



Deep-sea echinoids and holothurians (Echinodermata) near cold seeps and coral communities in the northern Gulf of Mexico

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ABSTRACT.—Seven National Oceanic and Atmospheric Administration and United States Geological Survey expeditions employed manned submersibles or remotely operated vehicles to explore deep-sea coral and cold seep habitats in the northern central Gulf of Mexico continental slope, off Mississippi and Louisiana. Ten species of echinoids and 21 species of holothurians were collected and/or documented by still photography or videography in a relatively small area, in depths of 309–2549 m. New information on ecology, behavior, and distribution of echinoids and holothurians is provided. A new genus name is proposed to replace *Meseres* Ludwig, 1893, which is preoccupied. *Myriotrochus ahearnae*, a new species of apodous myriotrochid holothurian, is described.

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In recent years, much attention has been focused on benthic habitats in the Gulf of Mexico (GOM), in particular deep-sea coral reefs and cold seep sites (see, for example Schroeder et al. 2005, Reed et al. 2006, Lumsden et al. 2007, Cordes 2008, Roberts 2010). Interest in the northern GOM benthos increased dramatically following the 2010 Deepwater Horizon oil spill (Crone 2010, White et al. 2012). Several recent cruises in the GOM, off Florida, Mississippi, and Louisiana, sponsored by the United States Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA), have been aimed at increasing our knowledge and understanding of the habitats and events noted above.

Still and video imagery can provide extraordinarily valuable information on members of the benthic and bathypelagic megafauna. For recent examples, see Hoving and Vecchione (2012) and Pietsch et al. (2013) for GOM squid and fishes, respectively. For the echinoderms, numerous publications, such as those by Heezen and Hollister (1971), Pawson (1976, 1982), and more recently Bluhm and Gebruk (1999), Gebruk (2008), and Rogacheva et al. (2013), have revealed much about the autecology and synecology of deep-sea echinoderms. Ideally, imagery might be accompanied by specimens, but even when imagery alone is available, much can be learned.

During the cruises discussed below, numerous images and collections of benthic invertebrates were acquired; preliminary studies have revealed that, at least for the megafaunal echinoderms, the fauna of the region is more diverse than previously

reported (Pawson et al. 2009). Of the 31 species of echinoids and holothurians represented by images and/or specimens, and briefly described below, approximately 10 holothurian species are new to the documented GOM fauna (Pawson et al. 2009). This brings the number of echinoderm species now known from the Gulf of Mexico to approximately 522 (Pawson et al. 2009, the present study). In addition to new records and new taxonomic information, some previously unknown aspects of ecology of the echinoids and holothurians are discussed.

MATERIAL AND METHODS

Materials.—One-hundred-and-eighty-six echinoids and holothurians were collected (Table 1) during the expeditions described below, along with still images or “frame grabs” from videos made from submersibles and remotely operated vehicles (ROVs). All specimens are deposited in the National Museum of Natural History, Smithsonian Institution.

Specimens were collected during seven USGS and NOAA expeditions in the Gulf of Mexico: Chemo III in 2007, Lophelia I in 2004–2005, and Lophelia II in 2008–2010. Images obtained by the NOAA ship OKEANOS EXPLORER 2012 Expedition to the Gulf of Mexico are also included. The overall objectives of these expeditions were to discover and explore deep-sea coral and seep habitats in the north-central and eastern Gulf of Mexico, to determine and quantify the extent of the ahermatypic coral *Lophelia pertusa* (Linnaeus, 1758) in these regions, to sample the fauna in habitats adjacent to coral reefs, and to describe the faunal assemblage(s) associated with these habitats. A specific objective of the present study was to make taxonomic identifications, to the species level where possible, of echinoids and holothurians observed on and near deep-sea habitats.

Most collecting and imaging stations were occupied in the general vicinity of the Mississippi Canyon, southeast of the Mississippi River delta, in depths of approximately 316–1789 m; seven collecting and imaging stations were near the Sigsbee Escarpment in 1426–1789 m; five collecting and imaging stations were on the west Florida Slope in 422–497 m; and six imaging only stations were occupied near Keathley Canyon in 1917–2013 m.

A variety of gear was used for collecting specimens. These included bottom trawls, manned submersible (JOHNSON-SEA-LINK), and ROVs (SEA-EYE and KRAKEN II). A few individuals were incidental catches in fish traps. Methods specific for each gear type are summarized below.

(1) Bottom trawl.—Trawl sites were selected using multibeam sonar maps with the objective of deploying this bottom-sampling gear near, but not on, known deep-sea coral communities as well as sampling nearby soft substrata. The otter trawl (4.9 m head rope, 3.5 m width, 3.8 cm mesh) was deployed from the stern and towed for 30 min at approximately 2 kts (3.7 km hr^{-1}) ground speed.

(2) Remotely Operated Vehicle (KRAKEN II).—ROV dives followed a similar pattern, emphasizing near-bottom transecting, collecting, and photographing specimens or habitats on or near the bottom. During descent of the ROV, observations were made of distributions/behaviors of fauna. Position fixes were noted when the ROV landed on bottom, at each collection, at the sites of noteworthy observations, and when the ROV left bottom. Specimen collecting occurred throughout most

dives in pursuit of a variety of research goals, including taxonomy, ecology, trophic biology, genetics, microbiology, and other objectives. Samples were placed in the biobox (approximately 30 × 91 × 25 cm, constructed of insulated polypropylene, divided into three chambers), or were suctioned into one of eight suction sample buckets. Still photography (digital camera, Insite Pacific Scorpio) and video photography were conducted throughout each dive. Specimens were photographed on deck before they were preserved.

(3) Submersible (JOHNSON-SEA-LINK II, JSLII).—Submersible dives followed a similar pattern to that of the ROV, emphasizing bottom video transecting, collecting, and photographing specimens on or near the bottom. Position fixes were requested in the same manner as with the ROV. Specimens were collected with either a suction tube or manipulator arm and housed in a variety of containers including a 12-bucket rosette, front collecting basket, and other sampling containers. Still photography (digital camera) and video photography were conducted throughout the dive. Specimens were photographed on deck before they were preserved.

The majority of invertebrates were fixed and preserved in 75% ethanol. In the laboratory, all collections were sorted and curated. After identification, specimens were cataloged and incorporated into the Smithsonian Institution collections.

High-definition images of various urchins and holothurians were included in the material examined. ROV LITTLE HERCULES took these images during NOAA ship OKEANOS EXPLORER 2012 Gulf of Mexico Expedition. Individuals photographed occurred in similar habitats to those physically sampled during expeditions summarized above. The images published here, along with selected additional images, will be publicly available on the Encyclopedia of Life, and on other deep-sea databases yet to be selected.

In the following descriptions, standard station data are provided for each species, along with USNM catalog numbers, and also the size of most specimens (echinoids—horizontal diameter of the test; holothurians, total length, and other dimensions as necessary). In the synonymies, original and current names and references are provided, along with references to authoritative descriptions and/or illustrations. Brief comments are provided on taxonomy, ecology, and biogeography where appropriate. In the in situ images, sizes are often not available unless the specimens illustrated were also collected. In some images, laser dots (10 cm apart) may enable reasonably accurate calculation of the sizes of specimens.

Station Data.—Table 1 provides station data for specimens collected. For individuals represented by imagery only, relevant station data are provided under each species in “Images Examined.” For example, in *Cidaris rugosa* (H.L. Clark, 1907) below, “IMG_20120324” the date is March 24, 2012. Next follow decimal versions of latitude (°N) and longitude (°W), preceded by a “–” symbol, and the depth in meters (m).

Abbreviations and Terminology.—GOM = Gulf of Mexico. MBARI = Monterey Bay Aquarium Research Institute, California. USNM1191541 is an example of a National Museum of Natural History, Smithsonian Institution, catalog number. HD = horizontal diameter of the test (skeleton) of a sea urchin. LS = longest spine of a sea urchin. TL = total length of a sea cucumber.

Table 1. Station data for specimens described in the present study.

Station no.	Date	Location	Gear	Start latitude	Start longitude	End latitude	End longitude	Depth range (m)
CH-2007-026	11-Aug-2007	GC852	OT - 4.877 m	27°06.965	91°09.951	27°06.086	91°09.688	1426-1521
CH-2007-027	11-Aug-2007	GC852	OT - 4.877 m	27°06.887	91°09.796	27°07.921	91°09.815	1426-1564
CH-2007-040	12-Aug-2007	GC852	OT - 4.877 m	27°03.707	91°09.564	27°02.603	91°09.599	1667-1704
CH-2007-042	12-Aug-2007	GC852	OT - 4.877 m	27°09.628	91°09.915	27°10.643	91°09.879	1478-1574
CH-2007-074	14-Aug-2007	GC852	OT - 4.877 m	27°09.061	91°10.164	27°07.977	91°10.161	1630-1789
CH-2010-006	22-Sep-2010	VK826	OT - 3.487 m	29°10.103	88°01.232	29°09.883	88°00.159	489-500
CH-2010-007	22-Sep-2010	VK826	OT - 3.487 m	29°09.962	88°01.049	29°09.749	88°01.193	478-500
CH-2010-011	23-Sep-2010	VK826	OT - 3.487 m	29°10.084	88°01.908	29°10.083	88°00.682	471-515
CH-2010-082	30-Sep-2010	West Florida Slope	Trawl - Tucker 2 m	29°12.338	84°43.014	29°12.004	84°44.975	315-364
JSL-2004-4744	30-Jul-2004	VK862 / VK906	JOHNSON-SEA-LINK I DSR/V	29°35.40	88°49.03	unknown	unknown	309-314
JSL-2004-4747	31-Jul-2004	VK862	JOHNSON-SEA-LINK I DSR/V	29°06.40	88°23.03	unknown	unknown	309-317
JSL-2004-4748	01-Aug-2004	VK862	JOHNSON-SEA-LINK I DSR/V	29°09.43	88°00.58	unknown	unknown	444-447
JSL-2004-4751	02-Aug-2004	VK862	JOHNSON-SEA-LINK I DSR/V	29°10.13	88°00.41	unknown	unknown	451-472
JSL-2004-4752	03-Aug-2004	VK862	JOHNSON-SEA-LINK I DSR/V	29°10.13	88°00.45	unknown	unknown	467-472
JSL-2005-4876	17-Sep-2005	VK906/VK862	JOHNSON-SEA-LINK I DSR	29°06.25	88°23.05	unknown	unknown	317-325
JSL-2005-4880	19-Sep-2005	VK862	JOHNSON-SEA-LINK I DSR/V	29°09.37	88°01.08	unknown	unknown	437-462
JSL-2005-4881	20-Sep-2005	VK862	JOHNSON-SEA-LINK I DSR/V	29°09.34	88°01.08	unknown	unknown	445-451
JSLII-2009-GOM-3723	16-Sep-2009	West Florida Slope	JOHNSON-SEA-LINKII DSR/V	26°12.4273	84°42.7262	26°12.7100	84°42.8279	414-428
JSLII-2009-GOM-3725	18-Sep-2009	VK862/VK906	JOHNSON-SEA-LINK II DSR/V	29°04.1462	88°22.5670	29°04.1667	88°22.6366	388-416
JSLII-2009-GOM-3726	19-Sep-2009	MC751	JOHNSON-SEA-LINK II DSR/V	28°11.6231	89°47.9398	28°11.7438	89°48.0501	434-438
JSLII-2009-GOM-3728	20-Sep-2009	VK862/VK906	JOHNSON-SEA-LINK II DSR/V	29°06.3761	88°22.9815	29°06.4038	88°23.1007	316-336
JSLII-2009-GOM-3730	21-Sep-2009	VK862/VK906	JOHNSON-SEA-LINK II DSR/V	29°05.0396	88°23.8196	29°05.2727	88°23.8715	396-419
JSLII-2009-GOM-3731	21-Sep-2009	VK862/VK906	JOHNSON-SEA-LINK II DSR/V	29°04.0984	88°22.7135	29°04.1397	88°22.6705	394-424
JSLII-2009-GOM-3732	22-Sep-2009	VK862/VK906	JOHNSON-SEA-LINK II DSR/V	29°06.5494	88°23.2500	29°06.4766	88°23.1176	312-354
JSLII-2009-GOM-3733	22-Sep-2009	VK826	JOHNSON-SEA-LINK II DSR/V	29°09.7694	88°00.5860	29°09.9620	88°00.7076	471-477
JSLII-2009-GOM-3735	23-Sep-2009	VK826	JOHNSON-SEA-LINK II DSR/V	29°10.2592	88°00.8034	29°10.2485	88°00.6861	464-484
JSLII-2009-GOM-3736	24-Sep-2009	VK826	JOHNSON-SEA-LINK II DSR/V	29°10.2541	88°00.6682	29°10.1867	88°00.6931	476-477
NF-2008-035	09-Oct-2008	VK862/VK906	OT - 4.877 m	29°06.979	88°21.174	29°06.447	88°22.155	364-365

Table 1. Continued.

