The Echinoderms of the Southern Islands, Singapore

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ABSTRACT. Echinoderms are a diverse phylum of marine invertebrates that come in remarkable forms and colours, from the charismatic sea star to the worm-like sea cucumber. Characterized by bony ossicles that often give them a spiny appearance, the echinoderms comprise five main classes with 7,000 extant species. The SIBS data showed that of 223 echinoderm species in Singapore, at least 109 species could be found in the Southern Islands. This signals the national importance of the Southern Island sites for echinoderm biodiversity and conservation. Site specific species richness is reported alongside a species list, forming an early baseline for future echinoderm biodiversity research in the Southern Islands.

Keywords. Echinodermata, biodiversity, conservation.

Introduction

Echinoderms are a diverse group of pentaradial marine invertebrates in the phylum Echinodermata, consisting of five main classes that are highly distinct in morphology, feeding and movement: the sea stars (Asteroidea), the crinoids (Crinoidea), the sea urchins (Echinoidea), the sea cucumbers (Holothuroidea) and the brittle stars (Ophiuroidea). Many have hard or spiny surfaces due to bony ossicles embedded in their cortex (Castro & Huber, 2003; Ng et al., 2011). The bilaterally symmetrical larvae start out as planktonic ciliated free-swimming organisms which, upon finding a suitable substrate, plant themselves and grow into their larger adult forms (Ruppert et al., 2004). In the adult stage, echinoderms are typically benthic, dwelling on the sea floor like sea urchins, sea stars and most sea cucumbers, moving slowly across the seafloor with tiny tube feet called podia from their undersides which are driven by a water vascular system (Tan et al., 2010; Hall, 2022). While they lack a brain, they do have a central nervous system. Certain groups are sessile or have a sessile stage such as the sea lilies, deepwater crinoids which are attached to the seafloor by a stalk, and feather stars, crinoids which do not have a stalk and inhabit shallower waters (Birkeland, 1989; Tan, 2020b). Other groups are free swimming as is the case with some brittle stars, some feather stars, and a few unique species of swimming sea cucumber (Tan, 2020a; Hall, 2022).

The diet and feeding habits of echinoderms are diverse. Many feed off bacterial films growing on the seabed or seagrass surfaces, and as they grow larger certain species may feed on bivalves, marine worms, and sometimes even other echinoderms (Tan, 2020c). Crinoids tend to be suspension feeders, trapping small organisms in the water column using their feathery arms, sea cucumbers have a ring of tentacles around their mouths that pick detritus off substrates or the water column, sea urchins have a beak-like structure for grazing algae, while sea stars tend to evert the stomach to engulf their food.

In the past, many subsistence fishing communities inhabited the Southern Islands of Singapore, and the reefs and associated marine biodiversity supported their livelihoods (Cornelius-Takahama, 2018; Muzaini et al., 2025). On some islands, colourful shells and coral fragments were collected to be sold on mainland Singapore (Cornelius-Takahama, 2016), and it is plausible that echinoderms formed a part of these harvests and marketplace transactions that sustained life for these villages, either as food (sea cucumbers, sea urchins)

or souvenirs (sea stars). Anecdotally, certain species of sea cucumber, especially the Sandfish Sea Cucumber *Holothuria (Metriatyla) scabra* (also known locally as the Garlic Bread Sea Cucumber), were harvested for food by locals including the indigenous Orang Laut of the Southern Islands. Species of *Stichopus*, *Thelenota* and *Actinopyga* have long been used in the region for medicinal and health reasons (Pangestuti & Zainal Arifin, 2018), often under the general name 'gamat'. Starfishes are widely recognized as a symbol for marine life. In Singapore, the Knobbly Sea Star (*Protoreaser nodosus)* was used as a mascot for the Comprehensive Marine Biodiversity Survey conducted from 2010 to 2015. These are popular in the aquarium trade in Southeast Asia and may also be collected and dried to make cheap trinkets, decorations, and souvenirs (Micael et al., 2009).

In Singapore, harvesting for food and souvenirs may have historically played a role in the decline of some echinoderm species (Iesa et al., 2024a), but today the main concern for echinoderm diversity is habitat loss due to land reclamation and coastal modification (Tan et al., 2010). The echinoderms in Singapore may form an important food source for various marine species, especially in their larval stages where they are accessible as food to commercially important species such as fishes and crustaceans (Castro & Huber, 2003; Tan et al., 2010). They also serve important ecological functions as sediment stirrers, filter feeders and algae grazers (Bruckner et al., 2003; Tan et al., 2010). Due to their regenerative abilities (Castro & Huber, 2003), sea stars are a target for bioprospecting for new compounds and biological processes which can aid in creating new medicines and assist in understanding processes in developmental biology and neural regeneration (Amemiya et al., 2005; Micael et al. 2009). Development of regulations on harvesting and keeping these animals for such research is still in its infancy (Micael et al., 2009). Declines in their population could therefore have serious consequences to the marine ecosystem in Singapore. Their genetic diversity and remarkable regenerative abilities also have enormous potential for biotechnological and biomedical applications (Medina-Feliciano et al., 2021), and if these species go extinct, potential medicines and cures that could be gathered from understanding their unique physiologies will be lost.

This chapter summarises the echinoderm diversity of the Southern Islands based on data compiled from published and unpublished literature, and SIBS intertidal field surveys. Site-specific distribution can provide a stronger basis for conservation and management as well as comparison for future monitoring of populations.

