

An Annotated Description of Shallow Water Holothurians (Echinodermata: Holothuroidea) from Cayos Cochinos, Honduras

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Abstract: Taxonomic and biological aspects are presented on five species of shallow water holothurians from the Cayos Cochinos Biological Reserve-CCBR located on the northern Honduran shelf, western Caribbean at 16° N, 86° W. This article provides a taxonomic key of the recorded holothurians and morphometric/morphologic descriptions of their corresponding spicules. These five species belong to a single order (Aspidochirotida) and two families: Stichopodidae (*Isostichopus badionotus*) and Holothuriidae (*Holothuria mexicana*, *H. thomasi*, *H. arenicola* and *Actinopyga agassizi*). In addition, the commensal pearlfish, *Carapus bermudensis* is recorded from *H. mexicana* and *A. agassizi*.

Key words: Honduras, holothurians, taxonomy, Echinodermata, Aspidochirotida, pearlfish.

Holothurians have been traditionally used as food source throughout the Pacific Region in Asiatic countries (Conand 1989). Due to their easy capture and to the fact that most countries in this region are currently exploiting this resource without management plans, whole populations have been depleted (Uthicke 1996). As a consequence, Asiatic markets' interest on this resource has expanded to areas where holothurians have never been traditionally harvested, including the Honduran Caribbean islands (G. Pineda/CITES-HN, pers. comm.). Considering that the criteria on welcoming or rejecting such interests should be based on sound biological knowledge of the targeted resource, research efforts need to be initiated, particularly in areas where no information is currently available. There are numerous articles on holothurians from the Caribbean (Clark 1919, 1933, Deichemann 1926, 1930, 1940, 1963, Engel 1939, Fontaine 1953, Domantay 1959, Tikasingh 1963, Levin and Gomes 1975, Pawson 1976, Martinez 1982, Miller and Pawson 1984). However, and despite this

wealth of information, holothurians from Honduras have never been described. To assist in this capacity, the Honduran Coral Reef Fund initiated in 1998 a study on the demography and life history of holothurians at the Cayos Cochinos archipelago located on the northern Honduran shelf, western Caribbean, at 16° N, 86° W (Fig. 1). Here we report on the holothurian species recorded, providing general information on their biology.

MATERIALS AND METHODS

Holothurians were collected throughout the CCBR between February and November of 1998. This was done by hand using snorkel or SCUBA gear between 0.5 and 12 m depth. Dives were performed mainly during daytime, with occasional night dives. To assess distribution of holothurians, 184 transects covering 120 m² (4 m x 30 m) were done throughout the study area by two divers using SCUBA gear. All holothurians encountered were

