

## LISTS OF SPECIES

### Echinoderms, Malpelo Fauna and Flora Sanctuary, Colombian Pacific: New reports and distributional issues

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#### Abstract

A systematic list of echinoderms from Malpelo Fauna and Flora Sanctuary (MFFS) was prepared, based on local sampling, literature review and identification of specimens from *Museo de Historia Natural Marina de Colombia* (MHNMC) and from National Museum of Natural History, Smithsonian Institution, Washington D. C. (USNM). Standard methodology for monitoring the Eastern Tropical Pacific Seascape was used in December 2006 and March 2007 to sample shallow water echinoderms (1-20 m deep). Malpelo is the richest locality of the Colombian Pacific with 84 species reported (56 % of them deep water organisms), belonging to 22 orders, 42 families and 68 genera, distributed between the surface and a depth of 5000 m. Thirty-six new records for MFFS and Colombian Pacific are reported. In Colombia the shallow water species are widely distributed in the Pacific, while deep forms only occur at Malpelo. The majority of species are mostly related to the Panamanian and Galapagos region showing a possible connectivity. This list increases knowledge on the echinoderm biodiversity from the Malpelo Island in 68 %.

#### Introduction

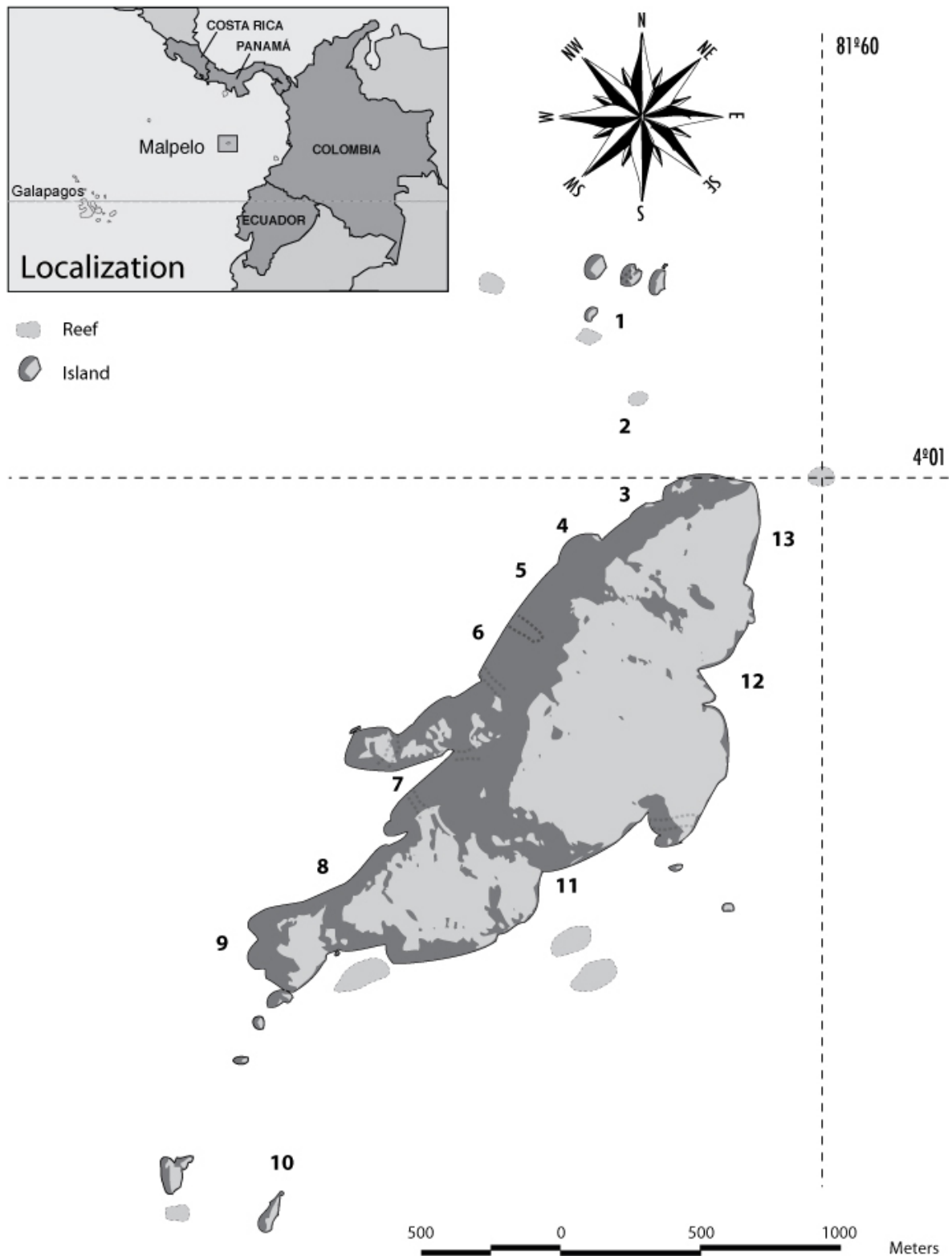
The echinoderms are organisms which are able to feed in a variety of levels, being an important link in the marine trophic networks (Birkeland 1989; Ruppert and Barnes 1995). As group, they play a key role in reef ecosystems, mainly because of the erosion they cause due to the mechanical action (Birkeland 1989). The phylum constitutes at least 90 % of the biomass of the benthic deep-water communities, substantially contributing to the ocean productivity (Birkeland 1989; Brusca and Brusca 1990).