Materials and Methods

Intertidal surveys were conducted at 15 sites at Pulau Biola, Pulau Berkas, Sentosa (formerly Pulau Blakang Mati), Pulau Hantu, Pulau Jong, Pulau Salu, Pulau Satumu (Raffles Lighthouse), Pulau Sakijang Bendera (Saint John's Island), Pulau Sakijang Pelepah (Lazarus Island), Pulau Semakau, Pulau Seringat (now merged with Lazarus Island), Pulau Subar Darat (Small Sister's Island), Pulau Tembakul (Kusu Island), Pulau Tekukor, and Terumbu Pandan (Cyrene Reef). The surveys were conducted between August 2020 and March 2022 during low spring tides, typically during early morning hours (6:00am to 10:00am) or during the evening (4:00pm to 8:00pm). Intertidal surveys were not conducted at Keppel Island and Pulau Subar Laut (Big Sister's Island), although other aspects of biodiversity at those islands were included in the SIBS study (Tan et al., 2025a).

A reconnaissance trip was organised for each site to identify suitable areas for laying out transects that would encompass a wide diversity of intertidal habitat types and maximise

species encounters. During the actual survey, a 30m line perpendicular to the shoreline was laid across the intertidal zone, and three sets of 25 m line transects were placed parallel to the shore. There was one set each within the zones 0–10m, 10–20m and 20–30m from the shoreline, so as to ensure sampling covered the upper, middle, and lower shore. Each transect set/shore level was surveyed by a team of 3-5 surveyors, and for each transect five quadrats (50cm by 50cm) were placed along either side of the transect tape at intervals determined via a random number generator. Tan et al. (2025a) provides an illustration of the layout of transects and quadrats. All living morphospecies in the quadrat were photographed for record keeping and identification to the lowest possible taxonomic level. Another team of 5-10 surveyors separately patrolled the intertidal zone beyond the vicinity of the transects to take photographs of as many morphospecies as possible for later identification.

Echinoderm biodiversity records were also compiled from published literature and NParks internal records. The earliest publication included in the literature review was published in 2007, although there may be earlier unpublished records drawn from the internal database, with the latest literature included published in 2020. Scientific names were standardised according to the Singapore Red Data Book (Iesa et al., 2024b).

Results

A total of 109 echinoderms identified to species level were recorded in the surveyed sites, with 24 species of Asteroidea, 21 Crinoidea, 14 Echinoidea, 29 Holothuroidea and 21 Ophiuroidea. Pulau Semakau had the highest recorded echinoderm species richness, with 71 species. The remaining sites had between four and 40 species (Figure 1). For Echinodermata as a whole there was no significant correlation between species richness per site and intertidal area available (Spearman Rank $\chi^2 = 0.4449$, $n=16$, $\Sigma d^2 = 377.5$, $p>0.05$). One species, *Pentaceraster mammillatus*, may be a recent introduction and the others are assumed to be native to Singapore and the region.

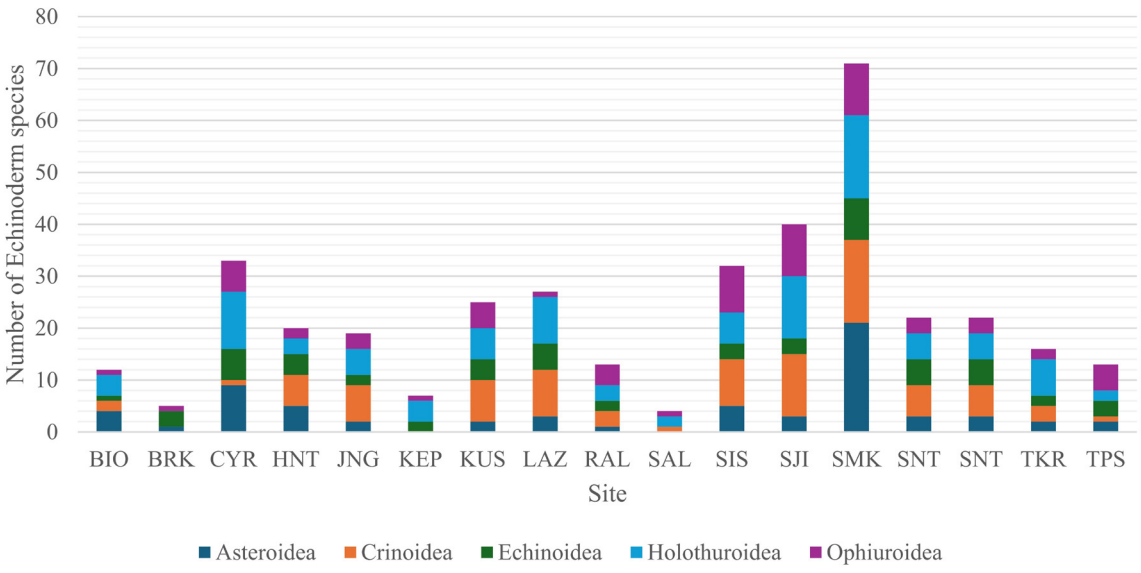


Figure 1: Recorded echinoderm species richness of the Southern Islands by site. BIO = Pulau Biola, BRK = Pulau Berkas, CYR = Terumbu Pandan (Cyrene Reef), HNT = Pulau Hantu, JNG = Pulau Jong, KEP = Keppel Island, KUS = Pulau Tembakul (Kusu Island), LAZ = Pulau Sekijang Pelepah (Lazarus Island), RAL = Pulau Satumu (Raffles Lighthouse), SAL = Pulau Salu, SIS = Pulau Subar Darat and Pulau Subar Laut (Sisters' Islands), SJI = Pulau Sekijang Bendera (St John's Island), SMK = Pulau Semakau, SNT = Pulau Blakang Mati (Sentosa), TKR = Pulau Tekukor, TPS = Terumbu Pempang

Based on the compiled data, Asteroidea was the second most biodiverse class of echinoderm in the Southern Islands. The Common Sea Star *Archaster typicus* was found at ten sites, the highest number of sites for asteroid species (Table 1). Other commonly recorded species include the Cushion Star *Culcita novaeguineae* recorded at eight sites, and the Tiny Seven-armed Coral Star *Aquilonastra anomala* and Knobbly Sea Star *Protoeaster nodosus*, both recorded at five sites. The remaining 20 asteroid species were each recorded at four or fewer sites.