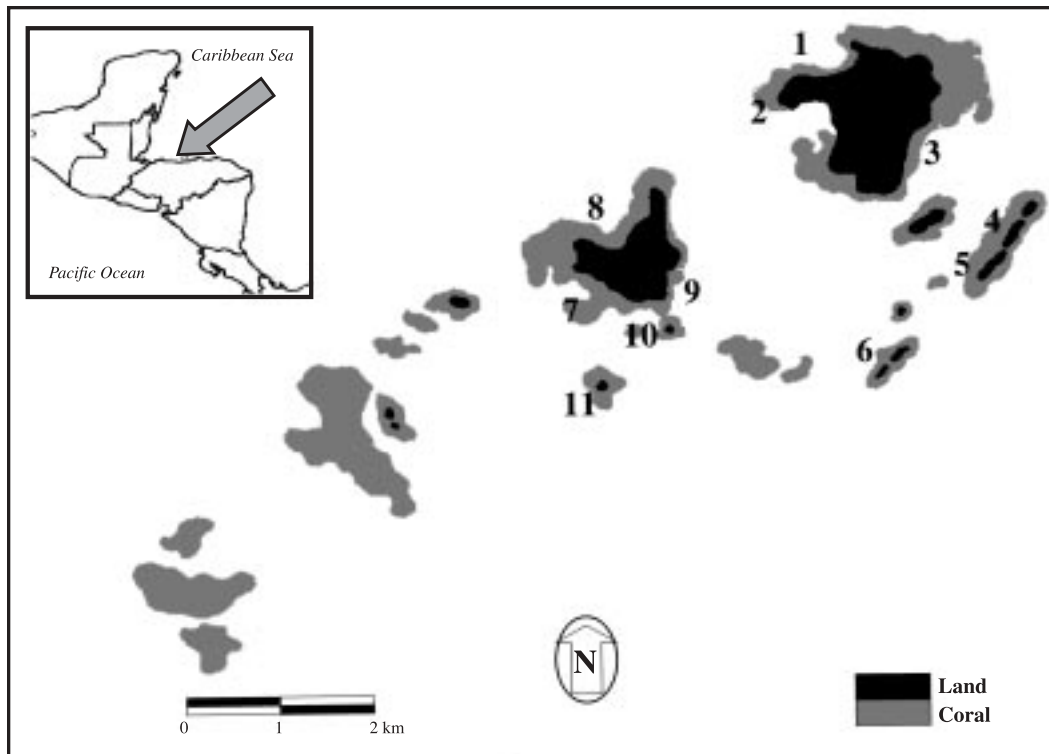


Fig. 1. Cayos Cochinos Archipelago off the Caribbean coast of Honduras: 1) Cayo Mayor-windward; 2) Cayo Mayor-Pelican Point; 3) Cayo Mayor-inner reef flat; 4) Cayo Largo Arriba-inner reef flat; 5) Cayo Largo Abajo; 6) Chachahuate; 7) Cayo Menor-coral shelf; 8) Cayo Menor-windward; 9) Cayo Menor-leeward; 10) Cayo Gallo; 11) Cayo Paloma.

recorded and only a representative sample of each species was collected. When possible, each collected specimen was measured in cm while being undisturbed using a flexible fiberglass tape (undisturbed length: ul) and when collected underwater and placed after a minute on a measuring board (contracted length: cl). Specimens to be preserved were then anesthetized by placing them in plastic trawls containing approximately 20 g of magnesium sulfate per individual per liter of ocean water. Specimens were again measured when relaxed (relaxed length: rl). The collected material was then dissected and preserved in ethanol. For spicule identification, 6mm sections from the dorsal and ventral tegument, from the oral tentacles and from the ventral podia were placed separately for an hour on concave glass discs with bleach. Once the tegument had disintegrated, the white precipitate on the concave discs was placed using a pipette on a slide for

microscopic examination (Ruzafa and Diego, 1985). Spicule measurements were made in mm using a micrometer eyepiece. The commensal pearl fish, *Carapus bermudensis*, was identified following Trott (1981). Voucher specimens are deposited on the Honduran Coral Reef Foundation (HCRF) collection, Honduras and at the Colección Nacional María Elena Caso Muñoz, Instituto de Ciencias del Mar y de Limnología (ICIMYL), Universidad Nacional Autónoma de México, México D. F. These are listed in the Appendix.

RESULTS

Five species from a single order (Aspidochirotida) and two families (Stichopodidae: *Isostichopus badionotus* (Selenka 1867) and Holothuriidae: *Holothuria mexicana* (Ludwig 1875), *H. thomasi* Pawson

Key for Species Identification

This key has been prepared for only those species included in this report and considers the most representative taxonomic characteristics. Other Caribbean species should be excluded from this key.

- 1a) Presence of five anal teeth *Actinopyga agassizi*
- 1b) Absence of anal teeth (2)
- 2a) Podia are scattered on the body wall (3)
- 2b) Podia arranged in three distinct longitudinal bands *Isostichopus badionotus*
- 3a) Terminally placed mouth; podia with conspicuous yellow tips *Holothuria arenicola*
- 3b) Ventrally placed mouth (4)
- 4a) Soft tegument; upper surface covered with conical papillae *Holothuria thomasi*
- 4b) Rigid tegument; smooth upper surface and distinctive dorso-lateral folding *Holothuria mexicana*

and Caycedo 1980, *H. arenicola* (Semper 1868), and *Actinopyga agassizi* (Selenka 1867) were documented.

Actinopyga agassizi

Observations of Examined Material:

Two individuals (ul=35 cm, 28 cm) from Cayo Largo Arriba (Fig. 1) collected on a seagrass bed, *Thalassia testudinum*, located at an inner reef flat of one to 4 m in depth. Another specimen was collected from Cayo Menor (ul=32.5 cm), encountered on a coral shelf 4 m in depth and composed of hard and soft coral and patches of seagrass (see Appendix for exact locations). All three specimens contained a single pearl fish, *C. bermudensis*. The fish were 13.5 cm, 9.5 cm and 10.5 cm in length from tip of snout to tip of tail. This finding is similar to those observations made of *C. bermudensis* on this holothuroid in the Bahamas (Trott 1981).

Description: This is a large species reaching 35 cm in length. The dorsal surface is rounded covered with numerous wartlike papillae and the flattened ventral surface is soft and contains broad rows of podia with suckers on their tips. The tegument is thick and leathery and mottled with brown, yellow and orange color. Its ventrally located mouth contains 20 to 30 peltate tentacles and its anus contains five calcareous teeth. This species contains cuvierian tubules that differ from others, as they are not adhesive and can not elongate. Spicules from the podia and body wall consist of rosettelike elements varying in shape from

very simple “dog biscuit” shapes to complex rods with dichotomously branched ends. Perforated plates and rodlike spicules on the ventral podia and body wall are also found (Fig. 2C). Spicules from their tentacles are rod shaped and vary in size from 16.5 to 356.4 μm in length.

