock Spicules tylostyle and subterminal tylostyle. Distribution: India, United Kingdom of Great Britain and Northern Ireland, France, Spain, U.S.A., Portugal, Isle of Man, Guernsey, Netherlands, New Zealand
(36) <i>Cliona viridis</i> (Schmidt, 1862)	Brown color boring sponge. Smooth surface composed of firm and tough material. Habitat: Rock pools, caves Spicules tylostyle, spherasters type. Distribution: India, France, Spain, Croatia, Portugal, Italy, Greece, Egypt, Turkiye, Martinique, Mauritania
(37) <i>Spheciospongia vagabunda</i> (Ridley, 1884)	Orangish brown color sponge with a smooth surface. Habitat: Rocky-sandy pools. Underneath rocks. Spicules straight styles, tylostyles, slightly curved C-shaped spirasters Distribution: Australia, Indonesia, South Africa, New Caledonia, Papua New Guinea, U.S.A., Malaysia, Sri Lanka, Palau, Fiji
Family: Placospongiidae	
(38) <i>Placospongia carinata</i> (Bowerbank, 1858)	Brown color encrusting and hard sponge. Cortical plates make the upper layer. Habitat: Underneath rocks Spicules tylostyle, spirasters (microspined rhabds, slender-spined streptasters). Distribution: India, Mexico, Indonesia, U.S.A., Seychelles, South Africa, Colombia, Jamaica, Madagascar, Mauritius
(39) <i>Placospongia melobesoides</i> Gray, 1867	Chalky white color hard encrusting sponge. Cortical plates make an upper layer. Habitat: Underneath rocks Spicules tylostyle, selenasters, spheres. Distribution: India, U.S.A., Indonesia, Mexico, Papua New Guinea, Australia, Philippines, South Africa, France, Malaysia, Palau
Family: Tethyidae	
(40) <i>Tethya robusta</i> (Bowerbank, 1873)	Yellow golf ball-type sponge. The rooting processes or filamentous extensions are present. Habitat: Shallow pools Spicules spherasters types. Distribution: India, Indonesia, Australia, Israel, Mauritius, South Africa, Egypt, Solomon Islands, Seychelles, American Samoa, Christmas Island
(41) <i>Timea</i> sp.	Yellow-green color encrusting sponge. Surface hispid. Habitat: Underneath rocks Spicules tylostyle type.
Family: Halichondriidae	
(42) <i>Halichondria (Halichondria) bowerbanki</i> Burton, 1930	Olive brownish color. Encrusting and branching. Habitat: Flat surfaces, caves, crevices, underneath rocks Spicules Oxea only. Distribution: India, Britain and Northern Ireland, U.S.A., France, Korea, Netherlands, Canada, Isle of Man, Sweden, Portugal
(43) <i>Halichondria (Halichondria) tenuiramosa</i> Dendy, 1922	Pink color sponge. Long, slender, and almost straight branch. Habitat: Crevices of rocks underneath rocks Spicules Oxea type. Distribution: India, Tanzania, British Indian Ocean Territory
(44) <i>Halichondria (Halichondria) panicea</i> (Pallas, 1766)	Greenish, pale yellow color, encrusting sponge. The surface is minutely granular and breadcrumb-type. Habitat: Underneath rocks, tide pools, rock pools, caves, algal beds Spicules oxea and slightly curved oxea. Distribution: India, Britain and Northern, U.S.A., Ireland, France, Norway, Sweden, Netherlands, Canada, Germany, Jersey

