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# Current status of intertidal Sea Urchins (Echinodermata: Echinoidea) in the rocky shores of Gujarat, India

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Original Article

## Abstract

The paper deals with the diversity, distribution and occurrence of intertidal Echinoidea from the rocky shores of Gujarat, India. The diversity of Echinoidea from the Gujarat coastline has not been studied for a long time. In the present study, two live Echinoidea species, *Echinometra mathaei* and *Salmacis bicolor* were recorded from the intertidal zones. From these two species, *E. mathaei* is the new record for the entire west coast of India. In Gujarat, this species was recorded from the intertidal areas of Veraval, Mangrol and Dwarka, the open coastline of Saurashtra, stretching about 300 km. Compared with previous literature, four species of intertidal Echinoidea, *Echinometra mathaei*, *Salmacis bicolor*, *Temnopleurus toreumaticus* and *Peronella oblonga* were known from the Gujarat coastline. However, only two Echinoidea species were recorded in the intertidal belt of the Gujarat coast in the current study.

**Keywords:** Sea urchin diversity, *E. mathaei*, rocky intertidal, Gujarat

## Introduction

Sea urchins and sand dollars are the members of a very interesting group of Echinodermata because of their significant ecological roles as grazers and cleaners of the ocean bottom (Hyman, 1955; Harrold and Pearse, 1987; Carreiro-Silva and McClanahan, 2001; Herrera-Escalante *et al.*, 2005; Uthicke *et al.*, 2009). These animals are also reported to have significant economic importance (Palacin *et al.*, 1998; Williamson *et al.*, 2000). Echinoidea belongs to a diverse group of marine deuterostomes in the animal kingdom, which appeared around 540 million years ago in the Ordovician period (Smith *et al.*, 2004, 2006). Approximately 1000 living species of echinoids are known worldwide belonging to 22 families (Serafy and Fell, 1985; Pawson, 2007; Kroh and

Mooi, 2024). Out of these, 138 species of echinoids were noted from India (Sastry, 2007; Samuel *et al.*, 2017).

Gujarat has a 1,600 km long stretch of coastline that includes three different areas, viz. Gulf of Kutch, Saurashtra coastline and Gulf of Khambhat. This coastline has diverse habitats such as coral reefs, sandy shores, rocky patches as well as large mudflats. A detailed review of the literature suggested that the studies on the diversity, distribution and ecology of Echinoidea are sparsely done from this coastline. Almost two decades ago, Sastry (2004) reported four Echinoidea (*Peronella oblonga*, *Clypeaster rarispinus*, *Temnopleurus toreumaticus* and *Salmacis bicolor*) from the Gujarat Coast. Recently, studies were conducted on the different groups of Echinodermata (Ophiuroidea and Asteroidea) covering species diversity, spatiotemporal variation, habitat preferences and potential role in the thriving sedentary communities from Gujarat coast (Baroliya and Kundu, 2021b, 2022; Baroliya *et al.*, 2022, 2023, 2024 a, b). Feather star colour morph and intertidal aggregation were also noted from the south Saurashtra coastline (Baroliya and Kundu, 2021 a; Baroliya *et al.*, 2024 b). Apart from this, detailed studies on different echinoderm groups in this region are not available in the literature.

Despite the critical role they have in the marine ecosystem, so far, the studies on the sea urchin (Echinodermata: Echinoidea) from Gujarat have not been conducted and no updated database are available. The literature indicates that for last two decades, species diversity of intertidal echinoids from Gujarat has not been evaluated and no significant data are available. Therefore, the present work was focused on intertidal Echinoidea diversity, their distribution pattern, habitat preferences and species occurrence status from the

rocky shores of Gujarat coastline. An extensive sampling effort in the rocky intertidal coastal zone was undertaken at distinct localities around the Gujarat coastline.