Distribution: Florida, Bermuda, Bahama Islands, Cuba, Belize, Hispaniola, Jamaica Barbados. Depth 0-54 m (Pawson 1986, Hendler *et al.* 1995)

Biology: *Actinopyga agassizi* is a nocturnal species that seeks cover on coral heads, rubble or seagrass during the day. They forage on algal turf, seagrass meadows and in rubble or sand covered areas. The commensal pearl fish, *C. bermudensis*, is frequently found inside their digestive tract or respiratory tree. Edwards (1889) reports the reproduction of *A. agassizi* this species between July and August in Bahamas.

Isostichopus badionotus

Observations of Examined Material:

Two individuals (ul=38 cm, dorsal coloration: orange with dark warts; ul=18 cm, dorsal coloration: uniform dark brown) were collected at 5 m depth on muddy substrate on leeward slope of Cayo Menor (Fig. 1). Both specimens were encountered inside a PVC 10 inch wide tube used as building material for an artificial reef. A third specimen was collected (ul=42 cm, dorsal coloration: orange with dark warts) at 4 m depth on a coral shelf containing

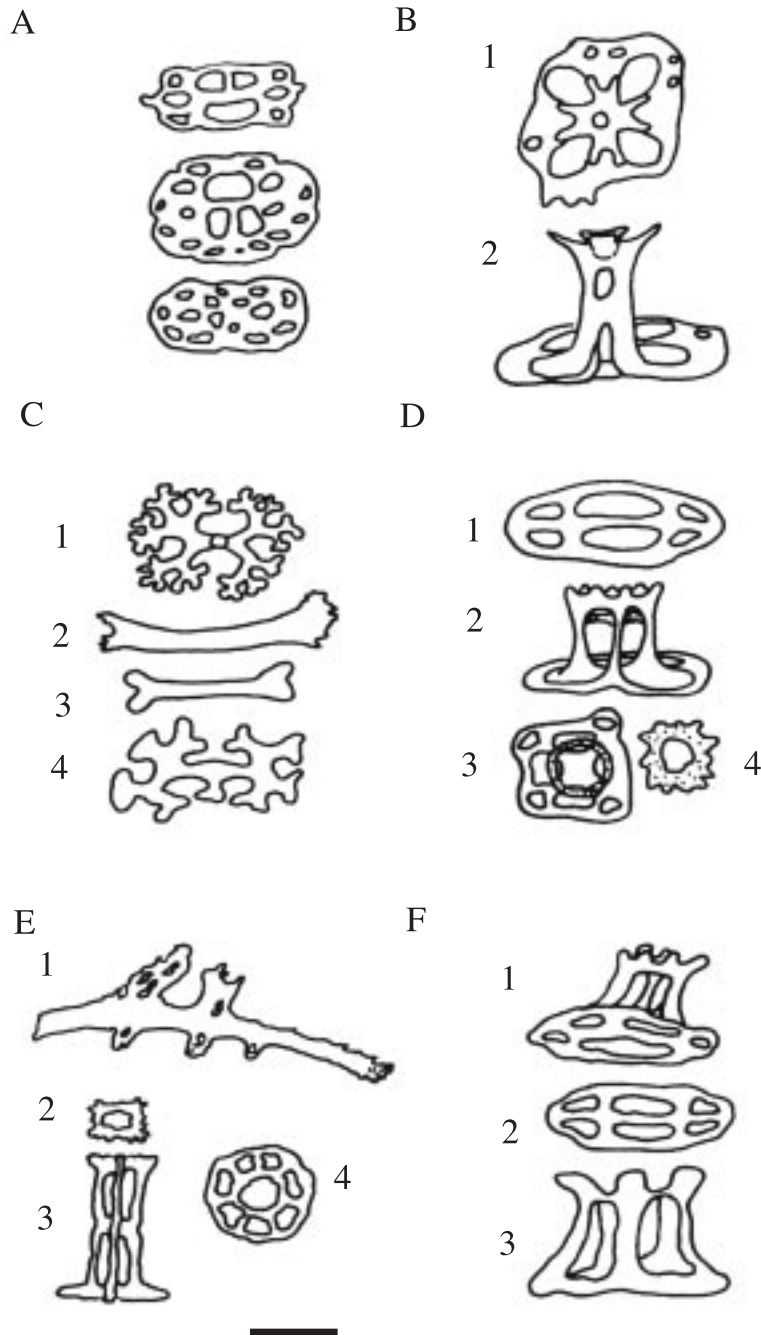


Fig. 2. Holothurian spicules from Cayos Cochinos, Honduras: A) *Holothuria mexicana*: variety of forms of buttons; B) *H. mexicana*: (1) top view of table, (2) side view of table; C) *Actinopyga agassizii* (1) rosette (2) rod from tentacles (3) rod from ventral tegument (4) variation in shape of rosettes; D) *H. thomasi*: (1) button (2) side view of table (3) top view of table (4) variation in shape of top view of table; E) *Isostichopus badionotus*: (1) bars that hold podia (2) top view of table (3) side view of table (4) bottom view of table; F) *H. arenicola*: (1) base of table (2) button (3) side view of table. Bar: 25 μm for all except E (1)=175 μm ; C (2)=125 μm ; C (3), D (1), B (1) and B (2)=15 μm .

patches of *Thalassia* meadow, on the same Cayo Menor. All three individuals were collected during night dives. This species was only observed to feed by night and was not encountered frequently.

Description: *I. badionotus* is a large species growing to a length of 45 cm and suffers little deformation and contraction under water. The ventro-lateral surface is covered by cone shaped papillae and their ventral podia are arranged in three distinct rows located lengthwise on their flattened surface. They possess a rounded dorsal surface covered by many dark warts and its tegument is thick and rigid. The mouth of this species is located ventrally and contains approximately 20 peltate tentacles and their gonads are attached by the gonadoduct and arranged into two bundles. Spicules from the body wall consist of abundant tables with a small disc and from 12 to 14 spines on their terminal end and of less abundant C-shaped elements. Their podia are held by long bar-shaped elements (Fig. 2E). The spicules from the tentacles are mainly rods, with fewer buttons and tables (25:5:1, respectively). Rods average 117 μm in length, while buttons average 62 μm and tables 59 μm measured from their base. This species can vary in coloration, ranging from hues of yellow, orange, red, brown and purple.