(45) <i>Halichondria (Eumastia) sitiens</i> (Schmidt, 1870)	Off-white color sponge, densely covered with cone-shaped papillae, looks like branched or oscules. Habitat: Underneath rocks Spicules Oxea type. Distribution: India, U.S.A., Canada, Russian Federation, Svalbard and Jan Mayen, Egypt, Greenland, Iceland, Japan, Norway
(46) <i>Hymeniacion perlevis</i> (Montagu, 1814)	Yellow color sponge. The surface has irregularly thin papillae. Habitat: Underneath rocks of pools All spicules style type. Distribution: India, United Kingdom of Great Britain and Northern Ireland, France, Spain, U.S.A., South Africa, Korea, Portugal, New Zealand, Isle of Man
(47) <i>Amorphinopsis excavans</i> Carter, 1887	A greenish-yellow sponge with massive growth form, its surface is opaque and convoluted. The oscules are not visible to the necked eyes. Habitat: Flat surface, tide pools Spicules large oxea type. Distribution: India, Australia, Indonesia, Myanmar, Malaysia, Seychelles, Vietnam, Egypt, Kuwait, Thailand, Oman
Family: Suberitidae	
(48) <i>Pseudosuberites andrewsi</i> Kirkpatrick, 1900	Pale-yellow color sponge. Oscules are small and irregular. The surface has a corrugated appearance. Habitat: Underneath rocks. Spicules tylostyle slightly curved. Distribution: India, Seychelles, Australia, Indonesia, Christmas Islands, Marshall Islands, Mauritius, Thailand, U.S.A.
(49) <i>Suberites carnosus</i> (Johnston, 1842)	Pinkish colour. Surface smooth-velvety feel. One oscula at the top of species. Habitat: On the rocks of pools Spicules tylostyle type. Distribution: India, United Kingdom of Great Britain and Northern Ireland, France, Italy, Australia, Isle of Man, Iceland, Norway, Croatia, New Zealand
Family: Plakinidae	
(50) <i>Plakortis simplex</i> Schulze, 1880	Thin, encrusting brown color sponge. The surface is smooth with scattered ostia. Habitat: Surface of intertidal area, Rock pools, and shallow pools. Spicules long shafted triene types. Distribution: India, Ireland, Reunion, Norway, Korea, New Caledonia, France, South Africa, Bermuda, Malaysia, Puerto Rico
(51) <i>Plakina monolopha</i> Schulze, 1880	The encrusting pale green-brown color sponge. Irregular lobate borders. Habitat: caves of rocks. Spicules triods and calthrospes types. Distribution: India, Antarctica, France, New Zealand, United Kingdom of Great Britain and Northern Ireland, Saint Helena, Ascension and Tristan da Cunha, Canada, Cabo Verde, Italy, Madagascar

Sponges have specific habitat preferences influenced by water temperature, salinity, substrate type, and wave action. Studied sponges prefer stable hard substrates such as rocks, boulders, and shells for attachment; most encrusting sponges are found underneath rocks and crevices. The substrate provides a solid anchor for the sponges to attach and grow. Among the 51 species, they prefer different levels of wave exposure. Some species thrive in areas with high wave action, while others prefer more sheltered locations. The ability to withstand wave energy can influence the sponge's morphology and attachment strategy. Studied sponges are also adapted to tolerate periodic air exposure during ebb and water immersion during high tide. They need to withstand fluctuations in temperature, salinity, and desiccation. Some species like *Cinachyrella* sp., *Haliclona* sp., *Tethya* sp., and other upper intertidal sponges are more resilient to these changes than lower zone species.

Water quality, including factors like nutrient levels, dissolved oxygen, and water clarity, also affects the distribution of sponges. Among the recorded species, some species are found with algae and seaweeds in tide pools, while some papillate species thrive in the intertidal flat surface zones. Most recorded sponge species do not fluctuate because of temperature and salinity on the coasts; the ecological condition is stable for those species, but they are adapted to a wide range of conditions. Interactions with other organisms, including competition for space and other resources and predation, can influence the distribution and abundance of sponges. Species like *Haliclona (Reniera) tubifera* (George & Wilson, 1919) act as host organisms for the brittle stars for their protection, food, and shelter purposes and show mutualistic and obligatory commensalism relationships (Baroliya et al. 2023). Some species may have specific ecological niches or adaptations to avoid predation. Within the intertidal zone, sponges have specific microhabitats, which is why they are found in caves, crevices, tide pools, etc.