## Material and methods

### Study area

Gujarat is located at the westernmost tip of the Indian subcontinent. In the pilot study, we surveyed different coastal habitats (Rocky, Muddy and Sandy) for Echinoidea, and we observed sea urchins in rocky and muddy coastal habitats. We aimed to focus on the rocky shores for the Echinoidea assessment. For this study, a total of 10 rocky shores *viz.*, Okha, Shivrajpur, Dwarka, Mithapur, Sikka, Mangrol, Veraval, Dhamlej, Simbor and Diu of the Gujarat coastline were selected (Table 1). The survey was done exclusively on non-MNP areas open to public activities. Echinoidea was present in the intertidal areas of Dwarka, Mithapur, Sikka, Mangrol, Veraval and Diu (Fig. 1). These sites were selected based on their physical and biological structural variability and contrast in the substratum. The intertidal zone has a flat rocky structure with coral, zoanthid and algal cover, and also has many pools/puddles, caves/crevices like habitat where small boulders were also present (Baroliya *et al.*, 2024 a, b). Apart from the rocky shores of Gujarat, Sea urchin (*Echinometra mathaei*) was observed in the muddy tidal flat of Jodiya in Jamnagar district, where more than 20 individuals, in aggregation, were present.

### Sample collection

The intertidal area of the Gujarat coast was exposed for 4-5 hours during low tides and submerged 2-3 m deep

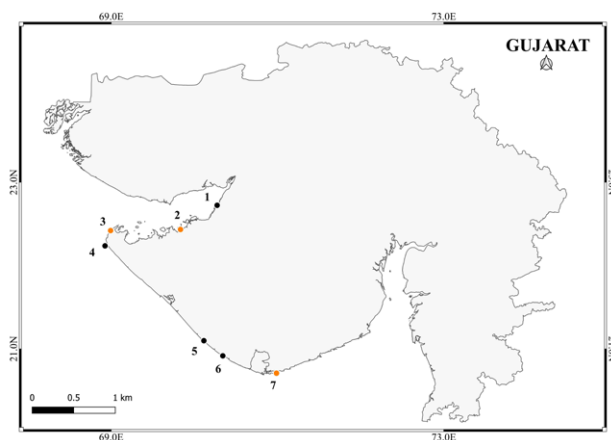


Fig. 1. Map showing locations of Gujarat, India where Echinoidea were reported. 1- Jodiya (Muddy), Rocky shores: 2- Sikka, 3- Mithapur, 4- Dwarka, 5- Mangrol, 6- Veraval, 7- Diu (Black dot for *Echinometra mathaei* and orange dot for *Salmacis bicolor*)

during high tides (Baroliya and Kundu, 2021 a). Therefore, intertidal areas of these 10 sites were extensively surveyed every month during low tide exposure from January 2018 to December 2019. The entire intertidal belt of each sampling site was subdivided into three vertical zones. To cover the maximum areas in each zone, 100 footsteps method following an oblique direction was employed. A minimum of 30 m nearby area of each habitat was checked in a crisscross manner at the intertidal zone to cover the maximum exposed area. Extensive *in situ* photography of live specimens was carried out to do the fieldwork in a non-destructive manner and to create minimum disturbances to the biota of the coastline during fieldwork. Physico-chemical parameters rarely change in open oceanic conditions (Bhadja *et al.*, 2014) and thus are not considered for this

Table 1. Detailed information of the studied localities of rocky shores of Gujarat during present study

Site Name	GPS coordinates	Description	Echinoidea observation & Collection
Diu	20° 42' N, 70° 98' E	Island located on outer rim of Gulf of Kambhat. Sampling sites: Jalandhar, is a flat rocky substratum with boulders.	Yes
Simbor	20° 45' N, 71° 09' E	Small islet located at the mouth of Sahil River at the Bay of Simbor. Sandy-rocky coast. Sampling site: rocky outcrop of ~350m length.	No
Dhamlej	20° 46' N, 70° 36' E	Near the Sutrapada, around 2 km long rocky substratum. Flat emergent rocky habitat covered by <i>Zoanthus</i> .	No
Veraval	20° 55' N, 70° 20' E	Largest fish landing site, 3 km long with fully rocky substratum with coral, zoanthid and <i>Cerithium</i> assemblage & Coralline algae. Sample collect from the flat rock crevices within <i>Cerithium</i> assemblage & Coralline algae	Yes
Mangrol	21° 60' N, 70° 60' E	40 km west off Veraval. Coastal stretch 3 km long with fully flat rocky substratum with coralline algae.	Observed but not collected
Dwarka	22° 14' N, 68° 57' E	South-west part of Saurashtra coastline. Light house, 800 m long, sandy-rocky coastal area, flat rocky substratum with caves/crevices.	Observed but not collected
Shivrajpur	22° 19' N, 68° 57' E	'Blue Flag beach', located between Dwarka and Okha. 1 km in length. Flat rocky substratum with many tidepools and boulders.	No
Mithapur	22° 42' N, 68° 99' E	Located between Dwarka & Okha, sandy-rocky habitat, many coral pools observed & flat rocky substratum	Observed but not collected
Sikka	22° 25' N, 69° 49' E	Its situated middle of southern coast of Gulf of Kachchh, with variety of habitat includes muddy, sandy and rocky substratum	Observed but not collected
Okha	22° 28' N, 69° 40' E	Located outer rim of the Gulf of Kutch, coastal length for this study was 3 km. Intertidal zone contains hard rocky substratum with sandy-rocky patches.	No