Distribution: Bermuda, South Carolina, Florida, Bahamas, Texas, Mexico, Belize, Panama, Colombia, Venezuela, Caribbean Islands as far south as Brazil, Ascención Islands and Gulf of Guinea. Depth: Low-tide mark to 65 m. (Hendler *et al.* 1995).

Biology: This is a principally a nocturnal species which initiates feeding in the afternoon and peaks before midnight and is rather sluggish, moving at approximately 0.5 m per day (Hammond 1982). It has been observed in fully exposed in bottoms covered by mud, sand or rock, and patches of seagrass (*Thalassia* and *Syringodium*) or coral. Adults are solitary and remain exposed while juveniles attach themselves to the underside of rocks, rubble or coral slabs (Hendler *et al.* 1995).

Holothuria (Thymiosycia) arenicola

Observations on Examined Material:

Three specimens were collected (cl=13 cm, 14.5 cm, 15 cm) on a 1 m deep sand plain close to the intertidal zone and on the leeward section of Cayo Menor. Specimens of *H. arenicola* were found buried under prominent conical mounds, approximately 15 cm deep into the sandy substrate. Conical mounds from this species were frequently observed at the inner reef flats closely associated with sandy bottoms and *Thalassia* meadows between one and two m in depth at Cayo Mayor, Cayo Largo Arriba and Cayo Largo Abajo, (Fig. 1).

Description: *H. arenicola* is a medium sized holothuroid reaching 20 cm in length. Their skin is thin and wrinkled and the dorsal and ventral surfaces are very similar with podia scattered throughout their body. The mouth contains 20 small peltate tentacles and is terminally located. They are light brown, tan or pale gray with dorsal longitudinal rows or blotches of dark coloration. They do not possess Cuvierian tubules and their body spicules consist of abundant buttons averaging 62 μm in length and having either three or six pairs of elongated holes. Tables are also present but less abundant and contain between eight and 12 terminal spines and have a circular or square disk perforated by four to eight marginal and four central holes (Fig. 2F). This species' podia are held by long bars having several holes. Their tentacles are also composed of rods that average 135 μm long.

Distribution: This is a littoral species reported to occur circumtropically, from Bermuda to Brazil, including the Gulf of Mexico and Florida Keys (Hendler *et al.* 1995).