Station no.	Date	Location	Gear	Start latitude	Start longitude	End latitude	End longitude	Depth range (m)
NF-2008-039	09-Oct-2008	VK862/VK906	Traps	29°06.302	88°23.137	29°06.302	88°23.137	335–335
NF-2008-043	10-Oct-2008	VK862/VK906	OT - 4.877 m	29°03.530	88°21.898	29°03.530	88°22.791	512–532
NF-2008-054	11-Oct-2008	VK826	OT - 4.877 m	29°10.424	88°02.098	29°11.177	88°01.373	457–502
NF-2008-056	12-Oct-2008	VK826	OT - 4.877 m	29°10.439	87°59.971	29°11.077	87°58.727	497–525
NF-2008-072	13-Oct-2008	VK826	OT - 4.877 m	29°08.844	88°02.976	29°09.456	88°02.089	534–557
NF-2008-073	13-Oct-2008	VK826	OT - 4.877 m	29°08.292	88°01.722	29°08.965	88°01.007	610–674
NF-2008-074	13-Oct-2008	VK826	OT - 4.877 m	29°09.255	87°59.606	29°08.928	87°58.669	645–744
ROV-2008-001	07-Oct-2008	VK826	ROV-SEA-EYE	29°09.664	88°01.095	29°09.939	88°01.009	415–452
ROV-2008-004	10-Oct-2008	VK826	ROV-SEA-EYE	29°10.185	88°00.683	29°10.289	88°00.604	466–473
ROV-2010-CH-001	21-Sep-2010	VK826	ROV-KRAKEN II	29°09.7102	88°00.6177	29.09.7200	88.01.2690	452–507
ROV-2010-CH-002	22-Sep-2010	VK826	ROV-KRAKEN II	29°10.191	88°00.873	29°10.179	88°00.757	435–485
ROV-2010-CH-003	23-Sep-2010	VK826	ROV-KRAKEN II	29°10.259	88°00.817	29°10.3238	88°00.7175	465–499
ROV-2010-CH-004	24-Sep-2010	VK862	ROV-KRAKEN II	29°06.444	88°23.456	29°10.3238	88°00.7175	360–371
ROV-2010-CH-005	25-Sep-2010	VK862	ROV-KRAKEN II	29°04.350	88°22.975	29°04.4956	88°22.6994	401–435
ROV-2010-CH-007	28-Sep-10	West Florida Slope	ROV-KRAKEN II	26°12.506	84°43.583	26°12.4392	84°43.5148	488–497
ROV-2010-CH-010	01-Oct-2010	West Florida Slope	ROV-KRAKEN II	26°20.1536	84°45.6766	26°20.0820	84°43.3350	422–514
SJ-2009-GOM-030	20-Sep-2009	VK862/VK906	Traps	29°06.283	88°23.091	29°06.394	88°23.282	451–451
SJ-2009-GOM-031	20-Sep-2009	VK862/VK906	Traps	29°06.390	88°23.140	29°06.523	88°23.482	325–350

COMMENTS ON IMAGES

Although some of the images on Figures 1–4 are extraordinary and informative, they at the same time have their limitations. They provide some useful details on the preferred habitats and lifestyles of the animals shown. In some cases, but not all, red laser dots 10 cm apart appear in the images, and the size of the animals can be determined. In other cases, shells of the pteropod *Clio* sp. on the seabed can be used as approximate indicators of size, for these shells average approximately 10 mm across. Unfortunately, the images of the several possibly new holothurians do not provide enough detail to warrant formal characterization as new species on the basis of images alone, such as was done in the case of *Peniagone leander* Pawson and Foell, 1986.

ECHINODERMS AT COLD SEEPS AND CORAL COMMUNITIES

With a few notable exceptions, such as apodous holothurians (Smirnov et al. 2000, Pawson and Vance 2004, 2005) and sea stars (MacAvoy et al. 2002, 2005), echinoderms seldom exploit cold seeps and their closely associated biota as food sources (Carney 2010). Of the 52 images of echinoids and holothurians forming the basis of the present study, only two showed echinoids, both of them *Gracilechinus alexandri* (Danielssen and Koren, 1882) (Fig. 1F), associated with seep site mussels (*Bathymodiolus* sp). In contrast, echinoderms that live epizoically, such as suspension feeding comatulid crinoids and euryalid ophiuroids, can be common in ahermatypic coral habitats. Some asteroids use these corals as a food source (for example, see Mah et al. 2010). But in the general vicinity of cold seeps and coral communities, where soft sediments may be organically enriched, echinoderms, holothurians in particular, can be numerous.

Class Echinoidea

Order Cidaroida

Family Cidaridae Gray, 1825

Cidaris rugosa (H.L. Clark, 1907)

(Figure 1A)

Dorocidaris rugosa.—Clark (1907): 210, pls. 4–5, 7 figs. 5–8.

Cidaris rugosa.—Phelan (1970): 11, pl. 6 figs. 2, 4, 6; pl. 7 figs. 2–5, 9; pl. 8 figs. 6, 7, 9; pl. 10, fig. 1.

Material Examined.—Forty-eight specimens: JSLII2009-GOM-3725, 1 sp., USNM 1191541; JSLII-2009-GOM-3726, 1 sp., USNM 1191542; JSLII-2009-GOM-3728, 1 sp., horizontal diameter 27 mm, longest spine 32 mm, USNM 1191538; JSLII 2009-GOM-3730, 3 sp., USNM 1191544; JSLII 2009-GOM-3732, 1 sp., HD 35 mm, LS 40 mm, USNM 1191546; JSLII 2009-GOM-3733, 1 sp, 1191547; JSLII 2009-GOM-3735, 5 sp., HD 60 mm, LS 90 mm; HD 50 mm, LS 95 mm; HD 55 mm, LS 80 mm, USNM 1191548; JSLII 2009-GOM-3736, 1 sp., USNM 1191554; NF-2008-035, 1 sp., USNM 1191555; NF-2008-039, 6 sp., HD 23 mm, LS 46 mm; HD 33 mm, LS 52 mm, USNM

1191556-61; ROV-2008-004, 1 sp., HD 51 mm, LS 85 mm, USNM 1191562; ROV-2010-CH-001, 3 sp., USNM 1191563; ROV-2010-CH-004, 10 sp., USNM 1191564; ROV-2010-CH-005, 2 sp., HD 59 mm, LS 87 mm, USNM 1191575; SJ-2009-GOM-030, 4 sp., USNM 1191576; SJ-2009-GOM-031, 8 sp., USNM 1191577.

Images Examined.—EX1202L2_IMG_20120324T145156Z_ROVHD, 28.50242417, -87.485078000000, 2464 m (Fig. 1A).

Diagnosis.—Primary spines brownish, circular in cross-section, all equipped with spinules, rough to touch. Oral primaries neither curved nor serrate. Large globiferous pedicellariae, each with distinct end tooth (after Serafy 1979).

Distribution.—East coast of USA, Caribbean Sea, southeastern Gulf of Mexico, 46–790 m (from Pawson et al. 2009). The new locality information extends the known range of the species to the northern Gulf of Mexico.

Habitat.—Hard substrates apparently preferred.

Remarks.—Phelan (1970) provided detailed descriptions of this species and of the closely-related *C. abyssicola*. However, these species can be readily distinguished in the laboratory. The aboral primary spines are usually brownish, have well-developed spinules, and are rough to the touch in *C. rugosa* whereas the aboral primary spines are smooth to the touch and usually whitish in *C. abyssicola* (after Serafy 1979). These species can be difficult to distinguish in bottom imagery. The image shown here (Fig. 1A) is presumed to be of *C. rugosa*, because the aboral primary spines are brownish, and the spines generally appear to have conspicuous longitudinal ridges.

Cidaris abyssicola (A. Agassiz, 1869)

Dorocidaris abyssicola.—Agassiz (1869): 253.

Cidaris abyssicola.—Mortensen (1928): 301; Phelan (1970): 9, pl. 1 fig. 7; pl. 4 figs. 1–6; pl. 5 figs. 1–6.

Material Examined.—Twelve specimens: JSL-2004-4744, 1 sp., HD 38 mm, LS 48 mm, USNM 1191616; JSL-2004-4747, 1 sp., HD 35 mm, LS 42 mm, USNM 1191615; JSL-2004-4748, 1 sp., HD 40 mm, LS 80 mm, USNM 1191531; JSL-2005-4876, 1 sp., HD 47 mm, LS 52 mm, USNM 1191532; JSL-2005-4880, 1 sp., HD 52 mm, LS 74 mm, USNM 1191533; JSL-2005-4881, 1 sp., HD 26 mm, LS 50 mm, 1191534; JSLII-2009-GOM-3728, 5 sp., HD 37 mm, LS 39 mm, HD 31 mm, LS 40 mm; HD 30 mm, LS 40 mm; HD 33 mm, LS 48 mm; HD 27 mm, LS 32 mm, USNM 1191539; NF2008-039, 1 sp., HD 30 mm, LS 47 mm, USNM 1191540.

Images Examined.—None.

Diagnosis.—Primary spines whitish, those above the ambitus smooth with reduced spinules. Below ambitus, spines with longitudinal ridges. Oral primaries neither curved nor serrate. Large globiferous pedicellariae, each with distinct end tooth (after Serafy 1979).

Distribution.—East coast of the USA, Caribbean, northeast and southeast Gulf of Mexico, 13–800 m (Pawson et al. 2009). The new locality information extends the known range of the species to the north central Gulf of Mexico.

Habitat.—Hard substrates.

Remarks.—See remarks for *C. rugosa* above.

Order Echinothurioida

Family Phormosomatidae Mortensen, 1934

Phormosoma placenta Thomson, 1872

(Figure 1B)

Phormosoma placenta.—Thomson (1872): 494. Mortensen (1935): 125, pl.1 figs. 1–5; pl. 2 figs. 1–19; pl. 74 figs. 1–6, 19; Gage et al. (1985): 181.

Material Examined.—None.

Images Examined.—EX1202L2_IMG_20120326T162730Z_ROVHD, 28.67797000000, -87.553804000000, 2253.9 m, 1 specimen; EX1202L2_IMG_20120326T165910Z_ROVHD, 28.677903833333, -87.553227500000, 2239 m, 3 specimens; EX1202L2_IMG_20120402T181929Z_ROVHD, 28.6315835, -88.17355367N, 1896.4 m, 1 specimen (Fig. 1B); EX1202L2_IMG_20120403T153835Z_ROVHD, 28.725513666667, -88.248156833333, 1586.3 m, 1 specimen.

Diagnosis.—Primary spines on oral surface lack whitish terminal hooves. Primary spines on upper surface covered with conspicuous fleshy sacs.

Distribution.—North and south Atlantic Ocean, 50–3700 m (Gage et al. 1985, Pawson et al. 2009).

Habitat.—Soft sediments.

Remarks.—It is impossible to tell, from images alone, whether these specimens represent the subspecies *P. placenta placenta* Thomson, or *P. placenta sigsbei* A. Agassiz. Mortensen (1935) discusses the status of these subspecies in some detail, and Serafy (1979), Pawson et al. (2009), and others record both subspecies from the Gulf of Mexico.

This species has pointed oral-surface spines, lacking the white hooves found in other echinothurioid taxa. The easily-removed fleshy sacs covering aboral spines in this species can vary greatly in number, with a maximum of about 20 recorded (Emson and Young 1998). Their specific function is unknown, but Emson and Young suggested that they may be sacrificial in nature. Predators can readily remove these sacs, leaving the rest of the animal intact. The notion that the sacs may be buoyant, and may assist this animal in moving on soft substrates, was disproved, for when the sacs were removed from individuals in situ, the sacs sank to the seabed (Pawson, in litt. 1984, and Emson and Young 1998). The large lecithotrophic eggs of this species are buoyant, and eggs produced at bathyal depths may develop at or near the ocean surface, thereby enhancing dispersal possibilities (Young and Cameron 1987).