For Crinoidea, the most widely recorded species was the Red Feather Star *Himerometra robustipinna* at 11 sites (Table 2). Another four crinoid species, *Oligometra serripinna*, *Pontiometra andersoni*, *Phanogenia typica*, *Heterometra schlegelii*, *Dichrometra flagellata*, *Lamprometra palmata*, *Stephanometra indica* and *Zygometra comata* were recorded from between five and nine sites. The remaining 12 crinoid species were each recorded at fewer than four sites from compiled records and were not observed during the SIBS intertidal surveys.

Class Echinoidea was the least species rich group of echinoderms reported in the Southern Islands, with 14 species. The Long-spined Black Sea Urchin *Diadema setosum* was the most widespread and reported from 14 sites (Table 3). Other echinoids such as *Arachnoides placenta*, *Jacksonaster depressum*, and *Lovenia elongata* were recorded at five to nine sites. Ten echinoid species were recorded or observed at fewer than five sites. Some of these, such as the heart urchins *Brissopsis luzonica* and *Metalia spatagus* previously known from the coastal waters of the Philippines, were reported for the first time in Singapore waters by Neo et al. (2020) and Toh et al. (2020).

The sea cucumbers or holothuroids were the most species-rich group of echinoderms reported (Table 4). Holothuroids were also the most widely recorded group across the Southern Islands, known from 18 sites with the White-rumped Sea Cucumber *Actinopyga lecanora* recorded at 15 of those. The Long Black Sea Cucumber *Holothuria leucospilota* was also widely recorded, at 14 sites. Other frequently recorded holothuroids, which were found at five or more sites, include *Afrocucumis africana*, *Colochirus quadrangularis*, *Holothuria (Metriatyla) scabra*, *Holothuria (Stauropora) fuscocinerea* and *Holothuria (Theelothuria) notabilis*. The remaining 22 species of holothuroid were each recorded at fewer than five sites. *Synapta maculata* and *Pseudocolochirus violaceus* were last reported in 2012 off Pulau Semakau, and may be of conservation concern, especially *Pseudocolochirus violaceus* which is listed as Vulnerable in the Singapore Red Data Book (Iesa et al., 2024b).

Ophiuroidea, brittle stars, were reported at 17 Southern Island sites (Table 5), with the most widely reported species being the tiny Savigny's Brittle Star *Ophiactis savignyi* which was found in 11 sites. Also known locally as the Tiny In-a-sponge Brittle Star, *Ophiactis savignyi* is the most common and widely distributed brittle star species in the world (Haas, 2011). Other frequently recorded species include *Macrophiothrix longipeda*, *Ophiothela danae* and *Macrophiothrix nereidina,* known from more than five sites. The other 17 species of brittle stars were each recorded at fewer than five sites.

There were 76 echinoderm taxa across the five classes identified only to genus or morphospecies level (Table 6). Those identified only to higher taxonomic levels can be found in the full SIBS database (see Tan et al., 2025).

Table 1: Locations of asteroid species found in Southern Island intertidal waters from published, unpublished literature and Southern Islands Biodiversity Survey (SIBS). SIBS indicates species was observed during Southern Islands Biodiversity Survey 2019-2022. Year corresponds to year of most recent publication or NParks internal record with species observation. RDB3 = Singapore Red Data Book 3 Status, IUCN = International Union for Conservation of Nature Status, BIO = Pulau Biola, BRK = Pulau Berkas, CYR = Terumbu Pandan (Cyrene Reef), HNT = Pulau Hantu, JNG = Pulau Jong, KUS = Pulau Tembakul (Kusu Island), LAZ = Pulau Sekijang Pelepah (Lazarus Island), RAL = Pulau Satumu (Raffles Lighthouse), SIS = Pulau Subar Darat dan Laut (Sisters' Islands), SJI = Pulau Sekijang Bendera (St John's Island), SMK = Pulau Semakau, SNT = Pulau Blakang Mati (Sentosa Island), TKR = Pulau Tekukor, TPS = Terumbu Pempangs. Acronyms for RDB3/IUCN: EX = Globally Extinct, NEx = Presumed Nationally Extinct, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient, NE = Not Evaluated, NA = Not Assessed.

Species	RDB3	IUCN	BIO	BRK	CYR	HNT	JNG	KUS	LAZ	RAL	SIS	SJI	SMK	SNT	TKR	TPS
Order Paxillosida																
Family Astropectinidae																
Craspidaster hesperus	VU	NE												2015		
Family Luidiidae																
Luidia maculata	EN	NE											2020			
Order Spinulosida																
Family Echinasteridae																
Echinaster callosus	EN	NE											2013			
Metrodira subulata	NE	NE											2013			
Order Valvatida																
Family Archasteridae																
Archaster typicus	VU	NE			SIBS; 2020	SIBS; 2020		SIBS; 2020	2020		2020	SIBS; 2020	2020	SIBS; 2020	2020	2020
Family Asterinidae																
Aquilonastra anomala	NE	NE			2020	2020	2020				2020		2020			
Aquilonastra coronata	NE	NE											2020			
Cryptasterina pentagona	VU	NE											2013			
Disasterina ceylanica	NE	NE											2013			
Family Asterinidae																
Nepanthia belcheri	VU	NE			2020								2013			
Nepanthia maculata	NE	NE	2013										2013			

Table 1 continued: Locations of asteroid species found in Southern Island waters from published, un-published literature and Southern Islands Biodiversity Survey (SIBS) data. SIBS indicates species was observed during Southern Islands Biodiversity Survey 2019-2022. Year corresponds to year of most recent publication or NParks internal record with species observation.