Biology: *H. arenicola* is a burrowing species that produces large, conical mounds on sandy surfaces including seagrass meadows. However it has been found under rubble and in dead conch shells. They ingest both surface and subsurface sediments through a funnel that ends 15-20 cm below the surface (Mosher

TABLE 1

Morphometrics of table shaped spicules. Isostichopus badiionotus (I.b.), Holothuria thomasi (H.t.). Measurements in μm . Values should be read as mean \pm standard deviation; minimum-maximum (sample size)

Species	Origin	Top Width	Base Width	Height
I. b.	Tegument	27.2 \pm 1.44; 26.4-29.7 (17)	41.2 \pm 4.97; 33-49.5 (17)	44.25 \pm 1.67; 42.9-46.2 (17)
H.t.	Tegument	27.06 \pm 2.08; 26.4-33 (10)	48.9 \pm 3.41; 42.9-52.8 (10)	32.67 \pm 1.04; 29.7-33 (10)
I.b.	Tentacles	27.2 \pm 1.49; 26.4-29.7 (12)	59.1 \pm 2.26; 56.1-62.7 (12)	33.55 \pm 1.26; 33-36.3 (12)

TABLE 2

Morphometrics of button shaped spicules. Isostichopus badiionotus (I.b.), Holothuria thomasi (H.t.), Holothuria mexicana (H.m.) Holothuria arenicola (H.a.). Measurements in mm. Values should be read as mean \pm standard deviation; minimum-maximum (sample size)

Species	Origin	Length	Width
H.m.	Tegument	28.95 \pm 3.69; 23.1-36.3 (31)	25.44 \pm 1.95; 19.8-29.7 (31)
H.t.	Tegument	60.6 \pm 7.28; 46.2-82.5 (48)	25.2 \pm 4.18; 13.2-42.9 (48)
I.b.	Tegument	63.36 \pm 5.99; 56.1-72.6 (10)	27.72 \pm 3.55; 23.1-33 (10)
H.a.	Tegument	61.96 \pm 8.15; 49.5-82.5 (27)	19.92 \pm 3.72; 13.2-29.7 (27)
I.b.	Tentacles	62.13 \pm 5.6; 56.1-72.6 (12)	27.22 \pm 4.48; 19.8-33 (12)
H.m.	Tentacles	28.23 \pm 4.08; 23.1-33 (9)	25.66 \pm 3.61; 19.8-29.7 (9)

TABLE 3

Morphometrics of rod shaped spicules. Isostichopus badiionotus (I.b.), Actinopyga agassizi (A.a.), Holothuria thomasi (H.t.), Holothuria mexicana (H.m.) Holothuria arenicola (H.a.). Measurements in mm. Values should be read as mean \pm standard deviation; minimum-maximum (sample size)

Species	Origin	Length	Width
H.t.	Tentacles	107.9 \pm 84.5; 16.5-356.4 (53)	7.78 \pm 7.18; 3.3-33 (53)
I.b.	Tentacles	117.97 \pm 127.19; 29.7-495 (52)	9.44 \pm 10.8; 3.3-49.5 (52)
H.m.	Tentacles	109.56 \pm 35.39; 59.4-204.6 (30)	10.23 \pm 5.08; 3.3-23.1 (30)
A.a.	Tentacles	106.71 \pm 56.49; 33-346.5 (71)	9 \pm 6.57; 3.3-49.5 (71)
H.a.	Tentacles	135.3 \pm 51.24; 52.8-214.5 (12)	7.13 \pm 1.91; 3.3-9.9 (12)

TABLE 4

Morphometrics of rosette shaped spicules (including "bone shaped" biscuits). Actinopyga agassizi (A.a.). Measurements in μm . Values should be read as mean \pm standard deviation; minimum-maximum (sample size).

Species	Origin	Length	Width	No. Terminal Ends
A.a.	Tegument	30.128 \pm 6.856; 23.1-62.7 (71)	5.62 \pm 1.271; 5-13.2 (71)	6.41 \pm 2.259; 3-16 (71)

1980). They burrow with their anterior end (Caycedo 1978).

Holothuria (Thymiosycia) thomasi

Observations on Examined Material:
Two individuals (rl=129 cm, 158 cm) were

collected from Cayo Menor and Cayo Gallo respectively, on leeward coral patches at five to six m depth. One specimen (rl=173 cm) was collected from Pelican Point, Cayo Mayor at seven m depth. This species was also observed at various points of the Cayos Cochinos Archipelago (Cayo Mayor-windward and

leeward slopes; Cayo Paloma -leeward slopes; coral shelves between Cayo Paloma and Chachahuate and between Cayo Menor and Cayo Paloma) at depths ranging from four m to 21 m (Fig. 1). *H. thomasi* was frequently encountered during night dives and always associated with hermatypic corals, lodged in crevices and extending approximately one third to half of their anterior sections into the sandy substrate when feeding. Individuals were also observed to feed during the day and late afternoon, but with less frequency. Individuals kept in aquariums were only active during the night.