The echinoderms of Malpelo Fauna and Flora Sanctuary (MFFS) have been little studied even when continued research has been held in the area. The first scientist that collected the group in the MFFS area was Alexander Agassiz (1892), who led the U.S. Fishing Commission expedition on board of the “Albatross” steamer. Later, Downey (1975) and Birkeland et al. (1975) provided the first inventories of asteroids, ophiuroids and echinoids. Since then, Neira and von Prah (1986), Neira and Cantera (1988),

Pardo-Ángel (1989), Pardo-Ángel and Neira (1990), Neira et al. (1992) and Brando et al. (1992) have extended the knowledge of the richness of species within the MFFS. More recently, Arboleda (2002) and Neira and Cantera (2005) increased the number to 29 species of echinoderms, without considering the Crinoidea class. Some Colombian authors (Cantera and Neira 1987; Cantera et al. 1987; Toro-Farmer et al. 2004; Ortiz 2006; Cohen-Rengifo 2008) also gave important ecological and distributional contributions to the knowledge of echinoderms showing, besides inventory information, data about relationships with environmental factors, biogeography and anthropogenic and natural threats.

The current island information related with the assemblage composition of echinoderms is scarce and disperse. Therefore, this inventory was obtained by sampling waters between 7 and 20 m deep and by a comprehensive revision of scientific literature and museum collections.

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**Figure 1.** Map of Malpelo Island indicating the sampling stations. 1: D'Artagnan; 2: Bajo del Ancla; 3: Pared del Náufrago Norte; 4: Pared del Náufrago; 5: Pared del Náufrago Sur; 6: Freezer; 7: Bahía de la Nevera; 8: La Nevera; 9: Sahara; 10: Scuba; 11: La Pared del Resguardo; 12: El Arrecife; 13: La Pared del Fantasma.

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### Materials and Methods

The MFFS (3°51'07" N, 81°35'40" W) is located 490 km west of Buenaventura port in the Colombian Pacific. The island emerges from a volcanic submarine mountain called the Malpelo ridge that extends in northeast-southwest direction being 241.4 km long and 80.5 km wide (Graham 1975). Its range goes from abyssal depths to 360 m above sea level with an extension of 1.2 km<sup>2</sup> of land and 8574 km<sup>2</sup> of marine protected area (Figure 1) (Fundación Malpelo y otros Ecosistemas Marinos 2005; 2006).

This project was carried out at the IV and V Scientific Research Cruises of the "Fundación Malpelo y otros Ecosistemas Marinos" and the assistance of UNESCO Seascope project, CI Seascope project (Walton Family Foundation) and Marine Management Area Science project (Gordon and Betty Moore Foundation). The samplings were part of a regional study of the islands within the Marine Conservation Seascope of the Eastern Tropical Pacific (MCSETP) that seeks to evaluate the shallow water marine ecosystems. Quantitative censuses using underwater visual techniques from the standard Edgar et al. (2004) methodology were used in December 2006 and March 2007. Thirteen stations around the island (Figure 1) were sampled between 7 to 20 m of depth by scuba diving. Every echinoderm seen over and between the corals, rocks, and crevices was counted, photographed and identified during immersions.