Species	RDB3	IUCN	BIO	BRK	CYR	HNT	JNG	KUS	LAZ	RAL	SIS	SJI	SMK	SNT	TKR	TPS
Order Valvatida																
Family Goniasteridae																
Stellaster equestris	VU	NE	2013						2020				2020	2020		
Iconaster longimanus	VU	NE	2013			2013					2019		2013			
Family Ophidiasteridae																
Ophidiaster granifer	NE	NE											2013			
Tamaria fusca	VU	NE											2013			
Family Oreasteridae																
Anthenea aspera	VU	NE			2020								2012			
Culcita novaeguineae	NE	NE		SIBS	2020	2020	2020				2019		2020		2019	2020
Goniodiscaster scaber	VU	NE	2013		2020								2013			
Gymnanthenea laevis	NE	NE			2020						2013		2013			
Pentaceraster alveolatus	NE	NE			2013											
Pentaceraster mammillatus	EN	NE			2008							2020	2012			
Protoreaster nodosus	EN	NE			SIBS; 2020			2020	2020			2020	2020			
Order Velatida																
Family Pterasteridae																
Euretaster insignis	EN	NE				n.d.							2013			

n.d. = no date

Table 2: Locations of crinoid species found in Southern Island intertidal waters from published, unpublished literature and Southern Islands Biodiversity Survey (SIBS). SIBS indicates species was observed during Southern Islands Biodiversity Survey 2019-2022. Year corresponds to year of most recent publication or NParks internal record with species observation. RDB3 = Singapore Red Data Book 3 Status, IUCN = International Union for Conservation of Nature Status, BIO = Pulau Biola, CYR = Terumbu Pandan (Cyrene Reef), HNT = Pulau Hantu, JNG = Pulau Jong, KUS = Pulau Tembakul (Kusu Island), LAZ = Pulau Sekijang Pelepah (Lazarus Island), RAL = Pulau Satumu (Raffles Lighthouse), SAL = Pulau Salu, SIS = Pulau Subar Darat dan Laut (Sisters' Islands), SJI = Pulau Sekijang Bendera (St John's Island), SMK = Pulau Semakau, SNT = Pulau Blakang Mati (Sentosa Island), TKR = Pulau Tekukor, TPS = Terumbu Pempangs. Acronyms for RDB3/IUCN: EX = Globally Extinct, NEx = Presumed Nationally Extinct, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient, NE = Not Evaluated, NA = Not Assessed.

Species	RDB3	IUCN	BIO	CYR	HNT	JNG	KUS	LAZ	RAL	SAL	SIS	SJI	SMK	SNT	TKR	TPS
Order Comatulida																
Family Antedonidae																
Dorometra nana	DD	NE									2013					
Family Colobometridae																
Cenometra bella	DD	NE					2016									
Colobometra perspinosa	VU	NE					2016									
Oligometra serripinna	NT	NE				2016	2016	2013			2019	2016	2016	2015	2016	
Pontiometra andersoni	VU	NE	2016		2016	2016	2016	2016				2016	2016	2015	2013	
Family Comatulidae																
Capillaster multiradiatus	NT	NE											2016			
Capillaster tenuicirrus	DD	NE											2013			
Comaster multifidus	DD	NE											2013			
Comaster schlegelii	DD	NE											2012			
Comatula (Comatula) purpurea	DD	NE									2019					
Phanogenia gracilis	DD	NE										2013	2013			
Phanogenia typica	LC	NE			2013	2013	2013	2013			2018	2016	2013			2018

Table 2 continued: Locations of crinoid species found in Southern Island waters from published, unpublished literature and Southern Islands Biodiversity Survey (SIBS) data. SIBS indicates species was observed during Southern Islands Biodiversity Survey 2019-2022. Year corresponds to year of most recent publication or NParks internal record with species observation.

Species	RDB3	IUCN	BIO	CYR	HNT	JNG	KUS	LAZ	RAL	SAL	SIS	SJI	SMK	SNT	TKR	TPS
Family Himerometridae																
Amphimetra ensifer	NT	NE									2018		2018	2015		
Heterometra schlegelii	LC	NE						2016			2016	2016	2016	2015		
Himerometra robustipinna	LC	NE		2020	SIBS; 2020	SIBS	2020	2020		SIBS	2020	2020	2020	SIBS; 2015	2020	
Family Mariametridae																
Dichrometra flagellata	DD	NE			2016	2016		2013	2016		2016	2016	2016			
Lamprometra palmata	DD	NE			2016	2016	2016	2013	2016		2016	2016	2016	2015		
Order Comatulida																
Family Mariametridae																
Stephanometra indica	DD	NE				2016	2016		SIBS			2016	2016			
Stephanometra indica form spicata	DD	NE						2013				2013				
Stephanometra tenuipinna	DD	NE										2016	2012			
Family Zygometridae																
Zygometra comata	DD	NE	2013		2016			2016				2016	2016			

Table 3: Locations of echinoid species found in Southern Island intertidal waters from published, unpublished literature and Southern Islands Biodiversity Survey (SIBS). SIBS indicates species was observed during Southern Islands Biodiversity Survey 2019-2022. Year corresponds to year of most recent publication or NParks internal record with species observation. RDB3 = Singapore Red Data Book 3 Status, IUCN = International Union for Conservation of Nature Status, BIO = Pulau Biola, CYR = Terumbu Pandan (Cyrene Reef), HNT = Pulau Hantu, JNG = Pulau Jong, KEP = Keppel Island, KUS = Pulau Tembakul (Kusu Island), LAZ = Pulau Sekijang Pelepah (Lazarus Island), RAL = Pulau Satumu (Raffles Lighthouse), SIS = Pulau Subar Darat dan Laut (Sisters' Islands), SJI = Pulau Sekijang Bendera (St John's Island), SMK = Pulau Semakau, SNT = Pulau Blakang Mati (Sentosa Island), TKR = Pulau Tekukor, TPS = Terumbu Pempangs. Acronyms for RDB3/IUCN: EX = Globally Extinct, NEx = Presumed Nationally Extinct, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient, NE = Not Evaluated, NA = Not Assessed.