Description: *H. thomasi* is the largest holothuroid in the western Atlantic reaching 200 cm in length. Its body is elongated, cylindrical and very contractile with a slight dorsoventral flattened surface containing scattered cylindrical podia. The dorsal surface is scattered by conical papillae. Their skin is soft and of mottled yellow to golden brown and the dorsal papillae have white tips. The oral cavity is ventrally located containing 20 peltate tentacles and their gonads are attached on a single tuft; the highly adhesive Cuvierian tubules are present. Their body spicules consist of tables and buttons. Tables have irregular or squared margins and perforated by a ring of 12 marginal and four central holes and average 48 μm in length measured from their base and their terminal ends are formed by 18-20 spines that surround a large perforation. Buttons are more frequent than tables (5:1 ratio). Buttons are elongated and usually with six elongated holes (Fig. 2D). Tentacles have rods with spinelike projections.

Distribution: This species is distributed widely in the Caribbean Sea (Bahama Islands, Florida Keys, Cuba, Puerto Rico, St. Croix, St Vincent, Belize), Gulf of Mexico, Colombia. Depth: 3-30 m. (Pawson and Caycedo 1980, Hendler *et al.* 1995).

Biology: *H. thomasi* is a cryptic organism and seen when feeding with its anterior end extending from coral crevices. When disturbed they rapidly retreat making it difficult to dislodge them from the coral structures. They are

active during the night, feeding on sand particles and algae covered substrates (Hammond 1982). This species can eject Cuvierian tubules and may host *Carapus* (Hendler *et al.* 1995).

Holothuria (Halodeima) mexicana

Observations on Examined Material:

Two individuals were collected on East End, Cayo Mayor, inner reef flat between 1 and 2 m in depth in *Thalassia* covered substrate. A single pearl fish, *C. bermudensis*, observed inside the digestive tract of one of these specimens. Three additional specimens of *H. mexicana* were collected at Cayo Menor leeward coral patch 2 to 5 m in depth. Frequently, specimens were covered partially or totally by debris and seagrass blades and, in some occasions, individuals were found totally clean, as if shedding their surface tegument. *H. mexicana* was easily observed from the boat or while diving and was considered to be the most conspicuous species in the Cayos Cochinos archipelago. Highest densities of this species were found at the inner reef flat of three islands: Cayo Largo Arriba (10.2 animals per transect), followed by Cayo Mayor (six per transect) and Cayo Menor (two per transect). Smaller individuals (ul \leq 15 cm) were always found in shallow, secluded seagrass meadows less than one m in depth. Larger animals (ul \geq 25 cm) only inhabited deeper waters (six to 22 m).

Description: *H. mexicana* is a large species that reaches 50 cm in length. Their bodies are very rigid and have large dorsal and lateral folds. In adults, the dorsal surface is either dark brown, gray or black. Some juveniles might be lighter brown and yellow. The ventral surface of this species varies greatly between bright red, pink, orange, white, gray and dark purple and black. A white ventral border is frequently observed. Both oral and aboral ends are rounded, their mouths are ventrally located containing 20-22 peltate tentacles and their body is smooth with few warts. Podia are scattered ventrally and possess smaller papillae located dorsally and laterally that tend to hold detritus, seagrass blades and algae. The body

spicules (Fig. 2A) are composed of slightly elongated buttons averaging 29 μm in length; tables and to a lesser extent, perforated plates, are also present. Tentacles are composed of mainly rod shaped spicules averaging 109 μm in length, but buttons are also present (4:1 ratio).

Distribution: *H. mexicana* is distributed widely along the Florida Keys, Bahama Islands, Cuba, Puerto Rico, Jamaica, Barbados, Tobago, Aruba, Yucatan Peninsula, Belize, Bonaire, Venezuela and islands off Colombia, at depths from 0.5 to 20 m (Hendler *et al.* 1995).

Biology: This conspicuous species inhabits a variety of biotopes as seagrass beds, coral reefs and patches, sand platforms and rock terraces. They are not easily disturbed and possess no Cuvierian tubules. According to studies performed by Hammond (1982) in Jamaica, their feeding activity is mainly during late afternoon and increasing until midnight. Both males and females reproduce by elevating their anterior two-thirds of their bodies and releasing gametes in an intermittent fashion. This species is also host for the commensal pearl fish.