A second stage of the research consisted in a literature review (Birkeland et al. 1975; Downey 1975; Maluf 1988; von Prah 1990; Maluf 1991; Brando et al. 1992; Hickman 1998; Arboleda 2002; Neira and Cantera 2005), and from Museum collections like the National Museum of Natural History, Smithsonian Institution, Washington D. C. (USNM) and the *Museo de Historia Natural Marina de Colombia* (MHNMC), compiling information from 1891 to 2008.

The classification of the species was done in accordance with Deichmann (1938), Rowe (1969), Pawson (1970), Downey (1975), Clark (1982), Caso (1983), Clark and Downey (1992), Hendler et al. (1995) and Hickman (1998).

### Results and Discussion

The systematic list was composed by 22 orders, 42 families, 68 genera and 84 species (Table 1). The Holothuroidea class was the richest with 24 species while the Ophiuroidea class showed the lowest richness with 18. From the total, 26 species were identified during immersions, while the remaining 58 were obtained from literature during the second stage of the project (Table 2).

Thirty-six species are new reports for MFFS, including: three asteroids (*Amphiaster insignis*, *Acanthaster planci*, *Phataria unifascialis*), one ophiuroid (*Ophiactis simple*), four echinoids (*Hesperocidaris asteriscus*, *Centrostephanus coronatus*, *Toxopneustes roseus*, *Brissus obessus*) and four holothuroids (*Holothuria* (*Halodeima*) *keffersteini*, *H. (Mertensiothuria) fuscocinerea*, *H. (Mertensiothuria) leucospilota* and *Isostichopus horrens*). From these, *A. insignis*, *B. obessus*, *H. keffersteini* and *I. horrens* also conformed new records for the Colombian Pacific. Only *O. simplex* and *B. obessus* were already stored in the MHNMC. It is important to mention that the shallow water species reported for the first time were observed during samplings in December and March while the deep sea species were referred mostly in the USNM reference list. Thus, 26 species mentioned as new records are stored in the collection of the USNM and/or MHNMC. Photographs of the remaining 10 species were taken, with the only exception of the holothuroid *Holothuria (Mertensiothuria) leucospilota*.

The shallow water starfishes *Narcissia gracilis malpeloensis* and *Tamaria stria* are endemic to the island and were described by Downey (1975) in The Biological Investigation of Malpelo Island from the Smithsonian Institution expedition in 1972. Also, *N. g. malpeloensis* is well represented in the USNM with six museum specimens.

At national level, according to Arboleda (2002) and Neira and Cantera (2005), Malpelo is one of the richest eco-regions with 39 shallow water species (0-200 m), followed by the eco-regions Gorgona and Pacific Ocean (IVEMAR 2000), both with 47 species. However, this study places Malpelo as the richest with a total of 84 shallow and deep water species.

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Despite the results for the country, MFFS shows the lowest richness from the Topical Eastern Pacific (TEP) islands, in comparison with the 114 shallow species from Galapagos, Ecuador (Maluf 1991) and 67 from Cocos Island, Costa Rica (Unpublished data from Juan José Alvarado). For example, for Malpelo only five ophiuroids were found, compared with a total of 11 from Galapagos (Hickman 1998) and 17 from Cocos Island (Unpublished data from Juan José Alvarado). This notorious difference could be the consequence of the methods used, which for this study did not include nocturnal immersions or rock removal in order to find cryptic and nocturnal organisms, where species such as *Astrodictyum panamense*, *Ophiocoma aethiops* and *O. alexandri* are considered present and even fairly common in other regions (Unpublished data from Juan José Alvarado; Hickman 1998).