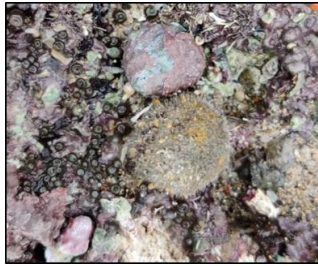




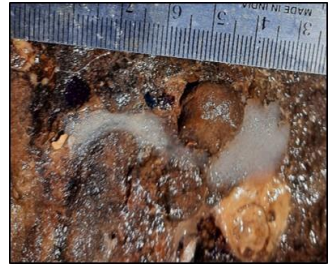
25



26



27



28



29



30



31



32



33



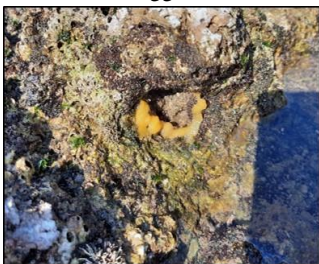
34



35



36



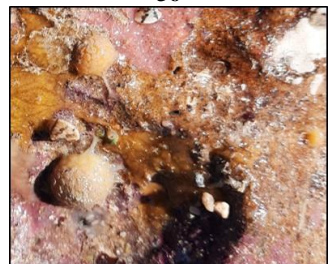
37



38



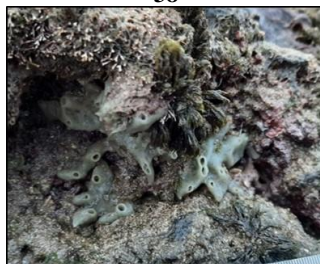
39



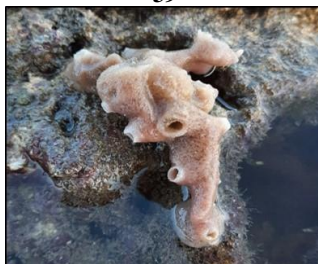
40



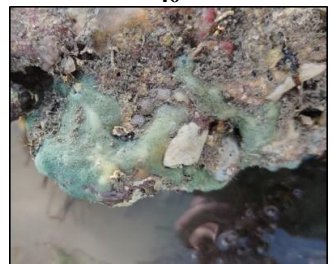
41



42



43



44



45



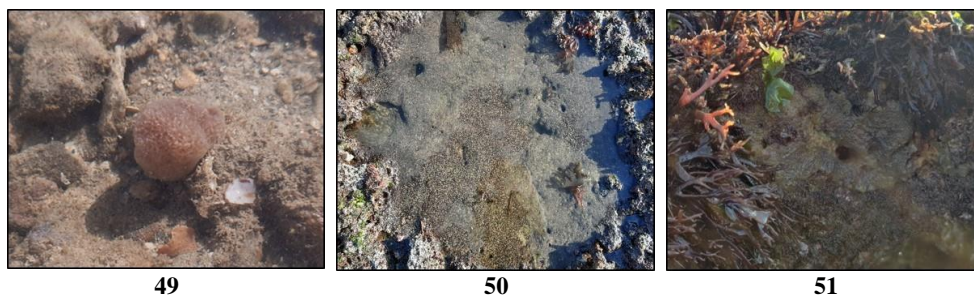
46



47



48



**Figure 3.** Recorded sponge species from Intertidal zones of Gujarat Coast, India. Note: (1) *Clathrina coriacea*, (2) *Sycon grantioides*, (3) *Dysidea avara*, (4) *Dysidea fragilis*, (5) *Dysidea granulosa*, (6) *Hyattella tubaria*, (7) *Hippospongia* sp., (8) *Chondrilla australiensis*, (9) *Aiolochoira crassa*, (10) *Aplysina lacunosa*, (11) *Pseudoceratina purpurea*, (12) *Amphimedon viridis*, (13) *Callyspongia (Cladochalina) aculeata*, (14) *Callyspongia (Cladochalina) diffusa*, (15) *Haliclona (Gellius) cymaeformis*, (16) *Haliclona (Gellius) fibulata*, (17) *Haliclona (Haliclona) oculata*, (18) *Haliclona (Reniera) cinerea*, (19) *Haliclona (Reniera) tubifera*, (20) *Neopetrosia chaliniformis*, (21) *Neopetrosia similis*, (22) *Raspailia (Clathriodendron) arbuscula*, (23) *Acanthella cavernosa*, (24) *Acanthella ramosa*, (25) *Biemna fortis*, (26) *Cinachyrella australiensis*, (27) *Cinachyrella hirsuta*, (28) *Geodia* sp., (29) *Coelocarteria singaporensis*, (30) *Desmapsamma anchorata*, (31) *Iotrochota baculifera*, (32) *Mycale (Mycale) grandis*, (33) *Mycale (Zygomycale) parishii*, (34) *Clathria (Microciona) atranguinea*, (35) *Cliona celata*, (36) *Cliona viridis*, (37) *Sphaciospongia vagabunda*, (38) *Placospongia carinata*, (39) *Placospongia melobesioides*, (40) *Tethya robusta*, (41) *Timea* sp., (42) *Halichondria (Halichondria) bowerbanki*, (43) *Halichondria (Halichondria) tenuiramosa*, (44) *Halichondria (Halichondria) panicea*, (45) *Halichondria (Eumastia) sitiens*, (46) *Hymeniacion perlevis*, (47) *Amorphinopsis excavans*, (48) *Pseudosuberites