DISCUSSION

Considering the shallow water holothurians documented for the Caribbean Sea (Miller and Pawson 1984) it is possible that as many as 31 species could occur in this archipelago. The five species reported here were observed throughout 9 months of study. This low number of species can be due to a variety of reasons, including the degradation or unsuitability of the marine habitat due to its proximity to the coast. The Aguán River and other smaller river systems empty their contaminated waters near the archipelago. Holothurians have never been harvested in this area therefore direct human impact is not likely. *H. mexicana* was by far the most conspicuous and most easily encountered species of all. On the same hand, *H. arenicola* mounds were also frequently observed, however these were restricted to the

sandy intertidal areas. The presence of *H. thomasi*, a cryptic species rarely encountered (Pawson and Caycedo 1980) reflects the urgent need to preserve this marine ecosystem. Sightings of *I. badionotus* were also considered rare events. Acknowledging the fact that the Mexican harvest of its close relative, *Isostichopus fuscus* has been recently banned (Herrero 1994), *I. badionotus* might become a targeted fishery resource. Due to their easy capture, these echinoids could become locally endangered if their harvest would be permitted without information on their status, demography and ecology. Additional work in these areas would benefit fisheries and protected area managers in the region.

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RESUMEN

Se presentan aspectos sobre la taxonomía y biología de cinco especies de holoturias de aguas someras de la Reserva Biológica de Cayos Cochinos-CCBR, ubicada en la plataforma norte del Mar Caribe de Honduras a los 16° N, 86° W. Este artículo provee la clave taxonómica correspondiente y descripciones morfológicas y morfométricas de las espículas de los holotúridos documentados. Las cinco especies pertenecen a un solo Orden (Aspidochirotida) y a dos familias: Stichopodidae (*Isostichopus badionotus*) y Holothuriidae (*Holothuria mexicana*, *H. thomasi*, *H. arenicola* y *Actinopyga agassizi*). Adicionalmente, se documenta la presencia del pez comensal *Carapus bermudensis* dentro de *H. mexicana* y *A. agassizi*.

REFERENCES

- Caycedo, I.E. 1978. Holothuroidea (Echinodermata) de aguas someras en la costa norte de Colombia. An. Inst. Inv. Mar. Punta Betón 10: 149-198.

- Clark, H.L. 1919. The distribution of littoral echinoderms of the West Indies. Carnegie Inst. Pap. Dep. Mar. Biol. 13: 49-74.
- Clark, H.L. 1933. A handbook of the littoral echinoderms of Porto Rico and the other West Indian Islands. Sci. Surv. Porto Rico, Virgin Islands 16(1): 1-147.
- Conand, C. 1989. The fishery resources of the Pacific island countries: Part 2: Holothurians. FAO Fisheries Tech. Paper, Rome. FAO No. 272.2. 143 p.
- Deichemann, E. 1926. Report of the holothurians collected by the Barbados-Antigua Expedition. Stud. Nat. Hist. Univ. Iowa 11(7): 9-31.
- Deichemann, E. 1930. The holothurians of the western part of the Atlantic Ocean. Bull. Mus. Comp. Zool. Harvard Univ. 71(3): 41-226.
- Deichemann, E. 1940. Report on the holothurians collected by the Harvard-Havana Expeditions 1938 and 1939, with revision of the Molpadonia of the Atlantic Ocean. Mem. Soc. Cubana Hist. Nat. 14(3): 183-240.
- Deichemann, E. 1963. Shallow water holothurians known from the Caribbean waters. Stud. Fauna Curaçao 14: 100-118.
- Domantay, J.S. 1959. Some holothurians from Florida in the collections of the Allan Hancock Foundation. Agra Univ. J. Res. Sci. 7: 181-202.
- Edwards, C.L. 1889. Notes on the embryology of *Mülleria agassizi*, Sel, a holothurian common at Green Turtle Cay, Bahamas. John Hopkins University Circulars 8: 37.
- Engel, H. 1939. Echinoderms from Aruba, Curacao, Bonaire and northern Venezuela. Capita Zool. 8: 1-12.
- Fontaine, A. 1953. The shallow water echinoderms from Jamaica. Part IV. The sea cucumbers (Class Holothuroidea). Nat Hist. Notes. Nat. Hist. Soc. Jamaica. Nos. 62, 63: 29-33.
- Hammond, L.S. 1982. Patterns of feeding and activity in deposit-feeding holothurians and echinoids (Echinodermata) from shallow water reef lagoon, Discovery Bay, Jamaica. Bull. of Mar. Sci. 32: 549-571.
- Hendler, G., J.E. Miller, D. Pawson & P.M. Kier. 1995. Sea stars, sea urchins and allies: echinoderms of Florida and the Caribbean. Smithsonian Inst. pp. 251-382.
- Herrero, M.D. 1994. Estudio comparativo de la reproducción de *Isostichopus fuscus* (Ludwig 1875) y *Neothyrone gibbosa* (Deichmann 1942), Echinodermata: Holothuroidea, en Baja de la Paz, Baja California Sur, México. Tesis Maestro en Ciencias Marinas, Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas. La Paz, Baja California Sur, México. 87 p.
- Levin, V.S. & O. Gomes. 1975. The shallow water holothurians of Cuba. Biol. Morya (Vladivost.) 6: 55-62.
- Martínez, A. 1982. Nuevos registros de holoturoideos (Holothuroidea: Dendrochirotida y Apoda) de la región insular del Oriente Venezolano. Bol. Inst. Oceanogr. Venez. Univ. Oriente 21: 113-121.
- Miller, J.E. & D.L. Pawson. 1984. Holothurians (Echinodermata: Holothuroidea). Memoirs of the Hourglass Cruises. Florida Dept. Nat. Res. FL, USA, VII, Part 1: 1-79.
- Mosher, C. 1980. Distribution of *Holothuria arenicola* Semper in the Bahamas with observations on habitat, behaviour and feeding activity (Echinodermata: Holothuroidea). Bull. Mar. Sci. 30: 1-12.
- Pawson, D.L. 1976. Shallow-water sea cucumbers (Echinodermata: Holothuroidea) from Carrie Bow Cay, Belize. Proc. Biol. Soc. Washington. 89: 369-382.
- Pawson, D.L. 1986. Phylum Echinodermata. 522-541. In: W. Sterrer, (ed.) Marine fauna and flora of Bermuda: a systematic guide to the identification of marine organisms. John Wiley and Sons, New York.
- Pawson D. & I.E. Caycedo. 1980. *Holothuria (Thymiosycia) thomasi* new species, a large Caribbean coral reef inhabiting sea cucumber (Echinodermata: Holothuroidea). Bull. Mar. Sci. 30: 454-459.
- Ruzafa, A.P. & C.M. Diego. 1985. Técnicas de recolección y estudio en la clase *Holothuroidea*. I. Generalidades, sistemática, ecología, biología y comportamiento. Universidad de Murcia. Anales de Biología 3 (Biol. Animal 1) 1985: 13-35.
- Tikasingsh, E.S. 1963. The shallow water Holothurians of Curacao, Aruba and Bonaire. Studies Fauna Curacao Carib. Isl. 14: 77-99.
- Trott, L.B. 1981. A general review of the pearlfishes (Pisces: Carapidae) Bull. Mar. Sci. 31: 623-629.
- Uthicke, S. 1996. Beche de Mer: a literature review on holothurian fishery and ecology. Australian Inst. Mar. Sci., Australia. 45 p.