When comparing the distribution of the echinoderms reported herein with those from other regions in the Pacific off the coast of Colombia, we can see the following particularity:

1. The asteroids *Nidorellia armata*, *Pentaceraster cumingi*, *Mithrodia bradleyi*, *Pharia pyramidatus* and *Phataria unifascialis*, the ophiuroids *Ophiocoma aethiops*, *O. alexandri*, *Ophiactis savignyi* and *Ophiothela* cf. *mirabilis*, the echinoids *Eucidaris thouarsi*, *Hesperocidaris asteriscus*, *Centrostephanus coronatus*, *Lytechinus pictus*, *Toxopneustes roseus* and *Tripneustes depressus*, and the holothuroids *Holothuria* (*Lessonthuria*) *pardalis*, *H. (Mertensiothuria) fuscocinerea*, *H. (Mertensiothuria) leucospilota*, *H. (Thymiosycia) hilla* and *H. (Thymiosycia) impatiens* are species that despite being present at Malpelo, are also spread in other regions of the Pacific coast of

Colombia, such as in Chocó, Ensenada de Utría, Bahía Málaga, Ensenada de Tumaco, the mouth of Guapi River, Playa Mulatos, Sanquianga, Baudó, Naya and Bahía de Buenaventura (Neira and Cantera 1988; Pardo-Ángel 1989; Pardo-Ángel and Neira 1990; Neira et al. 1992; Arboleda 2002; Neira and Cantera 2005).

2. The sea cucumbers *Holothuria hilla*, *H. pardalis*, *H. fuscocinerea* and *H. impatiens* are species that are exclusively shared with the island of Gorgona (Neira and von Prahll 1986; Neira and Cantera 2005).

3. The other species, mostly deep-sea ones, are only distributed at Malpelo.

Echinoderms found in MFFS are considered widespread, distributed from the Gulf of California, Galapagos islands, Peru and Chile (Maluf 1988; 1991; Hickman 1998; Edgar et al. 2004; Solís-Marín et al. 2005), being also related to the Panamanian and Galapagos region. Starfishes as *Acanthaster planci*, *Eremicaster pacificus*, *E. crassus gracilis* and the holothurians *H. keffersteini*, *H. fuscocinerea*, and *I. horrens* also occur in the Indo-Pacific region, indicating a possible connectivity between the eastern and western Pacific Oceans.

Based on the estimation made by Maluf (1991) who informed the presence of 50 species, this research enhanced the knowledge richness of MFFS in 68 %. Thus, the value of Malpelo as a World Heritage Site is established, where constant research on the marine ecosystems will not only create more tools of judgment and evidence in order to fulfil the statements of the Biological Diversity Convention, but will set the basis for the formulation of biodiversity conservation plans.

**Table 1.** Echinoderm species, genus, families and orders found in MFFS.

Class	Asteroidea	Ophiuroidea	Echinoidea	Holothuroidea	Total
Order	6	2	8	6	22
Family	14	8	11	11	42
Genera	21	14	17	16	68
Species	23	18	19	24	84

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**Table 2.** Echinoderm taxonomic checklist from the Malpelo Fauna and Flora Sanctuary. The abbreviations of the specimens stored at the two museums are: National Museum of Natural History (USNM), Smithsonian Institution, Washington D.C. and INV-EQUI from MHNMC. (•): New records for MFFS; (••): new records for the Colombian Pacific.

CLASSIFICATION	REFERENCE
<b>CLASS ASTEROIDEA</b>	
Order Paxillosida	
Family Astropectinidae	
<i>Astropecten sulcatus</i> Ludwig, 1905	USNM 34369
<i>Dytaster gilberti</i> Fisher, 1905 ••	USNM 34353, USNM 34359
Family Porcellanasteridae	
<i>Eremicaster pacificus</i> (Ludwig, 1905) •	USNM 34399
<i>Eremicaster crassus gracilis</i> (Sladen, 1883) ••	USNM 34393 - 34394
Order Notomyotida	
Family Benthopectinidae	
<i>Pectinaster agassizii</i> Ludwig, 1905 •	USNM 34329
Order Valvatida	
Family Gonisateridae	
<i>Mediaster elegans</i> Fisher, 1905	
Family Asterodiscididae	
<i>Amphiaster insignis</i> Verrill, 1868 ••	
Family Oreasteridae	
<i>Nidorellia armata</i> (Gray, 1840)	USNM E11835, INV-EQUI 2677
<i>Pentaceraster cumingi</i> (Gray, 1840)	
Family Asteropseidae	
<i>Asteropsis carinifera</i> (Lamarck, 1816)	USNM E11840
Family Acanthasteridae	
<i>Acanthaster planci</i> (Linnaeus, 1758) •	
Family Mithroididae	
<i>Mithrodia bradleyi</i> Verrill, 1870	USNM E11830
Family Ophidiasteridae	
<i>Leiaster teres</i> (Verrill, 1871)	USNM E11841
<i>Narcissia gracilis malpeloensis</i> Downey, 1975	USNM E11836 - E11837
<i>Pharia pyramidatus</i> (Gray, 1840)	
<i>Phataria unifascialis</i> (Gray, 1840) •	
<i>Tamaria stria</i> Downey, 1975	USNM E11838 - E11839, USNM E12431
Order Velatida	
Family Pterasteridae	
<i>Hymenaster gracilis</i> Ludwig, 1905 •	USNM 34367
<i>Hymenaster sp.</i> Wyville Thomson, 1873 ••	USNM 34370
Order Forcipulatida	
Family Asteroiidae	
<i>Distolasterias robusta</i> (Ludwig, 1905) •	USNM 34365
<i>Sclerasterias alexandri</i> Ludwig, 1905	USNM 34412
Order Brisingida	