Order Echinoida
Family Echinidae Gray, 1825
Genus *Gracilechinus* Fell and Pawson, 1966

Gracilechinus.—Fell and Pawson (1966): U431, fig. 322, 1a,b. Minin et al. (2015): 253.

Echinus.—Linnaeus (1758): 663, in part.

Type species.—*Echinus gracilis*.—Agassiz (1869): 261, by original designation.

Diagnosis.—Like *Echinus*, but with primary tubercle on every ambulacral plate (partly after Fell and Pawson 1966).

Remarks.—Mortensen (1943, p. 24) provided a key to the then-known species of the genus *Echinus*. One group of 12 species was immediately distinguished by having a primary tubercle on every second or third ambulacral plate. Another group of 10 species had primary tubercles on every ambulacral plate. This latter group was assigned to a new genus, *Gracilechinus* (Fell and Pawson 1966). Although this genus name was little used over the next 30 years, it has been accepted recently by two authoritative online databases, The World Echinoidea Database and The Echinoid Directory. In both databases, eight species are listed under *Gracilechinus*. Four species occur in the western Atlantic: *Gracilechinus affinis* (Mortensen, 1903); *Gracilechinus gracilis* (A. Agassiz, 1869); *Gracilechinus tylodes* (H.L. Clark, 1912); and *Gracilechinus alexandri* (Danielssen and Koren, 1882). The apparently rare species *Echinus wallisi* A. Agassiz, 1880, which ranges from Cape Cod to Georgia in 460–1885 meters depth, is the only member of *Echinus* sensu stricto currently known from the western Atlantic. An illustrated key to these western Atlantic Echinidae species is provided in Serafy and Fell (1985). Minin et al. (2015) provide a morphological and molecular analysis of the Pacific Ocean species of *Gracilechinus*.

Gracilechinus gracilis (A. Agassiz, 1869)
(Figure 1C)

Echinus gracilis.—Agassiz (1869): 261; Mortensen (1943): 70. pl. 15 figs. 1–4; pl. 55 figs. 11–13, 18, 22; Serafy and Fell (1985): 14, 22, fig. 27.

Gracilechinus gracilis.—Fell and Pawson (1966): U431, fig. 322, 1b.

Material Examined.—Two specimens: JSLII-2009-GOM-3723, 1 sp., HD 87 mm, USNM 1191608; JSLII-2009-GOM-3728, 1 sp., HD 56 mm, USNM 1191609.

Images Examined.—EX1202L2_IMG_30120322T195220Z_ROVHD, 26.438514000000, -84.764864833333, 401.7 m, 1 specimen.

Diagnosis.—Test more or less spherical, up to 100 mm diameter, dark green, pore zones and triangular patch below each primary tubercle white. Primary ambulacral tubercles equal in size, in regular series (after Serafy and Fell 1985).

Distribution.—Western North Atlantic, from Massachusetts south to Florida and Yucatán in 365–3150 m (Tyler et al. 1995, Pawson et al. 2009).

Habitat.—Usually on hard substrates.

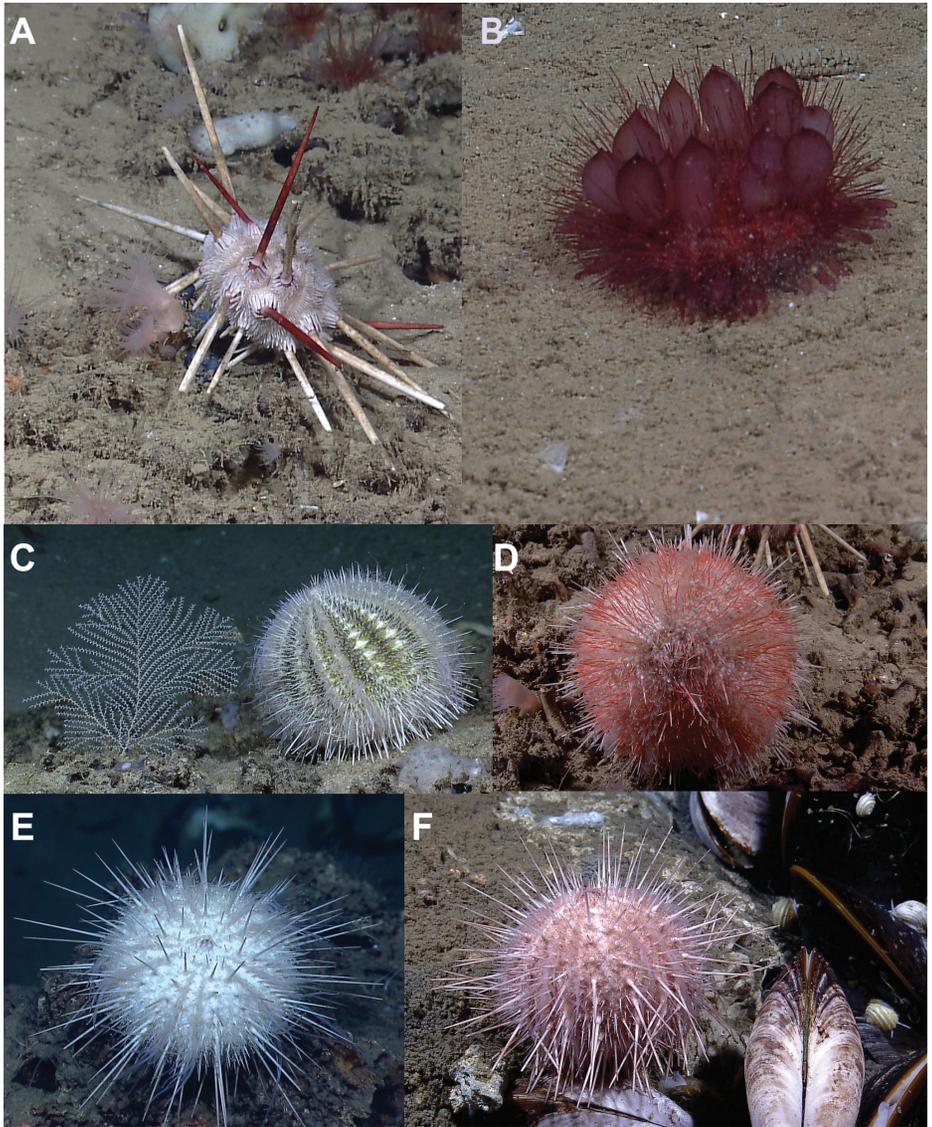


Figure 1. Gulf of Mexico deep-sea echinoids in situ. (A) *Cidaris rugosa*, (B) *Phormosoma placenta*, (C) *Gracilechinus gracilis*, (D) *Gracilechinus tyloides*, (E) *Gracilechinus affinis*, (F) *Gracilechinus alexandri*.

Remarks.—This beautiful species seems to vary little in color. Mortensen (1943) notes “General color of the test is green, but there is a very conspicuous white lozenge below each primary interambulacral tubercle. The tubercles are white. The interporiferous zones of the ambulacra may have green zig-zag bands...” Spines are white, sometimes light brownish distally. The apex is green, but the distal areas of the genital plates and periproctal plates are white.

In the specimen shown here (Fig. 1C), secondary spines are white, and tube feet are grayish-white.

Gracilechinus tylodes (H.L. Clark, 1912)

(Figure 1D)

Echinus tylodes.—Clark (1912): 269, pl. 93 figs. 11–15; pl. 109 figs. 1–3; Mortensen (1943): 68, pl. 15 figs. 5–6; pl. 55 figs. 6, 7, 9, 10, 21; Serafy and Fell (1985): 15, 22, fig. 28.

Material Examined.—Twenty-eight specimens: JSL-2004-4751, 1 sp., HD 66 mm, USNM 1191585; JSL-2004-4751, 1 sp., HD 71 mm, USNM 1191610; JSL-2004-4752, 1 sp., HD 77 mm, USNM 1191586; JSL-2005-4880, 1 sp., HD 58 mm, USNM 1191587; JSLII-2009-GOM-3722, 1 sp., HD 57 mm, USNM 1191611; JSLII-2009-GOM-3725, 1 sp., HD 70 mm, USNM 1191588; JSLII-2009-GOM-3731, 3 sp., HD 64, 65, 67 mm, USNM 1191589-91; JSLII-2009-GOM-3731, 1 sp., HD 67 mm, USNM 1191612; JSL-2009-GOM-3735, 1 sp., HD 57 mm, USNM 1191596; JSLII-2009-GOM-3735, 4 sp., HD 57, 65, 71 mm, USNM 1191593-96; JSLII-2009-GOM-3736, 1 sp., HD 47 mm, USNM 1191597; ROV-2008-001, 1 sp., HD 46 mm, USNM 1191598; ROV-2008-004, 3 sp., HD 58, 63 mm, 1191599-601; ROV-2010-CH-002, 1 sp., HD 70 mm, USNM 1191602; ROV-2010-CH-003, 3 sp., HD 35, 55, 62 mm, USNM 1191603-05; ROV-2010-CH-007, 1 sp. HD 101 mm, USNM 1191606; ROV-2010-CH-007, 1 sp., HD 73 mm, USNM 1191582; ROV-2010-CH-007, 1 sp., HD 73 mm, USNM 1191582; ROV-2010-CH-010, 1 sp., HD 61 mm, USNM 1191607.

Images Examined.—EX1202L2_IMG_20120328T151312Z_ROVHD, 29.473994500000, -86.8541301666667, 410.6 m, 1 specimen (Fig. 1D).

Diagnosis.—Test almost globular, whitish, height 75% of horizontal diameter. Primary ambulacral tubercles in regular-sized series. Regions above and below primary tubercles raised, appearing as vertical ridges (after Serafy and Fell 1985).

Distribution.—Western North Atlantic, from Maine to Florida, and the southeastern Gulf of Mexico, in 350–810 m (Tyler et al. 1995, Pawson et al. 2009). The current record, on the continental slope, south of Pensacola, Florida, at a depth of 411 m, extends the known distribution to the northern Gulf of Mexico.

Habitat.—Hard and soft substrates.

Remarks.—Mortensen (1943 p. 69) notes “The spines are light pink with white tips; the test is white.” In our alcohol-preserved material the test is dirty white, sometimes with light orange-pink areas adapically in the ambulacra; the primary and secondary spines are light to dark orange, fading to whitish distally. The individual shown here (Fig. 1D) illustrates the typical color pattern of this distinctive species. Note the relatively large size of the gray tube feet, suggesting this is a small specimen. This species appears to be relatively abundant given that it was the most commonly collected urchin during these expeditions.

Gracilechinus affinis (Mortensen, 1903)

(Figure 1E)

Echinus affinis.—Mortensen (1903): 100, 150, 179, pl. 5 figs. 4–8; pl. 15 figs. 3, 10; pl. 16 figs. 6, 20; pl. 18 figs. 4, 16, 28; pl. 19 fig. 27; pl. 20 figs. 17, 21. Mortensen (1943): 83, pl. 11 figs. 1–7; pl. 55 figs. 15, 17, 19; Serafy and Fell (1985): 14, 21, fig. 26; Gage et al. (1985): 183.

Material Examined.—None.

Images Examined.—EX1202L2_IMG_20120406T152243Z_ROVHD, 28.977276666667, -88.03175966667, 1150.2 m, 1 specimen (Fig. 1E).

Diagnosis.—Test low, height 50%–60% of horizontal diameter, white. Primary ambulacral tubercles of unequal size in a column, or in adjoining columns. All ocular plates exsert (after Serafy and Fell 1985).

Distribution.—North Atlantic, Ireland to Newfoundland, Azores, off US east coast and in the Gulf of Mexico, 241–3136 m (Pawson et al. 2009).

Habitat.—Prefers hard substrates.

Remarks.—The image shown is probably, but not certainly, an individual of *G. affinis*. The white color is often distinctive. Gage et al. (1985) discuss several aspects of the biology of this well-known species.

Gracilechinus alexandri (Danielssen and Koren, 1882)

(Figure 1F)

Echinus alexandri.—Danielssen and Koren (1882): 294, pl. 3, pl. 4 figs. 7–16; Mortensen (1943): 65, pl. 11 figs. 8–11; Serafy and Fell (1985): 15, 22, fig. 29; Gage et al. (1985): 184.

Material Examined.—Three specimens: ROV-2010-CH-003, 1 sp., HD 69 mm, USNM 1191583; ROV-2010-CH-005, 1 sp., HD 59 mm, USNM 1191584; ROV-2010-CH-007, 1 sp., USNM 1191582.