Appendix

Voucher Material Examined:

Actinopyga agassizi: Honduras, Cayos Cochinos, Cayo Largo Arriba: ICIMYL 5.21.6: 15°57'01" N, 86°29'52" W, collected after Hurricane Mitch at 4 m depth on a seagrass bed, *Thalassia testudinum*, leg. C.R. Hasbún, Nov. 1998.

Isostichopus badionotus: Honduras, Cayos Cochinos, Cayo Menor: HCRF 05.98.002: 15°57'30" N, 86°86'31" W, collected at 5 m depth on muddy substrate on leeward slope of Cayo Menor, leg. C.R. Hasbún, May 1998.

Holothuria arenicola: Honduras, Cayos Cochinos, Cayo Menor: HCRF 05.98.003, ICIMYL 5.11.58: 15°56'01" N, 86°30'04" W, collected 1 m depth sand plain close to the intertidal zone and on the leeward section of the island, leg. C. R. Hasbún, May 1998.

Holothuria thomasi: Honduras, Cayos Cochinos, Cayo Menor: HCRF 06.98.004: 15°57'06" N, 86°30'15" W, collected on a coral patch at 5 m depth by C. R. Hasbún, May 1998; Cayo Gallo: ICIMYL 5.85.3: collected on a coral patch at 6 m depth, leg. C.R. Hasbún, June 1998.

Holothuria mexicana: Honduras, Cayos Cochinos, Cayo Mayor, East End: HCRF 03.98.001: 15°58'19" N, 86°28'14" W, collected on the inner reef flat 2 m in depth in *Thalassia* covered substrate, leg. C. R. Hasbún, March 1998; Cayo Menor: ICIMYL 5.9.27: collected on a coral patch at 2 m depth, leg. C.R. Hasbún, June 1998.

Carapus bermudensis: Honduras, Cayos Cochinos, Cayo Largo Arriba: HCRF 11.98.006: 15°57'01" N, 86°29'52" W, found inside *Actinopyga agassizi* ICIMYL 5.21.6, at 4 m depth on a seagrass bed, *Thalassia testudinum*, leg. C.R. Hasbún, Nov. 1998.