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CLASSIFICATION	REFERENCE
Family Brisingidae	
<i>Astrolirus panamensis</i> (Ludwig, 1905)	USNM 34369
Family Freyellidae	
<i>Freyella insignis</i> (Ludwig, 1905) ••	USNM 34349
<b>CLASS OPHIUROIDEA</b>	
Order Phrynophiurida	
Family Gorgonocephalidae	
<i>Astrodictyum panamense</i> (Verrill, 1867)	USNM 1001273
Family Asteronychidae	
<i>Asteronyx plana</i> (Lutken & Mortensen, 1899)	USNM 19601
<i>Astrodia plana</i> Lutken & Mortensen, 1899	
Order Ophiurida	
Family Ophiuridae	
<i>Amphiophiura oblecta</i> Lutken & Mortensen, 1899 ••	USNM 19446
<i>Ophiocten hastatum</i> Lyman, 1878	USNM 19482, USNM 19483- 19484
<i>Ophiomusium lymani</i> Thomson, 1873	USNM 19508
<i>Ophiosphalma glabrum</i> (Lutken & Mortensen, 1899)	USNM 19492 - 19494
<i>Ophiura irrorata</i> (Lyman, 1878)	USNM 19453
<i>Ophiura plana</i> Lutken & Mortensen, 1899	USNM 19465
Family Ophiocomidae	
<i>Ophiocoma aethiops</i> Lutken, 1859	USNM 1001286
<i>Ophiocoma alexandri</i> Lyman, 1860	USNM 1001287, INV-EQUI 2679
Family Ophiacanthidae	
<i>Ophiacantha contigua</i> Lutken & Mortensen, 1899	USNM 19576
Family Ophiactidae	
<i>Histampica duplicata</i> (Lyman, 1875)	USNM 19518
<i>Ophiactis plana</i> Lyman, 1869	USNM 19516
<i>Ophiactis savignyi</i> (Muller & Troschel, 1842)	
<i>Ophiactis simplex</i> (Le Conte, 1851) ••	INV-EQUI 2679 - 2685
Family Amphiuridae	
<i>Amphiura assimilis</i> Lutken & Mortensen, 1899	USNM 19536
Family Ophiotrichidae	
<i>Ophiothela mirabilis</i> Verrill, 1867	INV-EQUI 2686 – 2687, INV-EQUI 3091
<b>CLASS ECHINOIDEA</b>	
Order Cidaroida	
Family Cidarridae	
<i>Aporocidaris milleri</i> (A. Agassiz, 1898)	USNM 21031, USNM 21064
<i>Eucidaris thouarsi</i> (Valenciennes, 1846)	
<i>Hesperocidaris asteriscus</i> H.L. Clark, 1948 •	
<i>Salenocidaris miliaris</i> (A. Agassiz, 1898)	USNM 21012
Order Echinothurioida	
Family Echinothuriidae	
<i>Tromikosoma hispidum</i> (A. Agassiz, 1989)	USNM 21047
<i>Tromikosoma panamense</i> (A. Agassiz, 1989)	USNM 21045