Images Examined.—EX1202L2_IMG_20120406T200247Z_ROVHD, 28.978555500000, -88.030332833333, 1120.5 m, 1 specimen (Fig. 1F).

Diagnosis.—Test low, conical, or flattened above. Primary ambulacral tubercles in regular-sized series. Primary spines long and slender. Primary ambulacral tubercles become abruptly smaller on aboral surface of test (after Serafy and Fell 1985).

Distribution.—Eastern and western North Atlantic, along the east coast of the United States, and southwestern Gulf of Mexico, in 365–3150 m. (Tyler et al. 1995, Pawson et al. 2009). The present record, northern Gulf of Mexico, south of Mobile, Alabama, in 1121 m, extends the known distribution into the northern Gulf of Mexico.

Habitat.—Hard and soft substrates.

Remarks.—Mortensen (1903) does not comment directly on the color in this species, but he notes that Koehler's (1896) material was rose-carmine in life, with the spines of the same color, but darker distally. The test and spines are dirty whitish to light brown, the spines rarely light olive greenish at the base in preserved material at the USNM. The individual in situ (Fig. 1F) has a light variegated rose-colored test, and the spines are whitish basally, often with pinkish distal areas.

Order Spatangoida
Family Brissidae Gray, 1855
Brissopsis alta Mortensen, 1907

Brissopsis alta.—Mortensen (1907): 159, pl. 3 figs. 5, 8, 9, 13, 16; pl. 18 figs. 7, 24, 26, 27. Chesher (1968): 15, figs. 2, 4–10, pls. 1–5, 11g; Turner and Norlund (1988): 890, fig. 3C.

Material Examined.—One specimen: NF-2008-035, 1 sp. TL 24 mm, USNM 1191530.

Diagnosis.—Posterior paired petals divergent, first primary tubercles of interambulacral columns 5.a, 5.b occurring 1–2 plates behind apical system; peripetalous fasciole without re-entrant angle in interambulacral column 3.a, crossing plates 3.a.4, 3.b.4; 2 pairs of pre-anal plates; first anal plates are 5.a.6, 5.b.6; subanal fasciole crossing 4 ambulacral plates on each side (from Turner and Norlund 1988, Pawson et al. 2009).

Distribution.—From the mouth of the Mississippi River in 216–310 m, and from Dry Tortugas to Fort Pierce, Florida, in 90–210 m (Chesher 1968).

Habitat.—Burrowing in muddy substrates.

Remarks.—The single specimen is damaged, and some diagnostic characters are destroyed or, in the case of globiferous pedicellariae, absent. We were able to determine that the labrum does not extend beyond the first adjoining ambulacral plate, and that the posterior petals are divergent proximally, not confluent. According to Chesher's (1968) key to Atlantic species of *Brissopsis*, these characters place the current specimen in a group of species which comprise *B. alta* and *B. lyrifera* sensu lato. While Turner and Norlund (1988) showed that labral extension is not a reliable character in *Brissopsis*, the presence of diverging posterior petals in the current specimen indicates that it is *B. alta*.

Order Clypeasteroida
Family Echinocyamidae Lambert and Thiéry, 1914
Echinocyamus grandiporus Mortensen, 1907

Echinocyamus grandiporus.—Mortensen (1907): 33, pl. 12 figs. 1, 3, 5, 8, 10–16, 21, 25, 28. Mironov (2006): 112.

Material Examined.—One specimen: CH-2010-082, 1 sp., TL 5.5 mm, USNM 1191578.

Diagnosis.—Periproct inframarginal. Petals well developed, but not reaching edge of test. Periproct round or transverse oval. Ocular pores as large as genital pores (after Mortensen 1948).

Distribution.—Mironov (2006) noted that this species occurs off the Azores, Canaries, Western Sahara, and the western Atlantic from Florida to Brazil in 110–1880 m depth, and at several northeastern Atlantic seamounts in 305–1910 m.

Pawson et al. (2009) report the bathymetric range as 150–2500 m. This is the first record of the species from the northern Gulf of Mexico.

Habitat.—Sand.

Class Holothuroidea
Order Aspidochirotida
Family Synallactidae Ludwig, 1894
Genus *Benthothuria* Perrier, 1898

This genus, comprising approximately four nominal species, was formerly assigned to the family Gephyrothuriidae Koehler and Vaney, 1905. O’Loughlin (1998) reviewed the Gephyrothuriidae and restricted its content, endorsing Deichmann’s (1940) opinion on the content of the family, and referred the Gephyrothuriidae to the order Molpadida. *Benthothuria* and other taxa were referred to the family Synallactidae. A key to the species of *Benthothuria* is provided by Heding (1940). As ossicles are absent from the body wall, it is often necessary to dissect specimens to determine their affinities.

Benthothuria funebris R. Perrier, 1898
(Figure 2A–C)

Benthothuria funebris.—Perrier (1898): 1665; 1902 365; Heding (1940): 363; Heding (1942): 6; Gage et al. (1985): 194; Rogacheva et al. (2013): 219; Gebruk et al. (2014): 166.
Benthothuria valdiviae.—Heding (1940): 365.

Material examined.—None.

Images Examined.—EX1202L3_IMG_20120427T193845Z_ROVHD, 26.303925000000, -93.438209000000, 1917 m, 1 specimen; EX1202L2_IMG_20120234T172453Z_ROVHD, 28.50362617, -87.484944000000, 2381.4 m, 1 specimen (Fig. 2C); EX1202L2_IMG_20120324T145243Z_ROVHD, 28.50236683, -87.485179000000, 2463 m, 1 specimen (Fig. 2B); EX1202L2_IMG_20120324T145156Z_ROVHD, 28.50242417, -87.485078000000, 2463.6 m, 1 specimen (Fig. 2A).

Diagnosis.—No large ambulacral papillae on the dorsal side. Longitudinal muscles unpaired. One polian vesicle (after Heding 1940).

Distribution.—Atlantic Ocean from off NW Africa and SW Greenland in 782–2996 m (Gage et al. 1985). The present records confirm the presence of this species in the North Central Gulf of Mexico in depths of 1698 to 2463 m. *B. funebris* is also known from the southern Indian Ocean in 4636 m (as *B. valdiviae*; Heding 1940), and from off Tanzania (AR Gates, National Oceanography Centre, Southampton, UK, pers comm). For details, see Gebruk et al. (2014).

Remarks.—Of the three individuals shown here (Fig. 2A–C), one (Fig. 2A) is resting on the seafloor, and two (Fig. 2B, C) are actively swimming. In all, it is notable

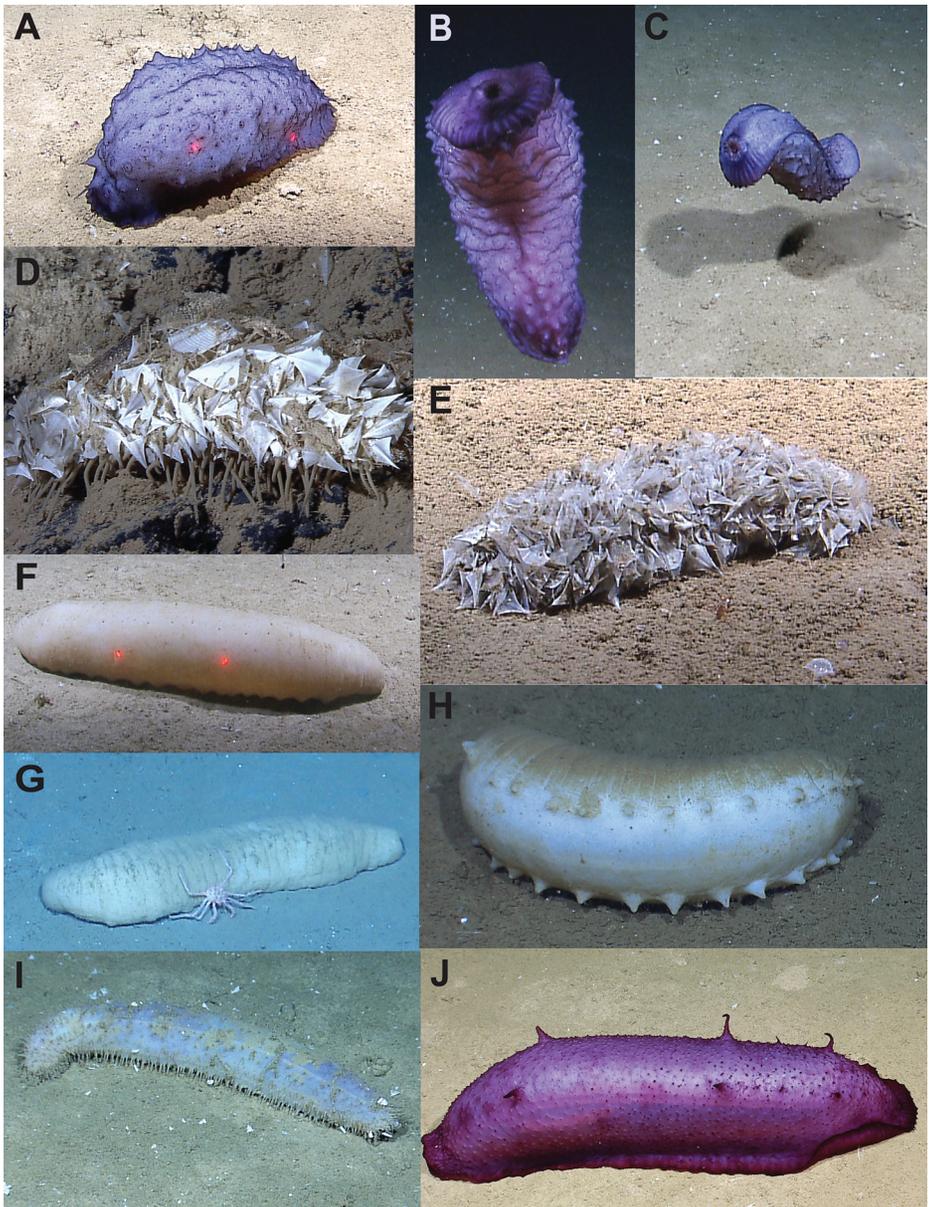


Figure 2. Gulf of Mexico deep-sea holothurians in situ. (A–C) *Benthothuria funebris*, (D, E) *Oloughlinius* ?n.sp., (F–H) *?Pseudostichopus* sp., (I) *Paroriza* ?n.sp., (J) *Benthodytes abyssicola*.

that the dorsal projections seem to be scattered, not confined to radii, and there is a conspicuous mid-dorsal groove, especially evident in Figure 2A and 2C. The color is light purplish (lilac) dorsally, slightly darker ventrally, especially around the margin. In Figure 2B, a conspicuous row of midventral tube feet is visible. Based upon the visible laser dots (which are 10 cm apart), the individual in Figure 2A is approximately 25 cm long.

As no fresh material has been collected, we have little to add to the detailed discussion provided by Gage et al. (1985) on the taxonomic status of this species, and some details of its morphology. They note that Heezen and Hollister (1971) and Pequegnat et al. (1972) show images of *Benthothuria*, but no species names are suggested. Pequegnat et al.'s (1972, p. 90, 95) images, presumably of *B. funebris*, are from the Gulf of Mexico and closely resemble those shown here. Heezen and Hollister's (1971, p. 85) image is of an individual in the South Central Pacific Ocean in 3657 m. While it appears to be a *Benthothuria*, the dorsal surface carries notably fewer projections than illustrated here for *B. funebris*. Thus this image likely represents another species.

Based upon the general morphology of this species, and perhaps in part upon the suggestion of Gage et al. (1985) that this species may be neutrally buoyant, Rogacheva et al. (2013) concluded that it was capable of swimming. The present records (Fig. 2B–C) amply confirm its swimming ability. The swimming movements are apparently similar to those documented for *Paelopatides* sp. (see Miller and Pawson 1990).

Hudson et al. (2003) discuss seasonal feeding ecology in this and other bathyal species, noting a distinct seasonal change in chlorophyll and carotenoid pigments. Felley et al. (2008) note that "*Benthothuria* sp." (presumably *B. funebris*) did not show a patchy distribution on the Mid-Atlantic Ridge; in contrast, Gage et al. (1985) concluded that this species has a patchy distribution in the Rockall Trough.

***Oloughlinius* Pawson and Pawson, new genus**

(new name for *Meseres* Ludwig 1893, preoccupied)

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Type species.—*Meseres macdonaldi* Ludwig, 1893.

