Holothuroidea species found in Belizean waters

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Introduction

Most sea cucumber fisheries are ineffectively managed, leading to declining stocks and potentially destroying the resilience of such important fisheries (Purcell et al. 2013). In their global analysis of drivers of sea cucumber overfishing, Purcell et al. (2013) revealed an alarmingly high incidence of overexploitation and depletion of sea cucumber stocks, particularly in the Indo-Pacific. In this region, much of the fishing of tropical sea cucumbers occurs on coral reefs and lagoons, which are under particular threat from global impacts such as climate change and ocean acidification. They note the lack of data on basic biological parameters of most species as a fundamental barrier to improved management of these fisheries and many species being threatened with local extinction.

The demand for sea cucumbers in the Asia and Pacific regions, especially as a food delicacy is the main driver for the overharvesting of various species. The highest number of species is exploited in the Asia and Pacific regions, where Indonesia is the world's top producer of Holothuroidea from the capture fishery. Indonesia, together with the Philippines produced an annual average of 47% of the world's Holothuroidea landings, comprising an annual average of 2,572 t (wet weight) between 2000 and 2005 (Choo 2008). A few sea cucumber species within the regions of Mexico, Central America and South America are commercially exploited; with most species lacking biological and ecological studies that would otherwise guide management plans for sustainable resource use (Toral-Granda 2008). Only Cuba, Peru, Chile, Mexico and Ecuador have regulated fishing activities, with Mexico and Ecuador focusing mostly on *Isostichopus fuscus*, and Mexico, to a lesser degree, on *Parastichopus parvimensis* (Toral-Granda 2008). Recently, however, other species such as *Holothuria fuscocinerea, H. inornata* (Benítez-Villalobos et al. 2013), *H. mexicana*, *H. floridana*, *Astichopus multifidus* and *Isostichopus badionotus* (Solís-Marín and Honey-Escandón 2014). In Belize, *H. mexicana* and *I. badionotus* have been legally fished since 2009 (Perez and Garcia 2012).

Of the 52 commercially exploited species reported by Purcell et al. (2012) most are tropical and subtropical species belonging to the families Holothuroidea and Stichopodidae. The systematic character of these or any other holothurian can be identified with the use of spicules (Pawson and Barraclough-Fell 1965). Toral-Granda (2005) suggests that using spicules can be particularly useful in identifying species illegally traded as, for example, when Galapagos *Isostichopus fuscus* had been impounded in the Galapagos National Park Service. The use of spicules in holothuroid identification is useful because some species have similar morphology and once processed, some species may look alike. Likewise, changes in morphology also occur during somatic growth from juvenile to adult stages (Cutress 1996). Depending on the species, these spicules constitute about 3–70% of the dry weight of the holothuroid body wall (Pawson et al. 2010) and may show a great variety of forms.

Although there have been only few arrests in the sea cucumber fishery in Belize, illegal harvests exist (Perez and Garcia 2012). The objective of this study was to confirm the identification of five species by spicule morphology. This study will fill a small gap, helping to create baseline information about sea cucumber species that may have market potential.

Methodology

Six species of sea cucumbers from southern Belizean waters were handpicked by free divers in the main lagoon between the Belize Barrier Reef, and near the mainland from Independence Village and Punta Gorda Town, between 2009 and 2015. Each individual was photographed, its morphological features studied, and regional geographic range noted. Individuals were subsequently preserved in methanol. Spicules were prepared using established methodologies (Purcell et al. 2012). The spicules were photographed and the species identified using identification guides by Purcell et al. (2012) and Pawson et al. (2010).

Results

In all samples, the spicules remained distinguishable although they were in a preserved state. The species and their extracted spicules are presented below.

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Holothuria mexicana (juvenile) (Fig. 1) exhibited the following spicule shapes (Fig. 2): ventral body wall: biscuit (A); dorsal body wall: developing biscuit shape (B); podia: developing biscuit shape (C and D); mouth: developing biscuit shape (E and F); anus: developing biscuit shape (G); table (H); biscuit shape (I).

Isostichopus badionotus (Fig. 3) exhibited the following spicule shapes (Fig. 4): ventral body wall: rod (A), table (B), C-shaped (C); dorsal body wall: C-shaped (D), table (E); podia: biscuit shape (F), perforated plate (G), rod (H); ventral mouth area: table (I); ventral anus area: table (J).

Actinopgya agassizii (Fig. 5) exhibited the following spicules (Fig. 6): ventral body wall: rosette (A); dorsal body wall: rosette (B); mouth: rod (C); anus: rosette (D).