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CLASSIFICATION	REFERENCE
Order Diadematoidea	
Family Diadematidae	
<i>Centrostephanus coronatus</i> (Verrill, 1867) •	
<i>Diadema mexicanum</i> A. Agassiz, 1863	USNM E31318
Family Aspidodiadematidae	
<i>Plesiodiadema globulosum</i> (A. Agassiz, 1898)	USNM 21014
<i>Plesiodiadema horridum</i> (A. Agassiz, 1898)	USNM 21015, USNM 21030, USNM 21046
Order Arbacioidea	
Family Arbaciidae	
<i>Arbacia incisa</i> (A. Agassiz, 1863)	
Order Temnopleurida	
Family Toxopneustidae	
<i>Lytechinus pictus</i> (Verrill, 1867)	
<i>Toxopneustes roseus</i> (A. Agassiz, 1863) •	
<i>Tripneustes depressus</i> A. Agassiz, 1863	
Order Echinoida	
Family Echinometridae	
<i>Echinometra vanbrunti</i> A. Agassiz, 1863	USNM E31319, INV-EQUI 1494
Order Holasteroidea	
Family Urechinidae	
<i>Pilematechinus rathbuni</i> (A. Agassiz, 1904)	USNM 21010 – 21011, USNM 21029, USNM 21046
Order Spatangoida	
Family Brissidae	
<i>Brissus obessus</i> Verrill, 1867 ••	INV-EQUI 3090
Family Hemiasteridae	
<i>Hemiaster tenuis</i> (A. Agassiz, 1898) •	USNM 21062
Family Loveniidae	
<i>Homolampas hastata</i> (Agassiz, 1898)	USNM 21079
<b>CLASS HOLOTHUROIDEA</b>	
Order Dendrochirotida	
Family Cucumariidae	
<i>Abyssocucumis abyssorum</i> (Théel, 1886) •	USNM 18225
Order Dactylochirotida	
Family Ypsilohuriidae	
<i>Ypsilothuria bitentaculata</i> (Ludwig, 1893)	
Order Aspidochirotida	
Family Holothuriidae	
<i>Holothuria (Halodeima) kefersteini</i> (Selenka, 1867) ••	
<i>Holothuria (Lessonthuria) pardalis</i> Selenka, 1867	
<i>Holothuria (Mertensiothuria) fuscocinerea</i> Jaeger, 1833 •	
<i>Holothuria (Mertensiothuria) leucospilota</i> (Brandt, 1835) •	
<i>Holothuria (Thymiosycia) hilla</i> Lesson, 1830	USNM E23719
<i>Holothuria (Thymiosycia) impatiens</i> (Forskäl, 1775)	USNM E23717
<i>Holothuria (Platyperona) parvula</i> (Selenka, 1867)	USNM E23718

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CLASSIFICATION	REFERENCE
<i>Holothuria (Vaneyothuria) zaca</i> Deichmann, 1937	USNM E23714
Family Stichopidae	
<i>Isostichopus horrens</i> Selenka, 1867 ••	
<i>Stichopus fuscus</i> (Ludwig, 1874)	USNM E23715
Family Synallactidae	
<i>Bathylotes patagiatus</i> Fisher, 1907 •	USNM E2019
<i>Synallactes aenigma</i> Ludwig, 1894	USNM 18207
<i>Meseres macdonaldi</i> Ludwig, 1894	USNM 18190
<i>Pseudostichopus mollis</i> Théel, 1886	USNM 18270, USNM 18271
Order Elasipodida	
Family Deimatidae	
<i>Oneirophanta mutabilis affinis</i> Ludwig, 1894 •	USNM 18187, USNM 18188
<i>Oneirophanta mutabilis mutabilis</i> Théel, 1879 •	USNM 18201
Family Psychropotidae	
<i>Benthodytes sanguinolenta</i> Théel, 1882	USNM 18235
<i>Psychropotes longicauda</i> Théel, 1882 •	USNM 18172
Family Elpidiidae	
<i>Peniagone vitrea</i> Théel, 1882 ••	USNM 18244
Family Pelagothuriidae	
<i>Pelagothuria natatrix</i> Ludwig, 1894	
Order Molpadiida	
Family Molpadiidae	
<i>Molpadia musculus</i> Risso, 1826 •	USNM 18256
Order Apodida	
Family Synaptideae	
<i>Protankyra pacifica</i> Ludwig, 1894 •	USNM 18191

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