Diagnosis.—See O'Loughlin and Ahearn (2005: 177) for a detailed diagnosis and a discussion of the status of this genus.

Remarks.—The holothurian genus-name *Meseres* Ludwig, 1893, is preoccupied by *Meseres* Schewiakoff, 1892, type species *Meseres cordiformis* (Protozoa: Ciliata: Oligotricha). The new name *Oloughlinius* (gender, masculine) is proposed in honor of our friend and eminent scholar P Mark O'Loughlin, who has contributed so much to our knowledge of echinoderms, especially the Holothuroidea. O'Loughlin (2002) provided a detailed synonymy of the genus *Meseres* and reviewed the 11 included species, one of them new. O'Loughlin and Ahearn (2005) revised the concept of this genus, and restricted it to a single species, the type species, *M. macdonaldi*. The other 10 species were transferred to other genera (*Pseudostichopus* and *Molpadiodemus*, the latter genus newly resurrected from synonymy with *Meseres*) in the Synallactidae. The extraordinary specimens described below may belong to the newly-restricted genus *Oloughlinius*, to *Pseudostichopus*, or to *Molpadiodemus*, sensu O'Loughlin and Ahearn (2005). Until specimens are collected and examined, final taxonomic disposition of these animals cannot be determined.

Oloughlinius ?new species

(Figure 2D–E)

Material Examined.—None.

Images Examined.—EX1202L2_IMG_20120323T142812Z_ROVHD, 27.91409733, -86.034467666667, 2140.4 m, 1 specimen (Fig. 2D); EX1202L3_IMG_20120323T190738Z_ROVHD, 26.30339167, -93.436491000000, 1933.5 m, 1 specimen (Fig. 2E).

Diagnosis.—Synallactids of approximately 100 mm total length, body approximately cylindrical. Ventrolateral tube feet large (up to 13 mm long when extended), numerous, approximately 50 in each radius. Dorsal and lateral body wall almost entirely covered with shells of dead pteropod mollusks of the genus *Clio*.

Distribution.—Northern Gulf of Mexico in approximately 1934–2140 m.

Habitat.—Muddy substrates.

Description.—See diagnosis above.

Remarks.—In his review of this genus as it was then known, O’Loughlin (2002) listed 11 species, and noted that the genus was “cosmopolitan,” with species occurring in bathyal and abyssal depths, 112–4380 m. Four species, *villosus* (Théel), *peripatus* (Sluiter), *occultatus* (Marenzeller), and *globigerinae* (Hérouard) were known from the Atlantic Ocean, and of these only *occultatus* was reported from the western Atlantic, near Cuba, by Deichmann (1930). O’Loughlin regarded Deichmann’s identification as doubtful, but he could not confirm the identity of Deichmann’s specimen. Then O’Loughlin and Ahearn (2005) reassigned several species, as noted above, and their new combinations for the Atlantic species of *Meseres* sensu lato were as follows: *Molpadiodemas villosus* (Theel, 1886), *Pseudostichopus peripatus* (Sluiter, 1901), *Pseudostichopus occultatus* (Marenzeller, 1893). *Meseres globigerinae* (Herouard, 1923) was regarded as a junior subjective synonym of *Molpadiodemas involutus* (Sluiter, 1901).

The two specimens illustrated here are not only a new record from the Gulf of Mexico (see Pawson et al. 2009); they probably represent a new species. All but one species that O’Loughlin (2002) described in *Meseres* sensu lato cover themselves, for unknown reasons, with debris that has been selectively picked up from the seabed. Usually the cover consists of sponge spicules or globigerine foraminiferans. The spectacular individuals illustrated here are covered by pteropod mollusk shells, presumably of the genus *Clio*. Shells of common species of *Clio* are approximately 10 mm wide. Using this as a “standard dimension”, we estimate that the lengths of the bodies of the specimens shown in Figures 1D and 1E are 100 and 110 mm, respectively. According to O’Loughlin (2002), most species formerly referred to this genus are of a similar size, averaging about 100 mm in length. Notable in Figure 1D are the numerous elongate ventrolateral tube feet, some appearing to be about 20 mm long. We were astonished to learn (L Kuhnz, MBARI, pers comm) that *Oloughlinius*, similarly covered in *Clio* shells, is “relatively abundant” in the northeastern Pacific in the Juan de Fuca/Gorda Ridge area, at depths of approximately 2500 m. Only a study of specimens collected from both areas will throw further light on these amazing animals.

Genus *Amphigymnas* Walsh, 1891

Remarks.—O’Loughlin et al. (2013) summarized in detail the status of this genus and its component species. They concluded that the genus comprised the type species *A. multipes* Walsh, *A. bahamensis* Deichmann, and their species *A. staplesi*. The genus is known from the Indian Ocean and western Atlantic Ocean in 344–896 m.

Amphigymnas bahamensis Deichmann, 1930

(Figure 3A,C, Table 2)

Amphigymnas bahamensis.—Deichmann (1930): 107, pl 9, fig 9; pl 10, figs 1–6; Deichmann (1940): 189, pl. 34 (not pl. 32), figs. 1–10; Deichmann (1954): 387; Miller and Pawson (1984): 10, 51; Borrero-Perez et al. (2003): 71 fig. 3E (not fig. 2E), fig. 4L–N.

Material Examined.—Thirteen specimens: CH-2010-006, 1 sp., TL 200 mm, USNM 1151133; CH-2010-007, 4 sp., TL 210, 230, 230, 250 mm, USNM 1151134; CH-2010-011, 2 sp., (both decayed) TL approximately 240, approximately 270 mm, USNM 1151135; JSLII 2009-GOM-3726, 1 sp., TL: 165 mm, USNM 1151132; NF-2008-043, 1 sp., TL 200 mm, USNM 1151129; NF-2008-054, 1 sp., TL 300 mm, USNM 1151131; NF-2008-056, 1 sp., TL 220 mm, USNM 1151130; ROV-2010-CH-001, 1 sp., TL 250 mm, USNM 1155727.

Images Examined.—EX1202L2_IMG_20120322T1839Z_ROVHD, 26.438516, -84.765154333333, 402.3 m, 1 specimen (Fig. 3C). EX1202L2_IMG_20120320T172502Z_ROVHD, 26.467651333333, -84.775359833333, 408.2 m, 1 specimen.

Diagnosis.—Body large (up to 300 mm TL), with four rows of dorsal papillae, right and left rows of ventrolateral papillae, and a double row of feet midventrally. Body wall thin, parchment-like, rough to touch, packed with ossicles in the form of circular to oval plates averaging 215 μ m in diameter, with up to 60 perforations, and with or without a short central spire of 3 or 4 pillars (in part after Deichmann 1940).

Distribution.—Known from between The Bahamas and Cape Fear, North Carolina, in 479 m, off the south coast of Cuba in 585 m (Deichmann 1940), and the northeastern and northwestern Gulf of Mexico in 439–586 m (Pawson et al. 2009). One specimen (USNM 1086594) was collected off Georgia, USA, at 900 m depth. Bathymetric range of this species is 402–900 m.

Habitat.—May prefer hard substrates with a thin veneer of soft sediment.

Remarks.—Color in life seems to vary considerably. Individuals illustrated here (Fig. 3A,C) are variegated orange overall; others that were observed or collected are variegated light to dark brown, or dark violet. Most specimens in alcohol are light to dark violet. Total length of adults ranges from 210 to 300 mm (Table 2). Number of dorsal and dorsolateral processes tend to increase with increasing body length. The individuals in Figure 3A,C have approximately 27 dorsal and dorsolateral processes, and are probably <200 mm in length. Ossicles (illustrated in Deichmann 1930, 1940, Borrero-Perez et al. 2003) in dorsal and ventral body wall circular to oval perforated plates averaging 215 μ m in diameter dorsally and 195 μ m ventrally.

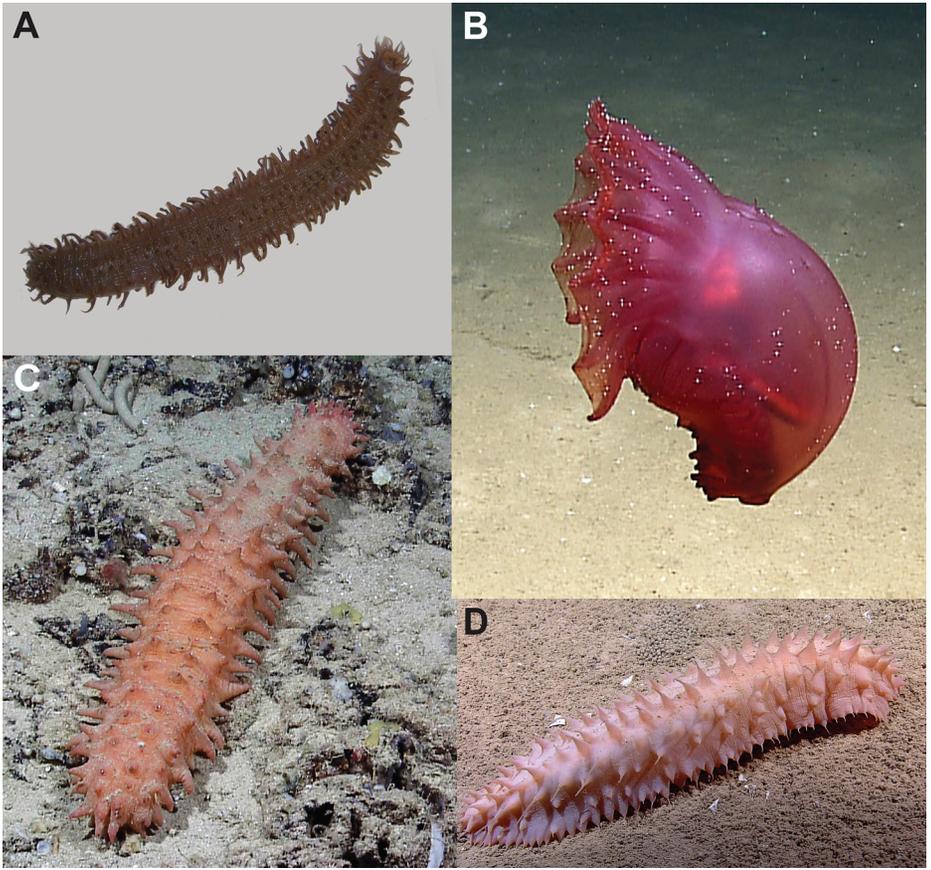


Figure 3. Gulf of Mexico deep-sea holothurians in the laboratory and in situ. (A) *Amphigymanas bahamensis* in the laboratory, ventral view; (B) *Enypsiastes eximia*; (C) *Amphigymanas bahamensis*; (D) ?*Bathyplotes* sp. B.

Table 2. Number of tube feet and lateral and dorsal processes in *Amphigymanas bahamensis*. For comparison, ^a = specimen from 666 m, near Dominica, Caribbean, and ^b = specimen from 900 m, off Georgia, USA. * = approximately. USNM is National Museum of Natural History.

USNM catalog no.	Length (mm)	Left ventral feet	Right ventral feet	Midventral pairs of feet	Left dorsolateral processes	Right dorsolateral processes	Left dorsal processes	Right dorsal processes
E46768 ^a	135	32	33	42	21	23	–	–
1086594 ^b	140	35	37	40	–	–	–	–
1151134	210	42	43	37	32	Damaged	Damaged	Damaged
1151130	220	30	35	41	36	59	66	44
1151134	230	52	44	43	38	31	38	46
1151134	230	46	47	35	42	30*	37	42
1151134	250	46	48	39	28	29	39	36
1155727	250	39	40	35	37	37	41	43
151131	300	42	42	41	47	45	57	45

The plates are essentially flat, smooth, with up to approximately 60 perforations, and usually have a short (approximately 75 μm) central spire of three, sometimes four, pillars. Pillars with 1–2 crossbars, terminating in simple blunt points. Some plates lack spires. Dorsal, lateral, and ventral projections, and midventral tube feet with numerous spired perforated plates, smaller than those in body wall, spires with 3 or 4 crossbars; also in the projections are straight to slightly curved rods, averaging 700 μm in length, with short projections along their sides, and a tendency to form few, small, terminal holes. Deichmann (1930) noted that the midventral feet may or may not possess endplates; no endplates were found in the present material. Tentacles with rods similar to those in projections, but much more variable in size (56–610 μm), and often strongly curved.