andrewsi*, (49) *Suberites carnosus*, (50) *Plakortis simplex*, (51) *Plakina monolopha*

## Discussion

Sponge fauna of India has been studied and documented by various researchers, including Thomas (1986, 1989), Dendy (1887), Pattanayak (2006), Vinod et al. (2014), Immanuel et al. (2015), Pawar and Al-Tawaha (2017), Lakwal et al. (2018), George et al. (2020) and Pereira and Raghunathan (2020). They collectively reported approximately 486 sponge species. Extensive investigations into sponge diversity have been carried out, particularly in the Andaman and Nicobar Islands and South India. Gujarat, boasting the longest coastline in India, spanning about 1,600 km along the Arabian Sea, is a focal point for such studies. Gujarat's Coastal zones have varied marine ecosystems, including mudflats of the Gulf of Khambhat and the South Gujarat Coast, the rocky-sandy coast of Saurashtra peninsula, and coral reefs of the Gulf of Kutch. The tides in these areas are mixed semidiurnal type with a large tidal amplitude. The intertidal zone of this coastline has been extensively studied by various researchers for diversity and other ecological aspects of intertidal fauna by Misra and Kundu (2005); Vaghela et al. (2010); Gohil et al. (2011); Bhadja and Kundu (2012); Faladu et al. (2014); Joseph et al. (2014); Poriya and Kundu (2014); Raval et al. (2015); Chaudhari et al. (2016); Vakani et al. (2016); Beleem et al. (2017); Kachhiya et al. (2017); Baroliya and Kundu (2021); Gajera et al. (2022); Jethva et al. (2022). They studied particular organisms like mollusks, limpets, crabs, worms, echinoderms, etc. However, the spongology of this coast is poorly studied. Previously, in Gujarat, only two pioneer comprehensive studies on the diversity of sponges were available. One is based on Mr. James Hornell's collection from Okhamandal in Kattiawar between 1905 and 1906, published by Dendy (1916), and the other is by Thomas et al. (1996). Thus, the present work fills a crucial knowledge gap about the

diversity of poriferans throughout the entire intertidal belt of this region after 1996.