Species	RDB3	IUCN	BIO	CYR	HNT	JNG	KEP	KUS	LAZ	RAL	SIS	SJI	SMK	SNT	TKR	TPS
Order Camarodonta																
Family Temnopleuridae																
Mespilia globulus	VU	NE								2015						
Salmacis sphaeroides	NE	NE		2020					2020				2020			
Salmacis virgulata	NE	NE		2020												
Family Toxopneustidae																
Toxopnesustes pileolus	NT	NE			2016.											
Order Cidaroda																
Family Cidaridae																
Order Clypeasteroida																
Family Clypeasteridae																
Jacksonaster depressum	VU	NE		2020			2015		2020				2020	2020		
Family Laganidae																
Arachnoides placenta	NT	NE		SIBS; 2020				SIBS; 2020	SIBS; 2020		2020	SIBS	2020	SIBS	2020	*2020*

Table 3 continued: Locations of echinoid species found in Southern Island waters from published, unpublished literature and Southern Islands Biodiversity Survey (SIBS) data. SIBS indicates species was observed during Southern Islands Biodiversity Survey 2019-2022. Year corresponds to year of most recent publication or NParks internal record with species observation.

Species	RDB3	IUCN	BIO	CYR	HNT	JNG	KEP	KUS	LAZ	RAL	SIS	SJI	SMK	SNT	TKR	TPS
Order Diadematoida																
Family Diadematidae																
Chaetodiadema granulatum	EN	NE						2013					2013			
Diadema setosum	NE	NE	SIBS	2020	2020	2020	2020	SIBS; 2020	SIBS; 2020	n.d.	2020	SIBS; 2020	2020	2020	2020	2020
Echinothrix calamaris	NE	NE									2019					
Order Spatangoida																
Family Brissidae																
Brissopsis luzonica	NE	NE			2020.											
Brissus latecarinatus	NE	NE				SIBS			2020				2020	2020		
Metalia spatagus	NE	NE										2020				
Family Loveniidae																
Lovenia elongata	NE	NE		2020	2020			2020					2020	2020		2020
Order Spatangoida																
Family Maretiidae																
Maretia planulata	NE	NE											2020			

Table 4: Locations of holothuroid species found in Southern Island intertidal waters from published, unpublished literature and Southern Islands Biodiversity Survey (SIBS). SIBS indicates species was observed during Southern Islands Biodiversity Survey 2019-2022. Year corresponds to year of most recent publication or NParks internal record with species observation. RDB3 = Singapore Red Data Book 3 Status, IUCN = International Union for Conservation of Nature Status, BIO = Pulau Biola, BRK = Pulau Berkas, CYR = Terumbu Pandan (Cyrene Reef), HNT = Pulau Hantu, JNG = Pulau Jong, KEP = Keppel Island, KUS = Pulau Tembakul (Kusu Island), LAZ = Pulau Sekijang Pelepah (Lazarus Island), RAL = Pulau Satumu (Raffles Lighthouse), SAL = Pulau Salu, SIS = Pulau Subar Darat dan Laut (Sisters' Islands), SJI = Pulau Sekijang Bendera (St John's Island), SMK = Pulau Semakau, SNT = Pulau Blakang Mati (Sentosa Island), TKR = Pulau Tekukor, TPS = Terumbu Pempangs. Acronyms for RDB3/IUCN: EX = Globally Extinct, NEx = Presumed Nationally Extinct, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient, NE = Not Evaluated, NA = Not Assessed.

Species	RDB3	IUCN	BIO	BRK	CYR	HNT	JNG	KEP	KUS	LAZ	RAL	SAL	SIS	SJI	SMK	SNT	TKR	TPS
Order Apodida																		
Family Synaptidae																		
Opheodesoma grisea	VU	NE					2018											
Opheodesoma spectabilis	NE	NE													2013			
Synapta maculata	NE	NE													2012			
Synaptula minima	VU	NE							2016									
Synaptula reticulata	VU	NE							2016				2019	2019			SIBS	
Order Dendrochirotida																		
Family Cucumariidae																		
Actinocucumis typica	VU	NE	2013											2013				
Cercodemas anceps	VU	NE			2020			2015										
Colochirus quadrangularis	NT	NE	2013		2020			2020		2020					2012	2020		
Mensamaria intercedens	VU	NE			2020									2020		2020		
Pseudocolochirus violaceus	VU	NE													2012			
Family Phyllophoridae																		
Hemithyone semperi	VU	NE				2013								2016				
Stolus buccalis	VU	NE								2013				2016			2013	
Family Sclerodactylidae																		
Afrocucumis africana	VU	NE					2020			2020	2013			2020	2020	2020	2020	
Cladolabes hamatus	VU	NE														2015		

Table 4 continued: Locations of holothuroid species found in Southern Island waters from published, unpublished literature and Southern Islands Biodiversity Survey (SIBS) data. SIBS indicates species was observed during Southern Islands Biodiversity Survey 2019-2022. Year corresponds to year of most recent publication or NParks internal record with species observation.