Figure 1. Live specimen of *Holothuria mexicana* (image: Arlenie Rogers)

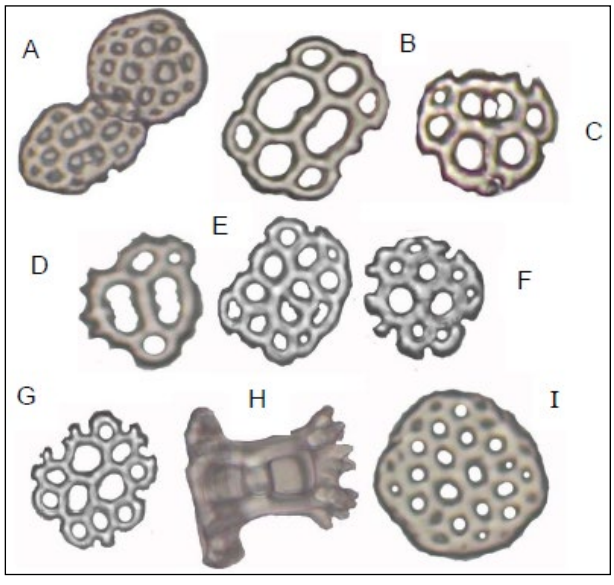

Figure 2. Microscopic images of *Holothuria mexicana* spicules. (image: Janel McNab)

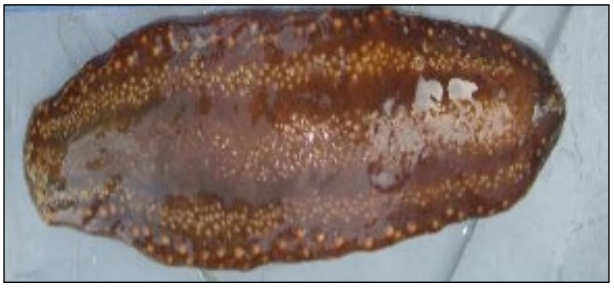

Figure 3. Live specimen of *Isostichopus badionotus.* (image: Arlenie Rogers)

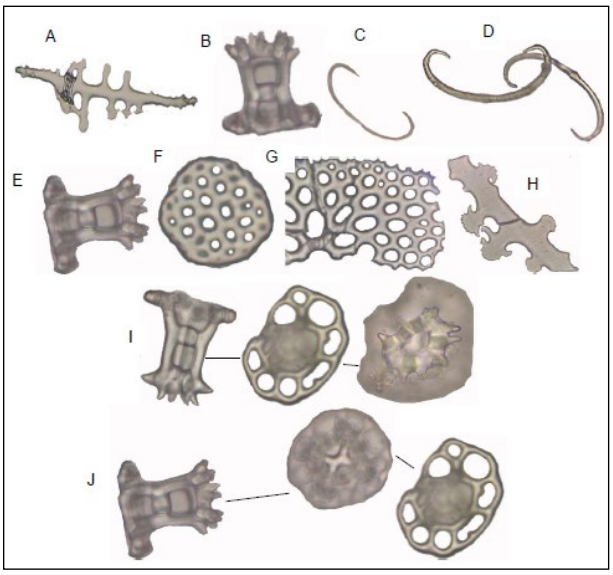

Figure 4. Microscopic images of *Isostichopus badionotus* spicules. (image: Janel McNab)

Figure 5. Live specimen of *Actinopgya agassizii*. (image: Arlenie Rogers)

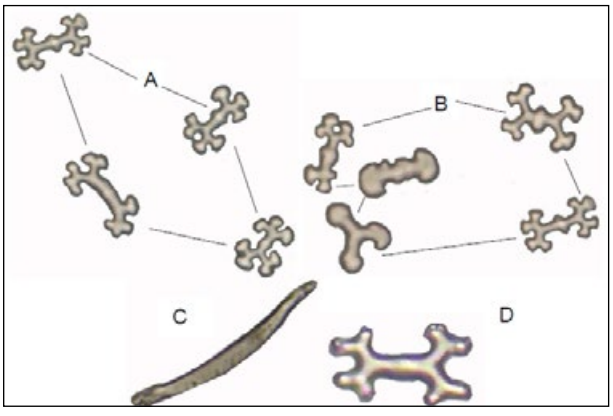

Figure 6. Microscopic images of *Actinopgya agassizii* spicules. (image: Janel McNab)

Holothuria mexicana (Fig. 7) exhibited the following spicules (Fig. 8): ventral body wall: biscuit shape (A); dorsal body wall: table (B), biscuit shape (C), biscuit shape (D); podia: biscuit shape (E); mouth area: biscuit shape (F), rod (G); anus: rod (H), biscuit shape (I & J), table (K).