The coastline of Gujarat State is known for its rich biodiversity due to its unique geographical location and varied habitat types. Sponges have notable ecological roles and are interesting subjects in pharmacological studies. The present study provides updated comprehensive reports of poriferan diversity from the Gujarat Coast after the last study by Thomas et al. (1996). Despite their widespread abundance and distribution, estimation of their global diversity poses a challenge because many still await description and proper taxonomic identification. There are only a few reports on the marine sponges of the Gujarat Coast, like Thomas et al. 1996, Kundu 2001, Poriya 2015, and Sabapara and Poriya 2023. Thomas et al. (1996) reported 24 sponge species from the Gulf of Kutch region, Gujarat. After that, Poriya (2015) reported 7 species, and Sabapara and Poriya (2023) noted 12 species from the Veraval coast of Gujarat. Altogether, 51 sponges were recorded, indicating rich poriferan biodiversity from this coastline. Calcarea and Homoscleromorpha are the two classes that represent the least in this inventory. Of the 51 species, 24 species are new records for Gujarat, which belongs to class demospongiae with 20 species, homoscleromorpha with 2 species *Plakortis simplex* Schulze, 1880; *Plakina monolopha* Schulze, 1880 and 1 species *Clathrina coriacea* (Montagu, 1814) from Calcarea. The number of species that occur from Okha to Gopnath coast shows geographical isolation, which could be attributed to habitat and coastal characteristics. Few species like *Halichondria (Halichondria) panicea* (Pallas, 1766) and *Cinachyrella australiensis* (Carter, 1886) were widely distributed, indicating their ubiquitous occurrences throughout the surveyed locations. Bio-eroding sponge species like *Cliona viridis* (Schmidt, 1862) and *Cliona celata* Grant, 1826 were also recorded, particularly within

the small coral colonies that may play a vital role in the assemblage phenomenon (Pohler et al. 2022). For example, *P. simplex* shows a coast-specific distribution and is found distributed throughout the Mangrol coast intertidal zone due to big boulders supporting the underneath growth of this species. Notably, *P. simplex* prefers coral reef habitats (Varsha et al. 2020), and presently, it was only reported from the intertidal zones with small to large coral colonies (Poriya et al. 2014). The studied coast sponges mostly prefer rock pools, zoanthid beds, underneath rock, shallow pools, coralline beds, caves-crevices, and algal beds. Most observed sponges were also encrusting in nature, occurring in the cryptic habitats of caves and under surfaces of boulders. Under-surfaces of rocks and caves protect from temperature, water current, and other extremes, and trapping pools help reduce evaporation, thus reducing desiccation and salinity changes. The intertidal belts of the selected 11 locations differ mainly in slope, substratum types, and length of the exposed area during ebb. The tearing force of the tidal wave increased towards Diu from Okha (Misra and Kundu 2005), and the Gopnath coast has muddy zones that affect the sponge diversity. A greater effort dealing with the taxonomy of sponges in this diverse locality and the geographical isolation of the coasts will reveal the species distribution and other ecological aspects of Indian sponges.

Poriferans are taxonomically diverse, which presents challenges in their phylogeny and classification. Rich, diverse species of sponges are popular subjects in the pharmacological study. On the other hand, boring and intertidal sponge species receive relatively less attention despite their ecological roles in bio-erosion. The knowledge of species diversity on the west coast of India continues to increase, and the present study highlights the importance of Gujarat's significantly unnoticed sponge diversity, which underscores the critical importance of preserving and studying marine ecosystems, particularly in the face of ongoing environmental changes. Opportunities for an increased sampling effort and application of D.N.A. barcoding techniques, especially for species that are challenging to discriminate morphologically, will also help reveal the actual poriferan diversity in Gujarat. Moreover, barriers to reporting biodiversity data at a local scale must be identified and addressed to improve our current knowledge.

## ACKNOWLEDGEMENTS

The authors are thankful to Bhakta Kavi Narsinh Mehta University, Junagadh, India and Dr. R. P. Bhatt, principal of Bahauddin Science College, Junagadh, India for their support and help during their studies. The first author is thankful to the Government of Gujarat, India, for providing a fellowship under the S.H.O.D.H. Scheme.

## REFERENCES

Ali MA. 1956. Additions to the sponges fauna of Madras. *J Madras Univ* 26: 289-301.