Species	RDB3	IUCN	BIO	BRK	CYR	HNT	JNG	KEP	KUS	LAZ	RAL	SAL	SIS	SJI	SMK	SNT	TKR	TPS
Family Holothuriidae																		
Actinopyga lecanora	VU	DD	SIBS	SIBS	SIBS; 2020	2020	2020	2020	2020	2020	2020	SIBS	2020	SIBS; 2020	SIBS; 2020		2020	2020
Bohadschia ocellata	VU	NE			2020					2020								
Bohadschia vitiensis	EN	DD		SIBS	2020										2020			
Holothuria (Lessonothuria) pardalis	VU	LC											2019	2019			2013	
Holothuria (Mertensiothuria) leucospilota	EN	LC	SIBS; 2007		SIBS; 2020		SIBS; 2020	2020	SIBS; 2020	SIBS; 2020	SIBS; 2020	SIBS	SIBS; 2020	SIBS; 2020	2020	2020	SIBS; 2020	2020
Holothuria (Metriatyla) albiventer	VU	DD			2020					2020					2020			
Order Dendrochirotida																		
Family Holothuriidae																		
Holothuria (Metriatyla) martensi	VU	NE												2016				
Holothuria (Metriatyla) scabra	EN	NE			2020				2020	2020				2020	2020			
Holothuria (Stauropora) fuscocinerea	VU	LC			2020	2020	2020						2020		2020			
Holothuria (Theelothuria) notabilis	EN	DD			2020				SIBS; 2020	2020			2019		2020			
Holothuria (Thymiosycia) impatiens	VU	DD															2020	

Table 4 continued: Locations of holothuroid species found in Southern Island waters from published, unpublished literature and Southern Islands Biodiversity Survey (SIBS) data. SIBS indicates species was observed during Southern Islands Biodiversity Survey 2019-2022. Year corresponds to year of most recent publication or NParks internal record with species observation.

Species	RDB3	IUCN	BIO	BRK	CYR	HNT	JNG	KEP	KUS	LAZ	RAL	SAL	SIS	SJI	SMK	SNT	TKR	TPS
Order Synallactida																		
Family Stichopodidae																		
Stichopus herrmanni	EN	VU													SIBS; 2020			
Stichopus horrens	VU	DD												SIBS; 2013	2020			
Stichopus ocellatus	EN	DD		SIBS											2020			
Stichopus vastus	EN	LC													2020			

Table 5: Locations of ophiuroid species found in Southern Island intertidal waters from published, unpublished literature and Southern Islands Biodiversity Survey (SIBS). SIBS indicates species was observed during Southern Islands Biodiversity Survey 2019-2022. Year corresponds to year of most recent publication or NParks internal record with species observation. RDB3 = Singapore Red Data Book 3 Status, IUCN = International Union for Conservation of Nature Status, BIO = Pulau Biola, BRK = Pulau Berkas, CYR = Terumbu Pandan (Cyrene Reef), HNT = Pulau Hantu, JNG = Pulau Jong, KEP = Keppel Island, KUS = Pulau Tembakul (Kusu Island), LAZ = Pulau Sekijang Pelepah (Lazarus Island), RAL = Pulau Satumu (Raffles Lighthouse), SAL = Pulau Salu, SIS = Pulau Subar Darat dan Laut (Sisters' Islands), SJI = Pulau Sekijang Bendera (St John's Island), SMK = Pulau Semakau, SNT = Pulau Blakang Mati (Sentosa Island), TKR = Pulau Tekukor, TPS = Terumbu Pempangs. Acronyms for RDB3/IUCN: EX = Globally Extinct, NEx = Presumed Nationally Extinct, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern, DD = Data Deficient, NE = Not Evaluated, NA = Not Assessed.

Species	RDB3	IUCN	BIO	BRK	CYR	HNT	JNG	KEP	KUS	LAZ	RAL	SAL	SIS	SJI	SMK	SNT	TKR	TPS
Order Amphilepidida																		
Family Ophiactidae																		
Ophiactis savignyi	NE	NE			2020	2020	2020				2013	SIBS	2020	2020	2020	2020	SIBS; 2013	2020
Family Ophionereididae																		
Ophionereis dubia dubia	NE	NE			2013													
Family Ophiopyrgidae																		
Ophiuroglypha kinbergi	NE	NE													2013			
Family Ophiotrichidae																		
Macrophiothrix caenosa	NE	NE											2019					
Macrophiothrix lineocaerulea	NE	NE							2020				2020					2020
Macrophiothrix longipeda	DD	NE		SIBS	2020				2020				2020		2020	2020	2020	2020
Macrophiothrix melanosticta	NE	NE											2019	2019	2013			
Macrophiothrix nereidina	NE	NE				2013		2020	2013		2013			2013		SIBS		
Ophiocnemis marmorata	DD	NE			2013										2012			
Ophiomaza cacaotica	VU	NE							2020		2020		2020	2013				
Ophiopsammium semperi	VU	NE													2013			
Ophiothela danae	NE	NE			SIBS; 2020		SIBS		2013	SIBS			2020	2020	2020			2020

n.d. = no date

Table 5 continued: Locations of ophiuroid species found in Southern Island waters from published, unpublished literature and Southern Islands Biodiversity Survey (SIBS) data. SIBS indicates species was observed during Southern Islands Biodiversity Survey 2019-2022. Year corresponds to year of most recent publication or NParks internal record with species observation.

Species	RDB3	IUCN	BIO	BRK	CYR	HNT	JNG	KEP	KUS	LAZ	RAL	SAL	SIS	SJI	SMK	SNT	TKR	TPS
Family Ophiotrichidae																		
Ophiothela vincula	NE	NE											2019					
Ophiothrix (Ophiothrix) ciliaris	NE	NE													2012			
Order Euryalida																		
Family Euryalidae																		
Euryale aspera	DD	NE											2019		2013			
Order Ophiacanthida																		
Family Ophiodermatidae																		
Ophiarachnella gorgonia	NE	NE	SIBS		2013		2013							2016				
Ophiodyscrita instratus	NE	NE												2016				
Family Ophiomyxidae																		
Ophioconis permixta	NE	NE												2016				
Order Ophiurida																		
Family Ophiolepididae																		
Ophiolepis cincta	NE	NE													2012			
Ophiolepis cincta cincta	NE	NE												2016				
Ophiolepis nodosa	NE	NE									2013			2016				2013

Table 6: Locations of echinoderm taxa identified to genus or morphospecies level found in Southern Island waters from published, unpublished literature and Southern Islands Biodiversity Survey (SIBS) data. SIBS indicates species was observed during Southern Islands Biodiversity Survey 2019-2022. Year corresponds to year of most recent publication or NParks internal record with species observation.