Astichopus multifidus (Fig. 9) exhibited the following spicules (Fig. 10): ventral body wall: O-shape (A), C-shape (B), miliary granules (C), rod (D); dorsal body wall: O-shape (E), C-shape (F), miliary granules (G); mouth: rod (H), C-shape (I), miliary granules (J); anus: C-shape (K) and miliary granules (L).

Holthuria thomasi (Fig. 11) exhibited the following spicules (Fig. 12): ventral body wall: smooth button (A), table (B); dorsal body wall: smooth button (C), rod (D), table (E); podia: perforated plate (F) and smooth button (G); mouth: smooth button (H) and table (I); anus: rod (J) and table (K).

Figure 7. Live specimen of *Holothuria mexicana*. (image: Arlenie Rogers)

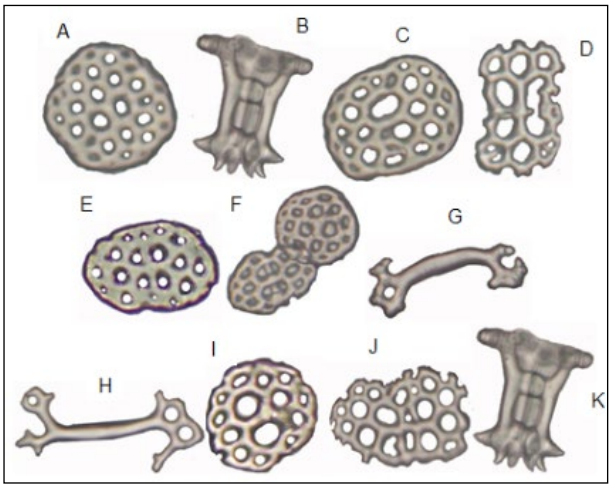

Figure 8. Microscopic images of *Holothuria mexicana* spicules. (image: Janel McNab)

Figure 9. Live specimen of *Astichopus multifidus*. (image: Jane Salazar)

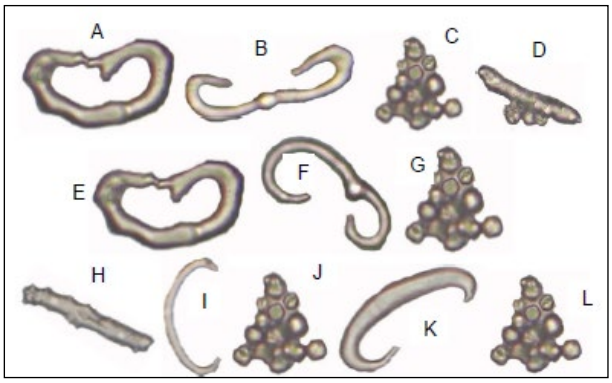

Figure 10. Microscopic images of *Astichopus multifidus* spicules. (image: Janel McNab)

Figure 11. Live specimen of *Holthuria thomasi*. (image: Arlenie Rogers)

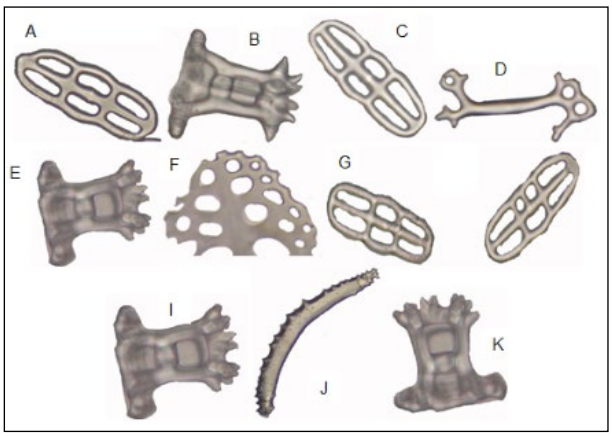

Figure 12. Microscopic images of *Holthuria thomasi* spicules. (image: Janel McNab)

Discussion

The use of spicules for identification is a rather simple method and can be completed within a few hours (Toral-Granda 2006). This is especially useful in developing countries, such as Belize, that lack expertise and technology to complete other identification methods such as the use of molecular analyses.

Although only *Holothuria mexicana* and *Isostichopus badionotus* are fished for in Belize, other commercial species can be found there, including *Actinopyga multifidus* and *A. agassizii* and *H. thomasi*. These results will hopefully provide useful information on the species found in Belize and aid in the identification of harvested species.

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