- Annandale N. 1915. Fauna of Chilka Lake: Sponges. *Mem Indian Mus* 5: 23-54.
- Baroliya H, Kundu R. 2021. Intertidal aggregation of feather stars (Echinodermata: Crinoidea) on the South Saurashtra Coastline of Gujarat State, India. *Intl J Ecol Environ Sci* 47: 339-344.
- Baroliya H, Sabapara Z, Poriya P. 2023. Habitat preference and role of Ophiuroidea in the intertidal community of Saurashtra Coast, Gujarat, India. *Species* 24: e12s1012. DOI: 10.54905/disssi/v24i73/e12s1012.
- Beleem I, Poriya P, Gohil B. 2017. Diversity and distribution of porcelain crabs of Gujarat, India. *Iran J Anim Biosyst* 13: 41-51. DOI: 10.22067/ijab.v13i1.58903.
- Bell JJ. 2008. The functional role of marine sponges. *Estuar Coast Shelf Sci* 79: 341-353. DOI: 10.1016/j.ecss.2008.05.002.
- Bhadja P, Kundu R. 2012. Status of seawater quality at few industrially important coasts of Gujarat (India) off Arabian Sea. *Indian J Geo Mar Sci* 41: 954-961.
- Bouchet P, Decock W, Lonneville B, Vanhoorne B, Vandepitte L. 2023. Marine biodiversity discovery: The metrics of new species descriptions. *Front Mar Sci* 10: 929989. DOI: 10.3389/fmars.2023.929989.
- Burton M, Rao HS. 1932. Reports on the shallow-water marine sponges in the collection of the Indian Museum. *Rec Zool Surv India* 34: 299-356. DOI: 10.26515/rzsi/v34/i3/1932/162576.
- Chapman AD. 2009. Numbers of Living Species in Australia and the World. 2nd Ed. Report for the Australian Biological Resources Study, Canberra, Australia.
- Chaudhari B, Poriya P, Kundu R. 2016. Community structure of the honeycomb worm *Neosabellaria clandestinus* from a biogenic reef of Gujarat Coast, India. *Intl J Ecol Environ Sci* 42: 333-340.
- Costello MJ, Wilson S, Houlding B. 2012. Predicting total global species richness using rates of species description and estimates of taxonomic effort. *Syst Biol* 61: 871. DOI: 10.1093/sysbio/syr080.
- Dendy A, Burton M. 1926. Report on some deep-sea sponges from the Indian Museum collected by R.I.M.S. Investigator. 1. Hexactinellida and Tetraxonida (Pars). *Rec Zool Survey India* 28: 225-248. DOI: 10.26515/rzsi/v28/i4/1926/163228.
- Dendy A. 1887. The sponge fauna of Madras. A report on a collection of sponges obtained in the neighbourhood of Madras by Edgar Thuston, Esq. *Ann Mag Nat Hist* 20: 153-165. DOI: 10.1080/00222938709460032.
- Dendy A. 1915. Report on the Calcareous Sponges Collected by Mr. James Hornell at Okhamandal in Kattiawar in 1905-1906. Report to The Government of Baroda on the Marine Zoology of Okhamandal in Kattiawar 2: 79-91.
- Dendy A. 1916. Report on the Non-Calcareous Sponges collected by Mr. James Hornell at Okhamandal in Kattiawar in 1905-6. Report to The Government of Baroda on the Marine Zoology of Okhamandal in Kattiawar 2: 93-146.
- Faladu J, Vakani B, Poriya P, Kundu R. 2014. Habitat preference and population ecology of limpets *Cellana karachiensis* (Winckworth) and *Siphonaria siphonaria* (Sowerby) at Veraval coast of Kathiawar Peninsula, India. *J Ecosyst* 2014: 874013. DOI: 10.1155/2014/874013.
- Fromont J, Abdul Wahab MA, Gomez O, Ekins M, Grol M, Hooper JNA. 2016. Patterns of sponge biodiversity in the Pilbara, Northwestern Australia. *Diversity* 8: 21. DOI: 10.3390/d8040021.
- Gajera N, Vakani B, Kundu R. 2022. Radular morphology and relationship between shell size and radula size of few dominating intertidal gastropod mollusks of Veraval Coast, Gujarat. *Front Mar Sci* 9: 657124. DOI: 10.3389/fmars.2022.657124.
- George A, Van Soest RWM, Sluka RD, Lazarus S. 2020. A checklist of marine sponges (Porifera) of peninsula India. *Zootaxa* 4885: 277-300. DOI: 10.11646/zootaxa.4885.2.10.
- Gohil B, Poriya P, Kundu R. 2011. Status of Intertidal macro faunal and floral diversity of Dwarka Sea Coast in prospects of some environmental factor. *Bionano Front* 4: 290-293.
- Hozawa S. 1937. Report on The Calcareous Sponges Collected by The Zoological Museum at Hamburg. Botany and Zoology, Tokyo.
- Immanuel T, Krishnan P, Raghunathan C. 2015. An updated report on the diversity of marine sponges of the Andaman and Nicobar Islands In: Venkatraman K, Sivaperuman C (eds). *Marine Faunal Diversity in India*. Academic Press, London. DOI: 10.1016/B978-0-12-801948-1.00001-X.
- Jethva S, Liversage K, Kundu R. 2022. Does topography of rocky intertidal habitat affect aggregation of cerithiid gastropods and co-