Zygothuria lactea (Théel, 1886)

Holothuria lactea.—Théel (1886a): p.183, pl. 9 fig. 15.

Zygothuria lactea.— Gebruk et al. (2012): 310, figs. 13, 14 (synonymy); Gebruk et al. (2014): 170.

Material Examined.—One specimen: CH-2007-040, 1 spec., TL 113m, USNM 1151116, ID Cynthia Ahearn.

Diagnosis.—*Zygothuria* with body wall ossicles in the form of fragile tables with spires usually triradiate, with long arms. Single-pointed spires may also be present (after after Gebruk et al. 2012).

Distribution.—Essentially cosmopolitan, occurring at 694–2102 m depth (Gebruk et al. 2014). Recorded many times from the Gulf of Mexico (Pawson et al. 2009) and the Caribbean Sea (Gebruk et al. 2012).

Habitat.—Usually on soft sediments.

Remarks.—In their thorough and comprehensive study of the species of *Zygothuria*, Gebruk et al. (2012) clarified the status of the species *lactea*, noting that “The form and size of the ossicles...are characteristic.” *Zygothuria oxysclera* Perrier, 1902, also occurs in the southern Caribbean and may be confused with *Z. lactea* (Gebruk et al. 2012).

?*Bathyplores* sp. A

(Figure 4D)

Image Examined.—EX1202L2_IMG_20120325T153614Z_ROVHD 28.30020177, -87.287464833333, 1872.9 m (Fig. 4D).

Remarks.—The individual shown is of unknown size, but it appears to be a typical specimen of *Bathyplores*, semi-translucent and pinkish-red in color, with dorsolateral rows of triangular papillae. The genus has previously been reported from the Gulf of Mexico in depths of 408–617 m (Pawson et al. 2009); the current image was taken at the much greater depth of 2115 m. According to the synonymy provided by Rogacheva et al. (2013), this individual may be *Bathyplores natans* (M. Sars), which is known from the Atlantic and Pacific oceans in 193–2750 m.

?Bathyplores sp. B

(Figure 3D)

Images Examined.—EX1202L2_IMG_20120326T171439Z_ROVHD, 28.67822783, -87.552415500000, 2216.4 m (Fig. 3D).

Remarks.—This interesting individual may be another species of *Bathyplores*, for it has numerous pointed papillae, tipped with extended tube feet. It differs from *?Bathyplores* sp. A, above, in color, and it possesses more conspicuous and more numerous dorsolateral papillae.

?Pseudostichopus sp.

(Figure 2F–H)

Images Examined.—EX1202L2_IMG_20120402T172719Z_ROVHD 28.633323666667N, -88.171256000000W, 1888.1 m. EX1202L3_IMG_20120424T210910Z_ROVHD 27.129441333333N, -90.486604833333W, 959.4 m. EX1202L3_IMG_20120424T194144Z_ROVHD, 27.130789, -90.485837500000, 957.4 m (Fig. 2F). EX1202L3_IMG_20120412T182148Z_ROVHD, 28.67644109, -88.47364806, 1358.1 m (Fig. 2G). EX1202L2_IMG_20120402T190957Z_ROVHD, 28.6290875, -88.17369600000 (Fig. 2H).

Remarks.—The individuals shown in Figure 2F–H may belong to the same species, perhaps in the genus *Pseudostichopus*. The body is more or less cylindrical, slightly tapering and rounded at the extremities. The ventral surface is more or less flat. The dorsal surface appears to be featureless in the individuals shown, but in one individual (not shown) there is a single row of about 12 small pointed papillae in each dorsal radius. The dorsal surface has 30 or more shallow transverse grooves (Fig. 2G). The individual in Figure 2F is approximately 35 cm long. There are no feet midventrally (Fig. 2H); ventrolateral radii each carry about 15 large and conspicuous pointed feet, the largest being approximately 12 mm high, and 12 mm wide at the base. These feet decrease in size towards anterior and posterior ends of the body. Color in life is dirty white to light brown, the dorsal surface carrying a thin irregular layer of sediment.

Molpadiodemas involutus (Sluiter, 1901)

Meseres involutus.—Sluiter (1901): 11.

Molpadiodemas involutus.—O'Loughlin and Ahearn (2005): 160, figs. 3m-o, 4u-x (synonymy); Gebruk et al. (2014): 167 (synonymy).

Material Examined.—Eight specimens: CH-2007-026, 1 sp., TL 38 mm, ID Cynthia Ahearn, USNM 1151110; CH-2007-042, 7 specimens, TL 24–55 mm, ID Cynthia Ahearn, USNM 1151111–1151114, 1151121.

Diagnosis.—Body wall wrinkled, with small digitate projections on low reticulate ridges. Margin serrated by transverse creasing of body. Tentacle ossicles include rods. Body typically encrusted with globigerines or small stones (after O'Loughlin and Ahearn 2005).

Distribution.—Widespread in Atlantic and Pacific Ocean, also Antarctica, 300–5801 m depth. A new record for the Gulf of Mexico.

Habitat.—Soft sediments, frequently with abundant *Globigerina*.

Remarks.—In their comprehensive revision of pygal-furrowed synallactid sea cucumbers, O’Loughlin and Ahearn (2005) synonymized four species under *M. involutus* and provided an extensive discussion of this species.

Genus *Paroriza* Herouard, 1902

Paroriza prouhoi is the type species of this genus and Herouard (1902) first described it from the northeastern Atlantic. Currently, four species of *Paroriza* are recognized; a fifth species may be present in the Gulf of Mexico (see *Paroriza* ?n.sp. below). The four known species may be distinguished as follows (partly after Massin 1987).

KEY TO SPECIES OF *PARORIZA*

- 1a. Tentacles 16; Indonesia, upper bathyal (750 m).....*Paroriza verrucosa* Massin, 1987
- 1b. Tentacles 20.....2
- 2a. Body with evenly distributed dorsal papillae/tube feet, all subequal in size. Bathyal to abyssal, Atlantic and Pacific oceans *Paroriza pallens* (Koehler, 1896)
- 2b. Body mostly covered dorsally by papillae/tube feet of varying size.....3
- 3a. Body, at least in larger specimens upwardly curved; Indonesia, hadal depths (6,000+ m)....
.....*Paroriza grevei* Hansen, 1956
- 3b. Body more or less cylindrical; abyssal depths northern Atlantic and Pacific oceans.....
.....*Paroriza prouhoi* (Herouard, 1902)

Paroriza pallens (Koehler, 1896)

(Figure 4E,F)

Stichopus pallens.—Koehler (1896): 50.

Paroriza pallens.—Hansen (1956): 46; Sibuet (1977): 554; Khripounoff and Sibuet (1980): 17; Massin (1987): 117; Massin (1993): 401, fig. 2; Gebruk et al. (2014): 166.

Material Examined.—Three specimens: CH 2007-026, 2 sp., TL 162 mm, 170 mm, USNM 1151102; CH-2007-074, 1 sp., TL 105 mm, USNM 1151117.

Images Examined.—EX1202L2_IMG_20120402T165830Z_ROVHD, 28.63362283, -88.170393333333, 1872.9 m, 2 specimens (Fig. 4E); EX1202L2_IMG_20120402T183751Z_ROVHD, 28.63050817, -88.173638666667, 1894.5 m, 3 specimens (Fig. 4F).

Diagnosis.—Tentacles 20. Body with evenly distributed dorsal papillae, all more or less of the same size.

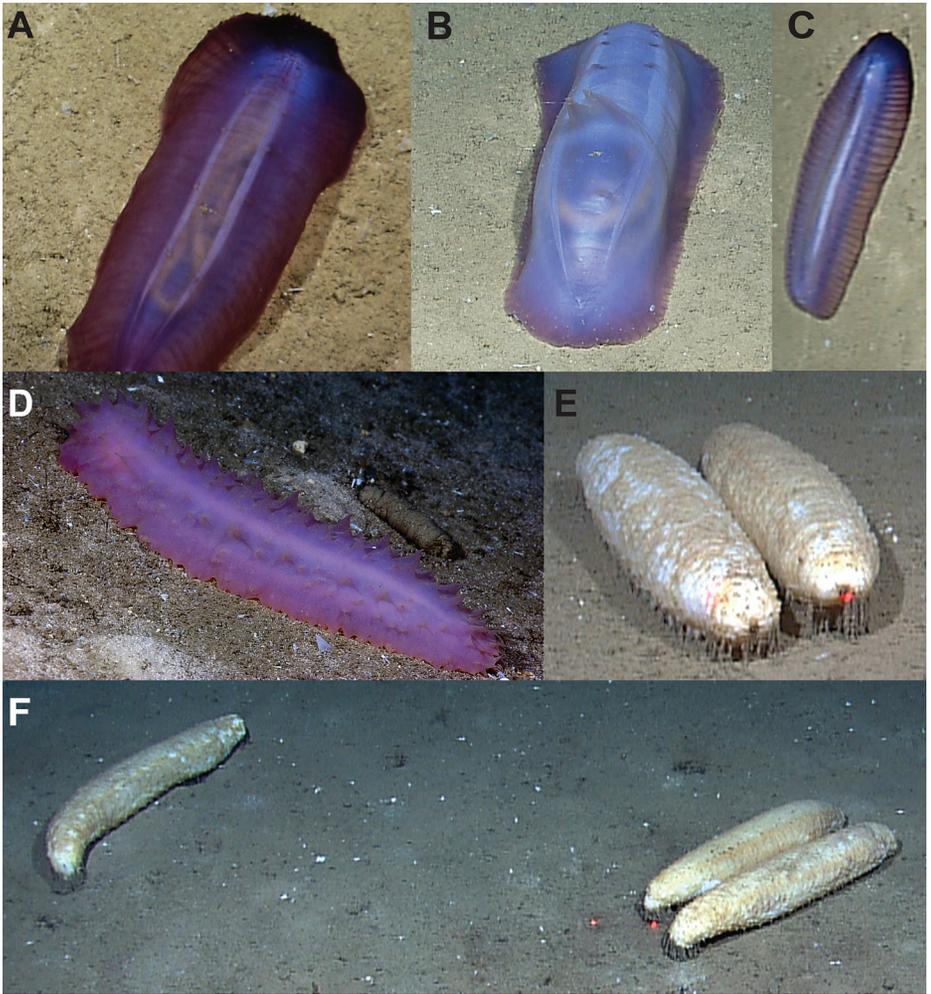


Figure 4. Gulf of Mexico deep-sea holothurians in situ. (A) *Benthodytes ?sanguinolenta*, (B) *Psychropotes depressa*, (C) *Benthodytes ?typica*, (D) *Bathylplotes* sp., (E–F) *Paroriza pallens*.

Distribution.—The present record is the first from the Gulf of Mexico. Tyler et al. (1992) and Billett (1991) note that this species occurs in the northeastern Atlantic from northeastern Spain to the Porcupine Seabight in 1300–2100 to 794–1430 m depth, respectively. Tyler et al. (1992) confirm its presence in The Bahamas at 900 m. Maximum abundance noted was 100+ individuals per hectare. Also known from the northern Pacific Ocean, at approximately 14°N, 124°30'W and approximately 5000 m depth (initially identified as “*Mesothuria* sp.”; Pawson and Foell unpubl data), and in the Philippines Trench (Fujioka et al. 1987).

Remarks.—The smallest specimen is strongly contracted, and typical of this species; the other two are badly deteriorated. Color in life (Figs. 4E,F) variegated light yellow. Both images shown here were taken on the same day but at depths about 20 m different. Both photos show pairs of individuals. One pair (Fig. 4E) shows the posterior ends in the foreground, the other pair is shown in oblique view. In all individuals, the body is raised off the substrate by numerous extended tube feet. Feeding

tentacles are extended in the three individuals in Fig. 4F; presumably, all are actively feeding. In both photos, the paired individuals have their anterior ends together.

Aggregation in deep-sea echinoderm species, in pairs or triplets, was noted by Pawson (1976), who suggested that such aggregations may facilitate reproduction. Young et al. (1992), Tyler et al. (1992), and Young (1994) showed that such aggregations, in the echinoid *Stylocidaris lineata* and the holothuroid *Paroriza pallens*, are indeed for the purpose of reproduction. Tyler et al. (1992) noted the paradox that *Paroriza pallens* is hermaphroditic. Figure 4A and 4D both date from April 2, 2012; Tyler et al. (1992) note that in The Bahamas this species reproduces year-round.

Aspects of the distribution, abundance, reproductive biology, and diet of this species are discussed briefly by Sibuet (1977), Khripounoff and Sibuet (1980), and in detail by Tyler et al. (1992).