study. In the present study, a live specimen of *Salmacia bicolor* was observed in the intertidal areas of the Jalandhar beach of Diu Island, Sikka and Mithapur (3 individuals, 4 individuals and 2 individuals respectively) which has flat rocky structure with algal bed and rock crevices. *Echinometra mathaei* was observed at Veraval, Mangrol and Dwarka. Two individuals each at Veraval and Mangrol were observed in the middle littoral zone. This zone is over 300 m area which has shallow water flat rocky substratum crevice (canal) with plenty of the gastropod *Cerithium* sp. and abundant coralline algae. At Dwarka, one individual was observed living in the flat rock caves of the middle zone. The voucher specimens were collected from the intertidal areas near Jaleshwar temple, Veraval (20° 55' N, 70° 20' E) and from the Jalandhar beach, Diu (20° 42' N, 70° 53' E) during low tide. The specimens were collected manually by direct hand-picking, using forceps to remove specimens from crevices. The collected specimen was kept alive in a 500 ml container filled with seawater and transferred to the laboratory.

### Identification and data analysis

Important morphological characters were photographed using the Image Stereo Microscope (L&M Model: ISH300). Thereafter, the specimens were preserved in 4% formalin and deposited in the museum of the Department of Biosciences, Saurashtra University, Rajkot, Gujarat, India with the Museum ID: ZEECTS (8)18H, ZEECEE (5)18. Identification of species using morphological characters was done following the descriptions given by Mortensen (1943 a, b), Agassiz and Desor (1846), Clark and Rowe (1971) and Lee and Shin (2012). General occurrence pattern was categorized based on individuals spotted during the survey, scarce (1–4 individuals), common (5–25 individuals), and abundant (more than

25 individuals) (Pearse, 2009). Based on data from the International Union for Conservation of Nature (IUCN), the corresponding conservation status of the Echinoidea was determined.

## Results

The existing diversity of the intertidal Echinoidea with their distribution pattern, species occurrence and habitat preferences from the Gujarat coastline is described (Tables 2 and 3).

### Systematics

Family : Temnopleuridae A. Agassiz, 1872

Genus : *Salmacis* L. Agassiz, 1841

*Salmacis bicolor* L. Agassiz in L. Agassiz & Desor, 1846 (Fig. 2 A-B)

*Salmacis varius* L. Agassiz in L. Agassiz & Desor, 1846

*Salmacis rubrotinctus* Grube, 1868

*Salmacis globatrix* Lovén, 1887

*Salmacis bicolor* L. Agassiz in L. Agassiz & Desor, 1846

*Salmacis bicolor* Mortensen 1943a

### Material examined

1 specimen, Jalandhar beach, Diu Island (20° 42' 32" N, 70° 59' 15" E), Gujarat, India, intertidal, Rocky shore, coll: H. Baroliya, 31<sup>st</sup> January 2018, ZEECTS (8)18H, deposited in the museum of the Department of Biosciences, Saurashtra University, Gujarat, India.