- occurring macroinvertebrates? *Oceanologia* 64: 387-395. DOI: 10.1016/j.oceano.2022.01.006.
- Joseph S, Poriya P, Kundu R. 2014. Probing the phylogenetic relationships of a few newly recorded intertidal zoanthids of Gujarat Coast (India) with mtDNA C.O.I. sequences. *Mitochondrial DNA A* 27: 3858-3864. DOI: 10.3109/19401736.2014.971239.
- Kachhiya P, Raval J, Poriya P, Kundu R. 2017. Diversity and new records of intertidal hermit crabs of the genus *Clibanarius* (Crustacea: Decapoda: Diogenidae) from Gujarat Coast off the Northern Arabian Sea, with two new records for the mainland Indian coastline. *J Threat Taxa* 9: 10334-10339. DOI: 10.11609/jott.2268.9.6.10334-10339.
- Kumar DA. 1925. Report on some Tetraxonid sponges in the collection of Indian Museum. *Rec Zool Surv India* 27: 211-229. DOI: 10.26515/rzsi/v27/i3/1925/163454.
- Kundu. 2001. Ecological status survey of the intertidal macrofauna of the Sikka & Vadinar coast off gulf of Kachchh, India. *Otsuchi Mar Sci* 26: 66-71. DOI: 10.15083/00038884.
- Lakwal VR, Kharate DS, Mokashe SS. 2018. Diversity and distribution of intertidal marine sponges from Ratnagiri Coast of Arabian Sea, India. *Fauna Flora* 24: 207-216.
- Maldonado M, Carmona MC, Velásquez Z, Puig A, Cruzado A, López A, Young CM. 2005. Siliceous sponges as a silicon sink: An overlooked aspect of the benthopelagic coupling in the marine silicon cycle. *Limnol Oceanogr* 50: 799-809. DOI: 10.4319/lo.2005.50.3.0799.
- Misra S, Kundu R. 2005. Seasonal variations in population dynamics of key intertidal molluscs at two contrasting locations. *Aquat Ecol* 39: 315-324. DOI: 10.1007/s10452-005-1779-9.
- Pattanayak JG. 2006. Marine Sponges of Andaman and Nicobar Islands, India. *Zoological Survey of India*, Kolkata.
- Pawar P, Al-Tawaha ARMS. 2017. Marine sponges as bioindicator species environmental stress at Uran (Navi Mumbai), West Coast of India. *Am Eur J Sustain Agric* 11 (3): 29-37.
- Pereira P, Raghunathan C. 2020. New records of Indo-Pacific sponges from the Andaman and Nicobar Islands, India. *Zootaxa* 4894 (4): 081-097. DOI: 10.11646/zootaxa.4894.1.4.
- Pohler SML, Feussner K, Kaniki HV, Rashni B, Wendt H. 2022. Patterns of substrate bioerosion by excavating sponges from the South-West and Central Pacific Ocean. *Front Earth Sci* 10: 914319. DOI: 10.3389/feart.2022.914319.
- Poriya P, Kundu R. 2014. Species invasion and succession as community and ecosystem responses towards climate change in the rocky intertidal ecosystems of Kathiawar Peninsula. *J Aquat Biol* 2: 426-430.