Class Asteroidea	**BIO**	**BRK**	**CYR**	**HNT**	**JNG**	**KEP**	**KUS**	**LAZ**	**RAL**	**SAL**	**SIS**	**SJI**	**SMK**	**SNT**	**TKR**	**TPS**
Family Asterinidae																
Cryptasterina sp.								2020				2013	2020			
Nepanthia sp.											2019					
Family Astropectinidae																
Astropecten sp.											2013					
Astropecten sp “orange”			2020										2020			
Astropecten sp “painted”												2020				
Family Goniasteridae																
Iconaster sp.	2013												2013			
Class Crinoidea	**BIO**	**BRK**	**CYR**	**HNT**	**JNG**	**KEP**	**KUS**	**LAZ**	**RAL**	**SAL**	**SIS**	**SJI**	**SMK**	**SNT**	**TKR**	**TPS**
Order Comatulia sp “10-armed”													2020			
Order Comatulida sp “black and white”		SIBS		2020					2020	SIBS	2020		2020			
Order Comatulida sp “blue”				2020					2020		2020	2020	2020			
Order Comatulida sp “brown”						2020	2020				2020		2020			2020
Order Comatulida sp “pale”				2020					2020		2020					
Family Antedonidae																
Dorometra cf *nana*								2016			2016	2016				
Family Colobometridae																
Oligometra sp.											2019					
Family Comatulidae																
Comatula sp.	2013			2013	2013						2013	2013	2016			
Comatula cf *pectinata*	2013			2016				2016				2016		2015		
Comatula cf *solaris*				2016				2016				2016		2015		

Table 6. Continuation.

Class Crinoidea	**BIO**	**BRK**	**CYR**	**HNT**	**JNG**	**KEP**	**KUS**	**LAZ**	**RAL**	**SAL**	**SIS**	**SJI**	**SMK**	**SNT**	**TKR**	**TPS**
Family Himerometridae																
Heterometra cf *bartschi*											2018					
Heterometra cf *crenulata*	2016							2016				2016	2016	2015		
Himetometra sp.													2013			
Family Mariametridae																
Dichrometra/*Liparometra* sp.													2013			
Dichrometra flagellata?				2013												
Class Echinodea	**BIO**	**BRK**	**CYR**	**HNT**	**JNG**	**KEP**	**KUS**	**LAZ**	**RAL**	**SAL**	**SIS**	**SJI**	**SMK**	**SNT**	**TKR**	**TPS**
Order Spatangoida sp "oval"			2020		2020		2020	SIBS; 2020			2020		2020			
Family Cidaridae																
Prionocidaris sp.			2020													
Family Diademetidae																
Diadema sp.						2015								2015		
Family Temnopleuridae																
Salmacis sp.	2013												2012			
Class Holothuroidea	**BIO**	**BRK**	**CYR**	**HNT**	**JNG**	**KEP**	**KUS**	**LAZ**	**RAL**	**SAL**	**SIS**	**SJI**	**SMK**	**SNT**	**TKR**	**TPS**
Family Caudinidae																
Acaudina sp.								2020					SIBS			
Actinocucumis sp.												2016				
Actinopyga sp.			2013								2013		2013			
Actinopyga sp "kumquat"			2020	2020							2020		2020			**2020**
Actinopyga sp "orange"													2020			
Family Cucmariidae																
Family Cucumariidae sp "purple"			2020										2020	2020	2020	

Table 6. Continuation.

Class Holothuroidea	BIO	BRK	CYR	HNT	JNG	KEP	KUS	LAZ	RAL	SAL	SIS	SJI	SMK	SNT	TKR	TPS
Family Caudinidae																
Colochirus sp.				2016								2016				
Plesiocolochirus cf australis											2018					
Family Holothuriidae																
Holothuria sp.														2015		
Holothuria (*Lessonothuria*) sp									2013							
Holothuria (*Mertensiothuria*) sp.									2013							
Family Phyllophoridae																
Thyone sp.							2013									
Family Scleractylidae																
Globosita sp				SIBS			2020	2020			2020		2020			
Family Sclerodactylidae																
Havelockia sp												2016				
Havelockia sp “mo”												2013				
Havelockia sp “wa”	2013						2013	2013								
Family Stichopodidae																
Stichopus sp.												2013	2013	2013		
Stichopus aff *monotuberculatus*												2016				
Family Synaptidae																
Family Synaptidae sp “big”			SIBS; 2020	SIBS; 2020			SIBS				2020		2020	2020		
Family Synaptidae sp “sponge”			2020	SIBS		2020										
Synaptula sp.			2013	SIBS; 2016			2016						SIBS			2018
Synaptula cf *recta*			2013												SIBS	

Table 6. Continuation.