Paroriza ?new species

(Figure 2I)

Material Examined.—None.

Image Examined.—EX1202L2_IMG_20120237T181048, 28.22112883, -87.521514833333, 2548.6 m, 1 specimen (Fig. 2I).

Remarks.—The single individual shown in Figure 2I has some puzzling features, but it appears to fall within, or close to, the genus *Paroriza*. The body is variegated light violet to dirty white, more or less cylindrical, probably flattened ventrally, approximately 38 cm in total length (according to the red laser dots, not shown) and approximately 5–6 cm in diameter. The dorsal and lateral surfaces carry sparsely scattered papillae, poorly defined in the image. Ventrolaterally there are 80 or more slender, cylindrical tube feet, and the rounded anterior end (left side of image) carries a fringe of tube feet. While all of these features are characteristic of *Paroriza*, as illustrated in Figures 4E and 4F, the current individual differs from *P. pallens* in color, the body is not nearly as plump, and the dorsal papillae are far less numerous and less conspicuous. Until specimens are collected, this intriguing animal must remain unnamed.

Distribution.—*Paroriza pallens* is reported above from a depth range of 1426–1894.5 m; *Paroriza* ?n. sp. is from 2548.6 m.

Order Elaspodida

Family Pelagothuriidae Ludwig, 1894

Enypniastes eximia Théel, 1882

(Figure 3B)

Enypniastes eximia.—Théel (1882): 56, pl. 8 figs. 6–7; Pawson (1982): 138, figs. 3a–c; Ohta (1985): 121, figs. 2–10; Miller and Pawson (1990): 10, figs. 1c, 1d, 4.

Material Examined.—None.

Images Examined.—EX1202L3_IMG_20120427T174427Z, 26.3038195, -93.433009500000, 1993.6 m, 1 specimen (Fig. 3B).

Diagnosis.—Benthopelagic, with bulbous barrel-shaped body up to 25 cm long, and large anterior webbed veil incorporating up to 12 conical podia. Two posterolateral veils each composed of 10–15 webbed podia (in part, after Miller and Pawson 1990).

Remarks.—This well-known swimming species has been documented by numerous authors. See Ohta (1985) and Miller and Pawson (1990) for a detailed analysis of swimming movements.

Distribution.—Cosmopolitan, but most commonly found near continental margins, at 516–5689 m depth (Miller and Pawson 1990). One near-surface record (as *Pelagothuria bouvieri*) in Herouard (1923).

Family Psychropotidae Théel, 1882

Psychropotes depressa (Théel, 1882)

(Figure 4B)

Euphronides depressa.—Théel (1882): 93, pl. 26, pl. 35 figs. 5–6, pl. 40 fig. 7, pl. 46 fig. 4.

Psychropotes depressa.—Hansen (1975): 106, figs. 43–44, pls. 7 figs. 1–3, 12 fig. 8, 14 1–2 (synonymy); Rogacheva et al. (2013): 599, fig. 17E,G (synonymy); Gebruk et al. (2014): 160 (synonymy).

Material Examined.—Two specimens: CH-2007-074, 2 sp., TL 31mm, 29mm, ID Cynthia Ahearn, USNM 1151115.

Images Examined.—EX1202L3_IMG_20120427T180854Z_ROVHD, 26.30372567, -93.433665666667, 1976.9 m, 1 specimen (Fig. 4B).

Diagnosis.—Dorsal appendage placed at least 1/5 of body length from posterior end of body; this appendage at most 1/6 length of body. Tentacles 18 (after Hansen 1975).

Remarks.—Both specimens are in poor condition, and external characteristics, including the number of tentacles, cannot be determined. It appears that Cynthia Ahearn identified these specimens as *Psychropotes depressa* on the basis of the well-known ossicles alone, many of which resemble the simple four-armed ossicle illustrated by Hansen (1975) in his description of this species (fig. 43, no. 2). The present specimens are small (29 and 31 mm TL) compared with Hansen's material (70–200 mm). These simple four-armed ossicles are commonly found in small specimens of several species in this genus. Therefore, the identification as *P. depressa* is tentative.

We believe that the individual shown here (Fig. 4B), viewed from the posterior end, is indeed a specimen of *P. depressa*, which is described in detail by Hansen (1975). Diagnostic external characters include: Body flattened ventrally, arched dorsally, approximately twice as long as wide; ventrolateral brim around entire body, conspicuously widening anteriorly. Anus and mouth ventral. Body wall translucent, intestine visible through body wall near posterior end, and dorsal longitudinal muscles visible along entire body. Color light violet, darker ventrally. A prominent dorsal projection

lies about one-third of the body length from the posterior end. This projection is a rudimentary veil, with approximately four broadly based triangular structures arising from it. Three or more pairs of short and blunt projections are equally spaced along the inner edges of the dorsal radii, the posteriormost pair, placed at about mid-body, being the largest. The projections become smaller towards the anterior end.

Unfortunately, Hansen (1975) provided no details about the shape of the “completely retractile” dorsal appendage in his detailed description. This structure as illustrated by Théel (1882) differs from the appendage shown here, but Deichmann (1930) notes that the posterior appendage can be “very variable in form and size.”

Distribution. Cosmopolitan. The record from the Gulf of Mexico is new. Otherwise, this species occurs over the “deeper bathyal and upper abyssal zone,” in 957–4060 m, in many parts of the world (Hansen 1975).

Benthodytes abyssicola Théel, 1882
(Figure 2J)

Benthodytes abyssicola.—Théel (1882): 106, pls. 36 figs. 26–27; 38 figs. 1–3; 46 figs. 9–10; Rogacheva et al. (2009): 465, figs. 3–4.

Material Examined.—None.

Images Examined.—EX1202L3_IMG_20120427T172847Z, 26.30407, –93.432392666667, 1998.3 m, 1 specimen (Fig. 2J).

Diagnosis.—See Rogacheva et al. (2009) for a detailed diagnosis of this species and descriptions of lectotype and paralectotypes.

Remarks.—The specimens available to Rogacheva et al. (2009), and described in detail, were up to 25 cm long. The beautiful individual illustrated here, however, is of unknown size. The color is typical of this species (purple to violet), and the bodywall is semi-translucent. The arrangement of the three larger pairs of dorsal papillae is typical, and in the present specimen there are three smaller pairs placed between the first two pairs of larger papillae. The anteriormost pair of larger papillae are placed 16% of the body length from the anterior end of the body; the middle pair at 40%, and the posterior pair 80%. The disposition of the larger papillae on the present specimen closely resembles that of the lectotype.

Distribution.—The present record from the Gulf of Mexico is new, and the depth is the shallowest on record. This species is known from the Southern Indian Ocean and Pacific Ocean, in 3294–4301 m (Rogacheva et al. 2009). Also known from the north-eastern Atlantic in 4400–4848 m. Rogacheva (PP Shirshov Institute of Oceanology, Moscow, Russia, pers comm) believes the northeastern Atlantic material may prove to represent a different species.

Habitat.—Mud and ooze.

Benthodytes spp.

(Figure 4A,C)

Material Examined.—None.

Images Examined.—EX1202L3_IMG_20120427T154846Z_ROVHD, 26.30450983, -93.430169000000, 2013 m (Fig. 4A); EX1202L3_IMG_20120427T155222Z_ROVHD, 26.30458883, -93.430214666667, 2012.6m (Fig. 4C).

Remarks.—The individuals shown probably represent two species of this genus. *Benthodytes sanguinolenta* Théel (?Figure 4A) and *Benthodytes typica* Théel (?Figure 4C) are both well-known from the Gulf of Mexico (Pawson et al. 2009).

Order Molpadida Haeckel, 1896

In several publications, especially since the 1960s, this ordinal name has been spelled Molpadiida, following the demonstration by HB Fell (in litteris 1964, pers comm) that the root of the name is “*molpadi...*”, and the ordinal name, arrived at by adding “*-ida*” to this root would result in Molpadiida. Ordinal names are not subject to the rules of nomenclature as set out in the International Code of Zoological Nomenclature and, as the name Molpadiida is cumbersome, several holothurian specialists informally agreed, early in 2013, that the ordinal name would henceforth be spelled Molpadida.

Family Molpadiidae Müller, 1850

Molpadia blakei (Théel, 1886)

Trochostoma blakei.—Théel (1886b): 16, pl. 1 fig. 8.

Molpadia blakei.—Deichmann (1940): 224, pl. 38 fig. 6–8; Pawson et al. (2001): 320, figs. 3A–B (synonymy); Gebruk et al. (2014): 172 (synonymy).

Material Examined.—Eight specimens: CH-2007-027, 2 sp., TL 55mm and 30mm, ID Cynthia Ahearn, USNM 1151103; CH-2007-074, 6 sp., TL 20-50 mm, ID Cynthia Ahearn, USNM 1151104-1151109.

Diagnosis.—Medium-sized form, up to 60 mm TL, gray to whitish. Body wall oscicles minute tables, averaging 106 µm in diameter, disc with three large holes, spire solid, derived from three rods fused together, tapering to a point or ending in a few hooks. Tail with fusiform rods averaging 256 µm in length with large holes and low spires often ending in hooks. No phosphatic deposits (from Pawson et al. 2001, partly after Deichmann 1940).

Distribution.—North Atlantic, including Gulf of Mexico, and off Brazil in 1747–5270 m (Pawson et al. 2001, 2009).

Habitat.—Buried in soft sediments.

Remarks.—Notes on feeding propensities in this species are described in Khripounoff and Sibuet (1980), and on reproductive biology in Tyler et al. (1987).

Molpadia parva (Clark, 1908)

Trochostoma arcticum var. *parva*.—Théel (1886b): 17.

Molpadia parva.—Clark (1908): 36, 168; Deichmann (1940): 223, pl. 37 figs. 4–6; Pawson et al. (2001): 320, figs. 3F–G.

Material Examined.—One specimen: NF-2008-074, 1 sp., TL 50mm, USNM 1151125.

Diagnosis.—Medium-sized, up to 70 mm TL, grayish-white. Body wall ossicles tables averaging 276 μm in diameter with three large central holes and three or more smaller holes; spire tall, comprising three discrete pillars with several cross-beams. Tail ossicles elongate, averaging 150 μm in length, typically with three larger central holes and several smaller holes towards the ends of the ossicles; spires of moderate height, 66 μm . Phosphatic bodies present or absent (from Pawson et al. 2001).

Distribution.—Off US east coast, eastern Gulf of Mexico, Grenada, Panama, in 761–2695 m depth.

Habitat.—Buried in soft sediment.

Remarks.—The single specimen is typical of this distinctive species.

Molpadia cubana Deichmann, 1940

Trochostoma antarcticum.—Théel (1886b): 16.

Nec *Trochostoma antarcticum*.—Théel (1886a): 44, pl. 2 fig.7.

Molpadia cubana.—Deichmann (1940): 220, pl. 37 figs. 1–3; Deichmann (1954): 406, fig. 68 21–22; Pawson et al. (2001): 320, figs. 4A–B.

Material Examined.—Three specimens: NF-2008-072, 1 sp., TL 34mm, USNM 1151126; NF-2008-073, 1 sp., TL 45 mm, USNM 1151127; NF-2008-074, 1 sp., TL 34 mm, USNM 1151128.

Diagnosis.—Small species, up to 40 mm TL, grayish-white to reddish. Body wall with tables averaging 218 μm in diameter, with three larger holes and a few smaller holes; spires of three pillars joined by four or more cross-bars. Tail ossicles small, elongate oval three-pillared tables averaging 78 μm in diameter, with up to approximately 12 perforations. Phosphatic deposits present (from Pawson et al. 2001).

Distribution.—Off southern Florida, northern Gulf of Mexico, and Panama, in 24–1464 m.

Habitat.—Buried in soft sediment.

Remarks.—These are typical specimens of this species.

Molpadia musculus Risso, 1826

Molpadia musculus.—Risso (1826): 293; Deichmann (1940): 225, pl. 40 figs. 1–15; Deichmann (1954): 405; Pawson (1977): 100, figs. 1–3, 4a–c, e (synonymy); Pawson et al. (2001): 320, figs. 2A–B; Rogacheva et al. (2013): p. 611; Gebruk et al. (2014): 172 (synonymy).

Material Examined.—Forty-eight specimens: NF-2008-073, 6 sp., TL 25–40 mm, USNM 1151122; NF-2008-072, 19 sp., TL 22–62 mm, USNM 1151123; NF-2008-074, 23 sp., TL 14–42 mm, USNM 1151124.