### Ecology

*S. bicolor* was found during the winter season (December-

Table 2. Diversity of intertidal Echinoidea from the Gujarat, India

Sl. No.	Species	Present study	Previous study
1	<i>Echinometra mathaei</i> (Blainville, 1825)	Veraval, Mangrol, Dwarka and Jodiya	x
2	<i>Salmacis bicolor</i> L. Agassiz in L. Agassiz & Desor, 1846	Jalandhar beach- Diu Island, Mithapur and Sikka	Jamnagar and Okha, Gulf of Kutch (James 1969; Sastry 2004); Sikka (Katariya 2021)
3	<i>Temnopleurus toreumaticus</i> (Leske, 1778)	X	Gulf of Kutch (Clark 1925); Broken test and spines from Balapur bay, Beyt Island and Jampore beach, Daman (Sastry 2004)
4	<i>Peronella oblonga</i> Mortensen, 1948	X	Balapur bay of Beyt Island, Sikka, Bedi bandar- Jamnagar (Sastry 2004)

\*indicates new record for Gujarat

Table 3. Current species list of intertidal Echinoidea from rocky shores of Gujarat with their general distribution pattern, habitat preferences and occurrences. (IUCN status of both species: Not evaluated)

Family	Scientific name	Distribution pattern	Habitat preferences	Occurrence
Temnopleuridae	<i>Salmacis bicolor</i> L. Agassiz in L. Agassiz & Desor, 1846	Random	Attach with rock, caves/crevices within <i>Halimeda</i> sp. Algal bed	Scarce
Echinometridae	<i>Echinometra mathaei</i> (Blainville, 1825)	Random	Flat rock crevices (canal)	Scarce

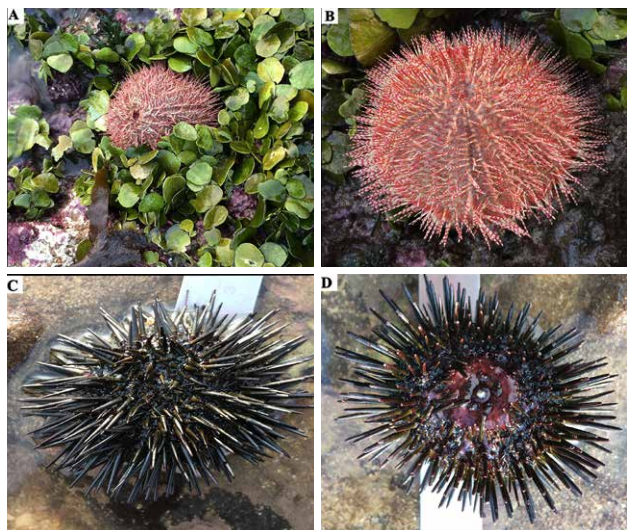


Fig. 2. Echinoidea recorded from the rocky shores of Gujarat. A, B: *Salmacis bicolor*; C, D: *Echinometra mathaei*

February) only. It lives in the algal bed and flat rock caves/crevices at the lower littoral zone of Jalandhar beach, Diu and within flat rock caves/crevices of Sikka and Mithapur.

### Description

The test is a rigid and circular, subconical shape with a dense layer of short spines. In the interambulacral lines, there are at least ten rows of tubers that create consistent horizontal lines, with distinct plate sutures. There is one primary tubercle on each ambulacral plate, each of which has a slight but noticeable crenulation. Visible angular pits. Tiny, pointy pores. The peristome's spines drastically flattened. Thick spines of an orange hue with a white ring around the base.

**Distribution in Gujarat:** Jamnagar and Okha, Gulf of Kutch (James, 1969; Sastry, 2004) Sikka (Katariya *et al.*, 2021) Jalandhar beach- Diu Island, Mithapur and Sikka (Present study, Fig. 1).