Class Ophiuroidea	BIO	BRK	CYR	HNT	JNG	KEP	KUS	LAZ	RAL	SAL	SIS	SJI	SMK	SNT	TKR	TPS
Class Ophiuroidea sp "bottlebrush"			SIBS; 2020		SIBS		2020					2020				
Class Ophiuroidea sp "flat-armed"		SIBS	2020													
Class Ophiuroidea sp "violet"			SIBS				2020			SIBS			2020	2020		
Family Amphiuridae																
Amphioplus sp.												2013				
Amphipholis sp.				2013			2013									2013
Amphipholis ?*squamata*													2013			
Amphiura (*Fellaria*) sp.															2013	
Amphiura (*Fellaria*/*Ophiopeltis*) sp 2												2013				
Opheodesoma sp.													2012			
Ophiocentrus sp.	2013															
Family Euryalidae																
Euryale sp.				2013			2013						2013		2013	
Euryale ?*aspera*				2013											2013	
Family Ophiacanthidae																
Ophiacantha sp				2013												
Family Ophiactidae																
Ophiactis sp				2013	2013		2013				2013	2019	2013		2013	
Family Ophiocomidae																
Ophiocoma sp.				2013												
***Family* Ophiodermatidae**																
Ophiarachnella sp.					SIBS											
Ophiarachnella cf. *gorgonia*										SIBS						

Table 6. Continuation.

Class Ophiuroidea	**BIO**	**BRK**	**CYR**	**HNT**	**JNG**	**KEP**	**KUS**	**LAZ**	**RAL**	**SAL**	**SIS**	**SJI**	**SMK**	**SNT**	**TKR**	**TPS**
Family Ophiolepididae																
Ophiolepis sp.											2013					
Ophiolepis cincta?									2013							
Family Ophionereididae																
Ophionereis sp			2013	2013	2013				2013		2013		2013			
Family Ophiotrichidae																
Macrophiothrix sp.			2013	2013	2013		2013					2013	2013		2013	2013
Macrophiothrix lineocaerulea?											2013					
Macrophiothrix ?longipeda				2013									2013			
Macrophiothrix nereidina?															2013	
Ophiocnemis sp.			2013													
Ophiomaza sp.					2013						2013				2013	
Ophiothela sp.							2013	2013			2019		2013			
Ophiothrix (*Ophiothrix*) sp.	2013															
Ophiothrix sp.			2020	2013	2013		SIBS; 2013	2013	2013		2013	2013	2013		2013	2013

Discussion

Of the 7000 extant species of echinoderms recorded globally, close to a thousand species have been identified in the South China Sea (Lane et al., 2000), of which approximately 223 species are found in Singapore (Iesa et al., 2024b). At least 107 species are listed here for the Southern Islands of Singapore, which is about half the echinoderm species recorded nationally. As another 76 taxa were identified only to genus or morphospecies level, with some others at an even higher taxonomic level, this is certainly an underestimate.

Pulau Semakau stands out as the site with the highest recorded echinoderm species richness, with nearly twice the number of species compared to the next most species-rich site, Pulau Sakijang Bendera (St John's Island). This may come as a surprise to some as parts of Pulau Semakau are managed as a landfill for incinerated waste that has seen major changes to its natural habitats due to land reclamation (Chia & Aziz, 2019). However, the protective measures taken at Semakau Landfill and limitation of impacts to the land area have presumably minimised effects on marine biodiversity (NEA, 2023). In addition, coral and mangrove restoration efforts have been made in parts of Semakau shores to reduce the environmental impact of constructing the landfill (NParks, 2009; Lim & Chou, 2020). Other sites with high echinoderm biodiversity include Pulau Sakijang Bendera (St John's Island), Terumbu Pandan (Cyrene Reef) and Pulau Subar Darat and Pulau Subar Laut (Sisters' Islands). Of note is that Cyrene is the southern stronghold of the nationally endangered knobbly sea star (*Protoreaster nodosus*), with a population we estimate at about 50-100 mature adults. Adult populations of this large and iconic species are now found only at a handful of sites in Singapore which have mature seagrass meadows (e.g. Beting Bronok and Chek Jawa in the north), and it has declined on Pulau Semakau in tandem with the decline of the seagrass meadow there (see Tan et al., 2025b). The continued survival of this species at Cyrene is an indicator that the seagrass meadow there remains healthy.

Dive surveys were not conducted during SIBS, which poses limitations to detecting echinoderm species at greater depths. In addition, intertidal surveys were limited to being conducted during the twilight hours. As brittle stars have a nocturnal lifestyle, there may be a tendency for their diversity and distribution to be underreported in intertidal surveys. Dredge surveys by the earlier Comprehensive Marine Biodiversity Survey (CMBS; 2010 - 2015) had previously found substantial populations of echinoderms on the seabed, some of which were previously thought to be rare (e.g. *Euryale aspera*). While some of the CMBS data has been included in the SIBS database, this generally includes only species records which can be reasonably associated with a specific island and excludes those from areas of open sea. Thus, the actual species richness of the echinoderms in the Singapore Strait may be underrepresented in the current data, and future work and research is still encouraged.

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Appendix 1 (**A**) Synaptid Sea Cucumber (Family Synaptidae) and Long Black Sea Cucumber (*Holothuria leucospilota*) at Pulau Tekukor, credit: Jonathan Tan. **(B)** Stonefish Sea Cucumber (*Actinopyga lecanora*) at Pulau Berkas, credit: Loh Kok Sheng. **(C)** Ocellated Sea Cucumber (*Strichopus ocellatus*) at Pulau Berkas, credit: Jonathan Tan. **(D)** Feather Star (Order Comatulida) at Pulau Satumu, credit: Marcus Ng. **(E)** Cushion Star (*Culcita novaeguineae*) at Pulau Berkas, credit: Loh Kok Sheng **(F)** Brown Sea Cucumber (*Bochadschia vitiensis*) at Pulau Berkas, credit: Loh Kok Sheng. **(G)** Brittle Star (Ophiuroidea), Pulau Biola, credit: Vincent Choo. **(H)** Group of Long-spined Sea Urchins (*Diadema setosum*), Pulau Biola, credit: Loh Kok Sheng.