Diagnosis.—Small to large species, up to 200 mm TL, grayish-white to red. Ossicles include fusiform rods 500–1300 μm long, always present in the tail, and usually also in the body wall. Body wall with tables with three or more perforations and a solid spire. Rosettes of racquet-shaped plates and anchors present in smaller specimens. Phosphatic deposits present (after Pawson et al. 2001).

Distribution.—Cosmopolitan occurring in 35–5205 m, but not known above the Arctic Circle (Pawson et al. 2001, 2009).

Habitat.—Buried in soft sediments.

Remarks.—On the basis of some preliminary molecular analyses, M O’Loughlin and others (pers comm) have suggested that, at least in the southern oceans, *M. musculus* sensu Pawson (1977) may comprise several species.

Order Apodida Brandt, 1835

Suborder Myriotrochina Smirnov, 1998

Family Myriotrochidae Théel, 1877

Genus *Myriotrochus* Steenstrup, 1851

Diagnosis.—Twelve tentacles. Wheel ossicles with or without holes; if holes present, they are regular or irregular, distributed around a small central inner hub. Rim teeth directed only towards center of hub. Rod ossicles absent (partly after Gage and Billett 1986).

Remarks.—Some recent publications dealing with myriotrochids include Gage and Billett (1986), Smirnov (1998), and O’Loughlin and VandenSpiegel (2010).

Myriotrochus ahearnae D. L. Pawson, Nizinski, and Ames, new species
(Figure 5A–G, Table 3)

urn:lsid:zoobank.org:act:06C641F2-42DB-439A-A38C-E9A6509DEB0B

Material Examined.—Holotype: USNM 1151121, Sta. CH-2007-042, 12 August, 2007, 27°09.628’N, 91°09.915’W to 27°10.643’N, 91°09.879’W, otter trawl, 1574–1478m. Total length of incomplete specimen 20 mm, greatest width 14 mm, identified by Cynthia Ahearn. Paratype: USNM 1151120, Sta. CH-2007-026, 11 August, 2007, 27°06.965’N, 91°09.951’W, to 27°06.086’N, 91°09.688’W, trawl, 1426–1521 m. Two fragments, TL 20 mm, 14 mm.

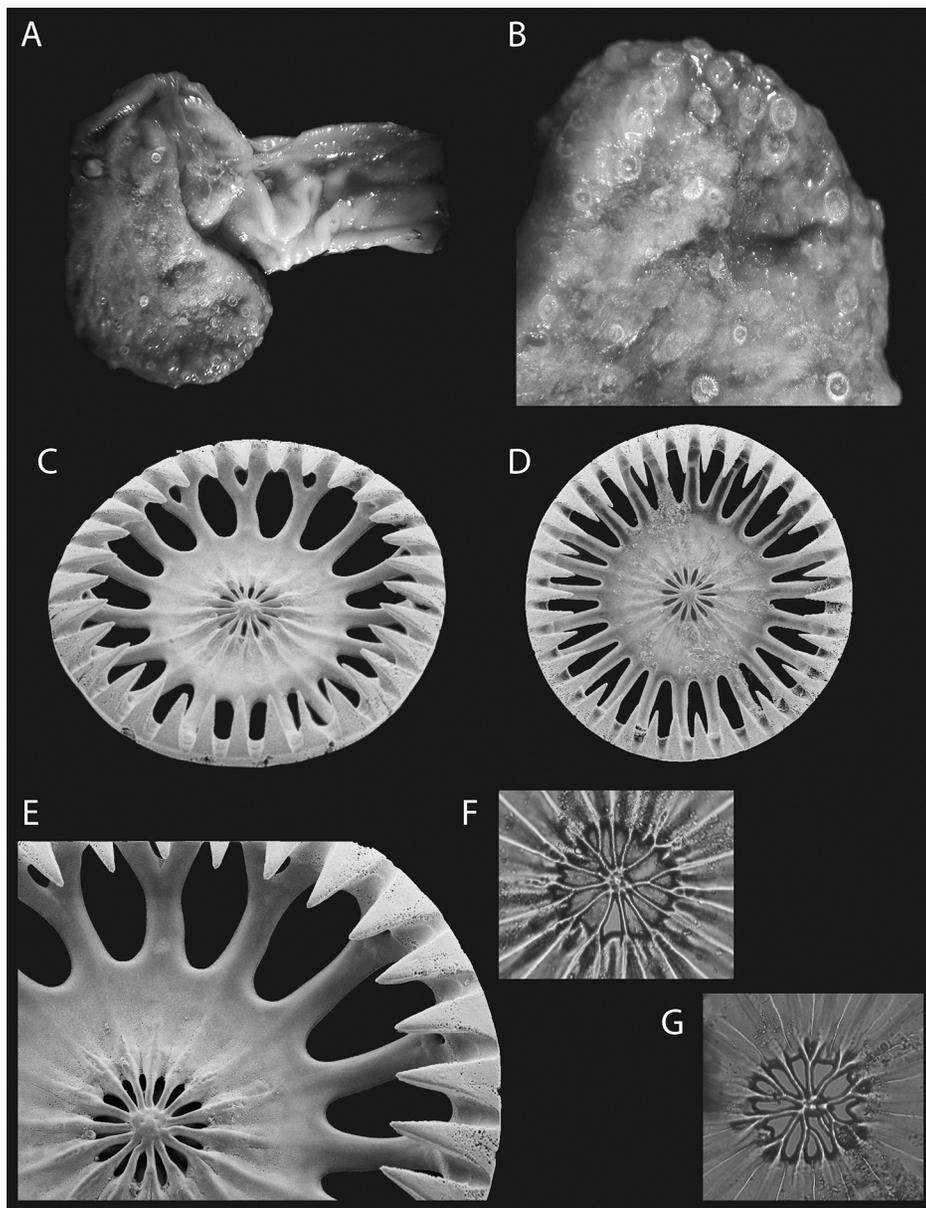


Figure 5. *Myriotrochus ahearnae* Pawson, Nizinski and Ames n. sp. (A) Holotype; (B) posterior end of holotype; (C) wheel, diameter 400 μm , external view; (D) wheel, diameter 426 μm , exterior view; (E) detail of C; (F, G); irregular central perforations of wheels.

Diagnosis.—Twelve tentacles. Ossicles wheels of one type, up to 581 μm in diameter, averaging 410 μm in diameter, aggregated towards anterior end of body, scattered elsewhere. Outer surface of wheel rim with 21–38 inwardly directed, sharply-pointed teeth, which have straight sides. Hub broad, occupying approximately 50% of wheel diameter, with 13–23 spokes attached to wheel rim. Center of hub perforated, perforations defined by 14–17 irregularly-shaped rods.

Table 3. Characteristics of wheel ossicles in *Myriotrochus ahearnae*, n. sp.

Diameter (μm)	Spokes	Teeth	Central rods
67	13	25	n/a
279	16	35	16
325	16	21	16
325	14	—	—
354	—	—	—
381	17	32	16
400	17	31	15
471	22	38	—
521	18	38	14
581	23	37	14

Description.—Holotype (Fig. 5A–B) approximately cylindrical, single specimen incomplete, lacking posterior end. Anterior end damaged; number of tentacles indeterminate, presumably 12. Color in alcohol variegated light yellow. Ossicles wheels (Figs. 5C–G), aggregated near anterior end of body, sparsely scattered elsewhere; more than 60 wheels present anteriorly. Wheel diameter (Table 3) variable, 279–581 μm , average diameter 410 μm ($n = 21$; 10 wheels measured in situ). In plan view, inwardly-directed teeth arise from outer edge of wheel rim (Fig. 5C–E); separated at their bases, so that bases in total occupy approximately 70% of circumference of rim. Rods defining perforations at center of hub vary greatly in shape, frequently branching (Fig 5F–G); their number may, or may not, correspond with number of spokes (see Table 3). Central perforations rarely more regularly arranged; in these cases number of rods may not correspond to number of spokes. Developmental stages of wheels rare, one observed, 67 μm in diameter; hub occupying 25% of diameter of wheel. Tentacles peltato-digitate, apparently lacking ossicles.

Paratype consists of two fragments, the smaller an anterior end, bearing 12 retracted tentacles, the larger a posterior end. Fragments may be parts of a single specimen approximately 35 mm in total length. Wheel ossicles uncommon, otherwise closely similar to those of holotype.

Distribution.—Known only from the north central Gulf of Mexico, in 1426–1574 m.

Habitat.—Buried in soft sediment.

Etymology.—This new species is named after our late dear friend, Cynthia Ahearn (1952–2008), who was the first to identify these specimens as possibly new.

Remarks.—This new species is distinctive in the genus in having the following combination of characters: large wheels of average diameter 410 μm ; wheels with a broad hub occupying approximately 50% of the wheel diameter; the hub perforated centrally, the perforations defined by irregularly-shaped and sometimes branching rods; 21–38 sharply-pointed inwardly-directed teeth, spaced around the wheel rim, the bases of the teeth in total occupying approximately 70% of the rim's circumference. It most closely resembles *Myriotrochus bathybius* H.L. Clark, 1920, which was originally described from the northeastern Pacific. *Myriotrochus bathybius* was admirably well described and recorded from numerous localities

in the northeastern Atlantic and elsewhere by Gage and Billett (1986), and they concluded, based upon their records and some previously unpublished records, that this species “has a cosmopolitan distribution at abyssal depths” (p 239). In their material the average diameter of the wheels was 312 μm , average number of spokes 16, and teeth 32. *Myriotrochus bathybius* and *M. ahearnae* are both characterized by having large wheels with very broad hubs, the hubs with central perforations, but they differ in several important respects. The teeth on the wheel rims in *M. bathybius* are broad at the base, the bases in total occupying almost 100% of the rim’s circumference, the teeth have slightly curved sides, and they are bluntly pointed (see Gage and Billett 1986: fig. 4). In *M. bathybius* the central perforations of the hub are regularly arranged, teardrop-shaped, corresponding in number to the number of hub spokes. Clark (1920) found only four wheels in his single specimen, the holotype of *M. bathybius*; diameter was 240–340 μm , spokes 12–14, teeth 37–38. His illustration of a wheel (pl. 4 fig. 3) shows a regular ring of central perforations, and the teeth appeared to be more sharply pointed than those illustrated by Gage and Billett (1986).

Gebruk et al. (2014) note that the northeastern Atlantic specimens identified as *M. bathybius* by Gage and Billett (1986) have wheels that differ from those of the holotype of *M. bathybius* from the Pacific Ocean, and that a study of new material from the Pacific would be informative. Regrettably, no further individuals of *M. bathybius* have been described from the Pacific, although Carney and Carey (1976) noted the presence of this species (as *Myriotrochus bathybius*) off Oregon, USA. The most conspicuous difference between *M. ahearnae* and *M. bathybius* is the presence of irregular central rods defining the perforations in wheels of the former, and of regularly arranged teardrop-shaped perforations in the latter.

Family Synaptidae Östergren, 1898

Protankyra brychia (Verrill, 1885)

Synapta brychia.—Verrill (1885): 539.

Protankyra brychia.—Gage et al. (1985): 201; Pawson et al. 2003: 170, figs. 1–11 (synonymy); Gebruk et al. (2014): p 158 (synonymy).

Material Examined.—One specimen: CH-2007-027, 1 sp., TL 70mm, USNM 1151119.

Diagnosis.—See Pawson et al. (2003) for detailed diagnosis.

Remarks.—This is a typical specimen of this essentially cosmopolitan species. Pawson et al. (2003) provide a detailed discussion of the complex taxonomy and distribution of this species.

Rynkatorpa felderi Pawson and Vance, 2005

Rynkatorpa felderi.—Pawson and Vance (2005): 15, figs. 1, 2 A–G.

Material Examined.—One specimen: CH-2007-026, 1 sp., TL 39 mm, ID F Solis-Marin, USNM 1161118.

Diagnosis.—Tentacles with two pairs of terminal digits. Body wall ossicles anchors, anchor plates, and accessory rods. Anchor stock unbranched. Perforations in anchor plates smooth, lacking denticulation. Accessory rods of uniform diameter, lacking central thickening (from Pawson and Vance 2005).

Distribution.—Now known from three sites in the North Central Gulf of Mexico, at depths of 620–1521 m.

Habitat.—The holotype of this species was collected at a hydrocarbon seep at the Brine Pool Site (Pawson and Vance 2005).

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