- Poriya P, Vakani B, Kundu R. 2014. New record of live coral species colonizing intertidal zones along Southern Saurashtra, India. *J Bombay Nat Hist Soc* 111: 98-105. DOI: 10.17087/jbns/2014/v111i2/71742.
- Poriya P. 2015. Ecological Status of The Intertidal Macrofaunal Assemblage in a Rocky Intertidal Coast. [Dissertation]. Saurashtra University, Rajkot. [Indian]
- Raval J, Kachhiya P, Poriya P, Kundu R. 2015. Population ecology of intertidal hermit crab *Diogenes avarus* (Decapoda: Anomura) from a muddy Coast of Western India. *Intl J Ecol Environ Sci* 6: 143-146. DOI: 10.9735/0976-9900.
- Sabapara Z, Poriya P. 2023. Assemblage depended distribution of Sponge community in Rocky Intertidal Ecosystem. *Indian J Ecol* 50: 830-838. DOI: 10.55362/IJE/2023/3978.
- Sivaramakrishnan V.R. 1951. Studies on early development and regeneration in some Indian marine sponges. *Proc Indian Acad Sci* 34: 273-310. DOI: 10.1007/BF03050616.
- Sweetlove L. 2011. Number of species on Earth tagged at 8.7 million. *Nature*. DOI: 10.1038/news.2011.498.
- Thomas PA, Pillai CSG, Rajagopalan MS. 1996. Demospongiae of the Gulf of Kutch. *J Mar Biol Assoc India* 38: 124-132.
- Thomas PA. 1972. Boring sponges of the reefs of Gulf of Mannar and Palk Bay. In: Proceedings of the First International Symposium on Corals and Coral Reefs, Marine Biological Association of India, Mandapam Camp, India, 12-16 January 1969, Mandapam.
- Thomas PA. 1986. Demospongia of the Gulf of Mannar and Palk Bay. Today and Tomorrow's Printers and Publishers, New Delhi.
- Thomas PA. 1989. Sponge fauna of Lakshadweep. *Bull CMFRI* 43: 150-161.
- Vaghela A, Bhadja P, Ramoliya J, Patel N, Kundu R. 2010. Seasonal variations in the water quality, diversity and population ecology of intertidal macrofauna at an industrially influenced coast. *Water Sci Technol* 61: 1505-1514. DOI: 10.2166/wst.2010.503.
- Vakani B, Poriya P, Kundu R. 2016. Spatio-temporal variations in the distribution pattern of key molluscs in a rocky intertidal habitat along South Saurashtra Coastline of Gujarat. *Intl J Ecol Environ Sci* 42: 341-348.
- Varsha MS, Ranjith L, Varghese M, Joshi KK, Sethulakshmi M, Prasad AR, Antony TP, Parvathy MS, Jesuraj N, Muthukrishnan P, Ravindren I, Paulpundi A, Kanthan KP, Karuppuswami M, Biswas M, Gopalakrishnan A. 2020. Biodiversity of sponges (Phylum: Porifera) off Tuticorin, India. *J Mar Biol Assoc India* 62: 40-57. DOI: 10.6024/jmbai.2020.62.2.2250-05.
- Vinod K, George RM, Thomas PA, Manisseri MK, Shylaja G. 2014. Diversity and distribution of shallow water sponges (Porifera) in the coastal waters from Enayam to Kollam, South-West Coast of India. *Indian J Fish* 61 (3): 52-57.