**Distribution in India:** Bombay (Agassiz and Desor, 1846) Karwar, Karnataka (Patil, 1953) Kovalam beach, Kerala (Sastry, 2007) Mudasal Odai and Nagapattinam, Tamil Nadu (Sakthivel and Fernando, 2014) Chennai, Tamil Nadu (Clark, 1925; Gravely, 1941; James, 1987) Kanyakumari, Tamil Nadu (Koehler, 1927) Gulf of Mannar (Bell, 1888; Thurston, 1895; Koehler, 1927; Satyamurti, 1976; James, 1969, 1985; Sastry, 2007; Venkataraman and Padmanaban, 2013; Venkataraman *et al.*, 2013; Sarvanan *et al.*, 2018) Palk Bay (Herdman and Herdman, 1904; Venkataraman *et al.*, 2013) Konark and Gopalpur, Orissa (Koehler, 1927) Vishakhapatnam, Andhra Pradesh (Clark, 1925; Sastry, 2007) Lakshadweep Island

(Nagabhushanam and Rao, 1972) Andaman and Nicobar Island, Bay of Bengal (James, 1969; Sastry, 2002, 2005; Sadhukhan and Raghunathan, 2011, 2012).

**Distribution Worldwide:** Zanzibar (Ludwig, 1899; Clark, 1925) Madagascar (Nossy-Faly) (Ludwig, 1899; Lambert, 1923; Clark, 1925) Karachi, Pakistan (Clark, 1925) Mauritius (Clark, 1925; Clark and Rowe, 1971) Mozambique (Kerimba Archipelago) (Clark and Rowe, 1971) Somalia (Tortonese, 1951) Seychelles (Clark, 1984); Philippines, Macclcsfield Bank, Singapore, East Indies (Clark, 1925) Sri Lanka (Clark, 1925; Koehler, 1927) Myanmar (Koehler, 1927) W India, Pakistan, Maldiva area, Ceylon, Bay of Bengal, East Indies, Philippine, China and south Japan (Clark and Rowe, 1971).

Family : Echinometridae Gray, 1855

Genus : *Echinometra* Gray, 1825

*Echinometra mathaei* (Blainville, 1825) (Fig. 2C, D)

*Echinus mathai* Blainville, 1825; 1830

*Echinometra mathaei* Blainville, 1834; Mortensen, 1903; A Agassiz and HL Clark, 1907; HL Clark, 1908; 1912; Koehler, 1914; Mortensen, 1940, 1943; Nisiyama, 1966 AM Clark and Rowe, 1971; Arakaki *et al.*, 1998; Arakaki and Uehara, 1999; Kroh and Mooi, 2012.

*Echinometra megastoma* M'Clelland, 1840.

*Echinometra heteropora* L Agassiz and Desor, 1846.

*Echinometra microtuberculata* A Agassiz, 1863.

*Echinometra picta* A Agassiz and HL Clark, 1907; HL Clark, 1912.

*Ellipsechinus decryi* Lambert, 1933.

### Material examined

1 specimen, Jaleshwar temple, Veraval (20° 55'14" N, 70° 20' 4" E), Gujarat, India, intertidal, Rocky shore, coll: H. Baroliya, 1<sup>st</sup> October 2018, ZEECEE (5)18, deposited in the museum of the Department of Biosciences, Saurashtra University, Gujarat, India.

### Ecology and description

The *E. mathaei* was found throughout the year. It lives in the flat rock caves/crevices at the middle littoral zone of Mangrol and Dwarka, the middle and lower intertidal zone of Veraval. *E. mathaei* is olive green or black. The aboral side black-dark green in colour and the oral side was maroon in the live specimen. All spine colour was dark green to olive colour with maroon base. Tube feet are purple to violet in colour. The species is like a regular urchin, a round to oval shape with the oral test flat. Four more pairs,

sometimes five to one oblique and rather unevenly curved pore-arcs, characterise an ambulacral structure. In the pore zone, one of the tubercles enlarged and formed a fairly noticeable vertical. In interambulacral, larger secondary tubercles usually form a distinct vertical series admedially and adradially to the primary series. Principal spines are sturdy, somewhat long, tapering, and lighter in colour near the tips. The secondary spines resemble rolling pins and are short with flat tips. Various types of pedicellariae are present. Globiferous pedicellariae is very infrequent and valve with a longer lateral tooth. Tridentate pedicellariae is the largest and has valve with curved tips. Ophiocephalous pedicellariae are narrow in the middle and valve having zigzag edges. Triphyllous pedicellariae is the smallest. Buccal plates with few assemblages of ophiocephalous pedicellariae and some small spines in the peristome. Genital plates are covered with some trivial spines. The anal aperture is acentric. C-shaped spicules are present in the tube feet.

**Distribution in Gujarat:** First report for Gujarat coast. In the present study it is reported from Veraval, Mangrol, Dwarka (Fig. 1). It was also observed in the muddy coast of Jodiya, Jamnagar.

**Distribution in India:** Devgad, Konkan coast (Ghatpande and Chandore, 2018) Vizhinjam, Kerala (Jean Jose *et al.*, 2007) Vishakhapatnam, Andhra Pradesh (Sastry, 2007) Gulf of Mannar (Clark, 1925; James, 1969; 1985; Satyamurti, 1976; Sastry, 2007; Venkatraman *et al.*, 2013; Sarvanan *et al.*, 2018) Palk Bay (Venkatraman *et al.*, 2013) Lakshadweep Island (James, 1969; Nagabhushanam and Rao, 1972; Sastry, 1991) Andaman and Nicobar Island (Clark, 1925; Koehler, 1927; James, 1969, 1983; Sastry, 1997, 2001, 2004, 2005, 2007; Rao and Sastry, 2007; Sadhukhan and Raghunathan, 2011, 2012; Rao and Kumar, 2014; Mishra *et al.*, 2015).

**Distribution Worldwide:** Indonesia, East Africa (Kenya, Mauritius, Mozambique, Tanzania) (Blainville, 1825; Clark, 1925) Red Sea, Egypt, Suez, Japan, Thailand, Vietnam, SE Arabia, Persian Gulf, W. India, Pakistan, Maldives area, Ceylon, Bay of Bengal, East Indies, north Australia, Philippines, China, south Japan, South Pacific Island and Hawaiian Island (Clark, 1925; Clark and Rowe, 1971) Madagascar, Amirantes, Sri Lanka, Cocos-Keeling, Borneo, Solomon Islands, Caroline Islands, Vanuatu (New Hebrides) (Clark, 1925) Pakistan (Hoque, 1969) Onotoa Atoll, Marshall Islands, Tuamotus, Guam, Saipan, Okinawa, Solomon Islands, Seleo Island, Netherlands New Guinea, New Caledonia (Hasikaya Island; Kuria Muria Islands) (Clark, 1925; Herring, 1972) Australia (Clark, 1925; Kalk, 1958; Rowe and Gates, 1995) Korea (Jeju Island) (Lee and Shin, 2012).

## Discussion

The current status of intertidal Echinoidea in the Gujarat Coast is characterized by four species which is low compared to other echinoderm groups, such as Ophiuroidea (12 species), Asteroidea (8 species) (Sastry, 2004; Baroliya *et al.*, 2022, 2024). In the recent evaluation, two Echinoidea species were recorded from Gujarat coast namely *E. mathaei* and *S. bicolor* (Table 3). Previously Sastry (2004) recorded four species of Echinoidea namely *P. oblonga*, *C. rarispinus*, *T. toreumaticus* and *S. bicolor* from the Gujarat Coast. Among them, specimen of *C. rarispinus* was collected from 22-23 m depth from Porbandar. Live specimen of *Temnopleurus toreumaticus* was not physically observed but parts of broken test and spine were collected from Balapur bay of Beyt Island and Jampore beach of Daman. Sastry (2004) collected broken parts of species *T. toreumaticus* and crosschecked those broken parts with specimen *T. toreumaticus* present in the Govt. Fisheries Institute Museum at Port Okha (collected from the Gulf of Kutch by Clark (1925) and James (1969)) and concluded that those broken parts were of *T. toreumaticus*. Also, *Salmacis bicolor* was studied from the museum collection of Okha, which might have been collected from the Gulf of Kutch. Rao and Sastry (2005) stated that in Gujarat, *Temnopleurus* and *Salmacis* were known only by the specimens in the Fisheries Institute Museum at Port Okha. As per the literature records, previously *S. bicolor* was reported from the Gulf of Kutch but present investigation revealed its presence also from the open coastline of Saurashtra. In the present study, a live specimen of *S. bicolor* was observed in the intertidal areas of the Jalandhar beach of Diu Island, Sikka and Mithapur. In India, *Salmacis* comprises two species (*S. bicolor* and *S. belli*) and three subspecies (*S. bicolor typica*, *S. sphaeroides*, *S. virgulata*). *S. bicolor* discriminate from other species due to its distinct colouration. *S. bicolor* has orange-red spines with white stripes and white test, *S. belli* have whitish brown spines with black test, *S. virgulata* has violet spine with pale white test. *E. mathaei* is the new record for a Gujarat coast and reported from the Veraval, Mangrol, and Dwarka on an open coast of the Saurashtra peninsula comprising a 300 km long area. *Echinometra* genus is widely distributed throughout the tropical Pacific and also from East Africa to the Indian Ocean (Clark and Rowe, 1971) which currently includes six species *E. viridis*, *E. insularis*, *E. vanbrunti*, *E. mathaei*, *E. oblonga*, and *E. lucunter*. Among them, three species *E. mathaei*, *E. oblonga*, and *E. lucunter* noted in India. *E. mathaei* has an immense variety of colours, form of spines, test and most abundant tropical sea urchin (Mortensen, 1943 b; Russo, 1977; Lawrence, 1983; Arakaki *et al.*, 1998). In India, Sastry (2005) has reported three different forms with spines of black, violet and olive green and with reddish tip from Andaman and Nicobar Islands. Unusually

high number of *E. mathaei* were present at Veraval at the lowest lower zone border (personal observation).

Both the rock-boring sea urchin *S. bicolor* and *E. mathaei* are well-known tropical Indo-West Pacific species, including the Red Sea (Mortensen, 1943 a, b; Clark and Rowe, 1971; Price, 1982; Rowe and Richmond, 1997). Both of these species have a well-known distribution record in India, mostly from the eastern parts of the Indian coastline. Despite their well-documented presence in various parts of the globe, the occurrence of *E. mathaei* in Gujarat has, until now, remained conspicuously absent from the scientific literature. In comparison with nearer adjacent areas of Gujarat, *E. mathaei* was recorded in Pakistan around 50 years ago Hoque (1970). Recently *Echiometra* genus is reported from Maharashtra (Ghatpande and Chandore, 2018), but species-level identification was not given. In the western Indian coast, *E. mathaei* was to date not reported, within this context, documenting the presence of *E. mathaei* in Gujarat holds significant ecological and taxonomic implications with its range expansion. The present study confirms the first record of *E. mathaei* from the west coast of India.

Currently, four Echinoidea, *E. mathaei*, *S. bicolor*, *T. toreumaticus* and *P. oblonga* were known from the intertidal areas of Gujarat (Table 2). However, *T. toreumaticus* and *P. oblonga* were not observed during the present study period. We exclude *Clypeaster rarispinus* because it was collected from 22-23 m depth and presumed to be a subtidal species. After the report of Clark (1925) made from the broken body parts, no live individual of *T. toreumaticus* has been observed so far. It appears that in many echinoderms group, some of the species were once common and rich in the areas of Gulf of Kutch (specially Balapur Bay, Adatra beach and Poshitra) but with the passage of time, their population became less and sometimes rare (Rao and Sastry, 2005). Industrial and human interference such as fishing, tourism, pollution might have caused significant changes in their habitat and surrounding marine environment which might have affected the faunal depletion. The sighting of these species was so rare that there is a possibility that *T. toreumaticus* and *P. oblonga* may be completely vanished from this region. At present, only two Echinoidea species were present in the intertidal belt of the Gujarat coast (Table 3). More extensive field work is needed in other coastal habitat such as sandy, muddy to clarify their presence. Information given in the present report offers better understanding of intertidal Echinoidea which may act as a baseline for future field and experimental studies on ecological aspects of marine intertidal community.

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## Author contributions

Conceptualization: HB, RK; Methodology: HB, RK; Data Collection: HB; Data Analysis: HB; Writing Original Draft: HB; Writing Review and Editing: RK; Supervision: RK

## Data availability

The data supporting this study are available within this manuscript.

## Conflict of interests

The authors declare that they have no conflict of financial or non-financial interests that could have influenced the outcome or interpretation of the results.

## Ethical statement

The study does not include activities that require ethical approval or involve protected organisms/ human subjects/ collection of sensitive samples/ protected environments.

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