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Observations on some biological characteristics of *Holothuria polii* and *Holothuria sanctori* from mediterranean Egypt

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Abstract
The study presents the first reported case of *Holothuria sanctori* distribution in the Egyptian Mediterranean coast and its biological characteristics, including *Holothuria polii* as the most common and over-exploited holothurians in the region. A total of 103 *H. polii and* 87 *H. sanctori* samples were collected based on their distinctive morphometric characteristics and ossicle composition. The calcareous structures of *H. polii* have the form of rugose buttons and short tables with maltese crown ossicles, rods and perforated plates, while the ossicle structures of *H. sanctori* are in the form of buttons with various sizes, smooth edge and different numbers of holes. *H. sanctori* was found on rocky substratum and rocky cavities at 5-22 m depth while *H. polii* was sampled from rocky and sandy substratum of 2-12 m depth. Results on studies of weight frequency distribution in both species have showed the heavy impact of over fishing in the region leading to the loss of large size class individuals.

Keywords: *Holothuria polii, Holothuria sanctori*, ossicles, weight frequency, Mediterranean Sea, Egypt

1. Introduction

Holothurians (sea cucumbers) are diverse organisms, considering as key creatures in marine ecosystems for having a considerable ecological importance [1]. They greatly affect the physico-chemical processes of soft-bottom and reef ecosystems [2] through their benthic bioturbation activity [3] and excretion of inorganic nitrogen and phosphorus that enrich the productivity of benthic biota [2]. Economically, they are known for their aphrodisiac property, as a rich source of protein containing up to 83.0% [4] and bioactive compounds such as chondroitin sulphate and mucopolysaccharides [5]. Also, they contain vitamin A, thiamin, riboflavin, niacin, calcium, iron, magnesium and zinc [6, 7]. Sea cucumber extracts have shown anticancer, antimicrobial, and antioxidant properties besides aiding in wound-healing [8]. Because of these, the global market demand has increased greatly resulting in overfishing of different sea cucumber stocks without adequate fishery management [9]. The overfishing of holothurian stocks in the Indo-Pacific region has resulted in increased catches of holothurian species found in the Mediterranean region which were not previously considered economically important [10].

In Mediterranean Sea, around 37 holothurian sea cucumber species are recorded from 1400 reported sea cucumber species worldwide [11]. *Holothuria mammata*, *H. tubulosa*, *H. forskali, H. sanctori* and *H. polii* are the most common Mediterranean holothurian species [12]. Of these, *H. polii* was the preferred target species in sea cucumber fishery [1]. It has an average protein content of 7.88–8.82%. The daily minimum requirement for adult of animal protein was measured at 87.86 g of *bêche de mer* product of *H. polii* [13]. Also, triterpene glycosides metabolites of *H. polii* showed anti-metastatic activity which could be an alternative natural anti-metastatic agent to current synthetic agents [14]. Besides, it is used as a biological model in assessing microevolution against environmental gradient [15]. Wherase *H. sanctori* is utilized in many Mediterranean countries for commercial purposes and for its saponine [16]. In aquaculture, it has an important role in the management of multi-trophic aquaculture systems through high OM concentrations absorption from off-shore sediments beneath fish cages during gonads development [17]. *H. sanctori* was also an efficient biofilter of nitrogen in the sediments returning them to normal conditions [18].

Although several studies have been published on sea cucumbers, little is known about holothurian culture in the Mediterranean Sea. In Egypt, its culture started in 1990, wherein sea cucumbers are gathered and processed for export to Asian market [19,20] making it an important sea cucumber supplier. However, information on the approximate total volume of sea cucumber harvest from the Egyptian sea remained unavailable due to improper reporting of harvest and proliferation of illegal exportations [21].

Identification of the exploited species is fundamental to fisheries management [22]. In holothurian, the calcareous structures are vital in the identification of specific/individual species [23]. Despite this information, detailed description of different calcareous structures in the Egyptian Mediterranean sea cucumber species remained nil and not available. With the discovery of presence of *H. sanctori* in the Egyptian sea water, attempts were made to provide details on its calcareous structures. Also, description of the calcareous structures of *H. polii* was done, being the most abundant and exploited species in the Mediterranean Sea.

2. Materials and Methods

A total of 103 *Holothuria polii* and 87 *H. sanctori* specimens were collected through Scuba diving at depth of 5 - 22 m from Miami (31.2713° N, 29.9878° E) and Abu-Qir (31.331° N, 30.0744° E) along Alexandria coast. Specimen' collection was in the morning and transported in plastic containers to the laboratory within 2 hrs. Specimens were anesthetized with the use of 5% magnesium chloride ($MgCl_2$) before measuring its total length (TL) and total weight (TW).

Specimen identification was based on its morphometric characteristics and ossicle composition. Ossicle isolation and preservation from the dorsal and ventral body wall including the tentacles were done according to Wirawati *et al*. (2007). The morphometric measurements were presented as mean values ± standard deviation using IBM SPSS software package**.**

3. Results

Species Description

Holothuria (Platyperona) sanctori (Delle Chiaje, 1823)

Specimens were collected at 5-22 m depth on rocky substratum and from rocky cavities. Body was cylindrical with ventral sole nearly flat; anterior end was narrower than posterior. Body colour was uniformly dark brown (Fig. 1A, 1B) or nearly black (Fig. 1C). Skin was thick and rough with no spines. Dorsal and lateral papillae were large, sparse, and scattered over the surface, sometimes with whitish or beige rings at the base (Fig. 1A, 1B). Twenty peltate tentacles were yellowish-brown with white stalk. Podia were arranged ventrally in 3 lines with suction cups on the ventral surface only. Ventral tube feet were dense.

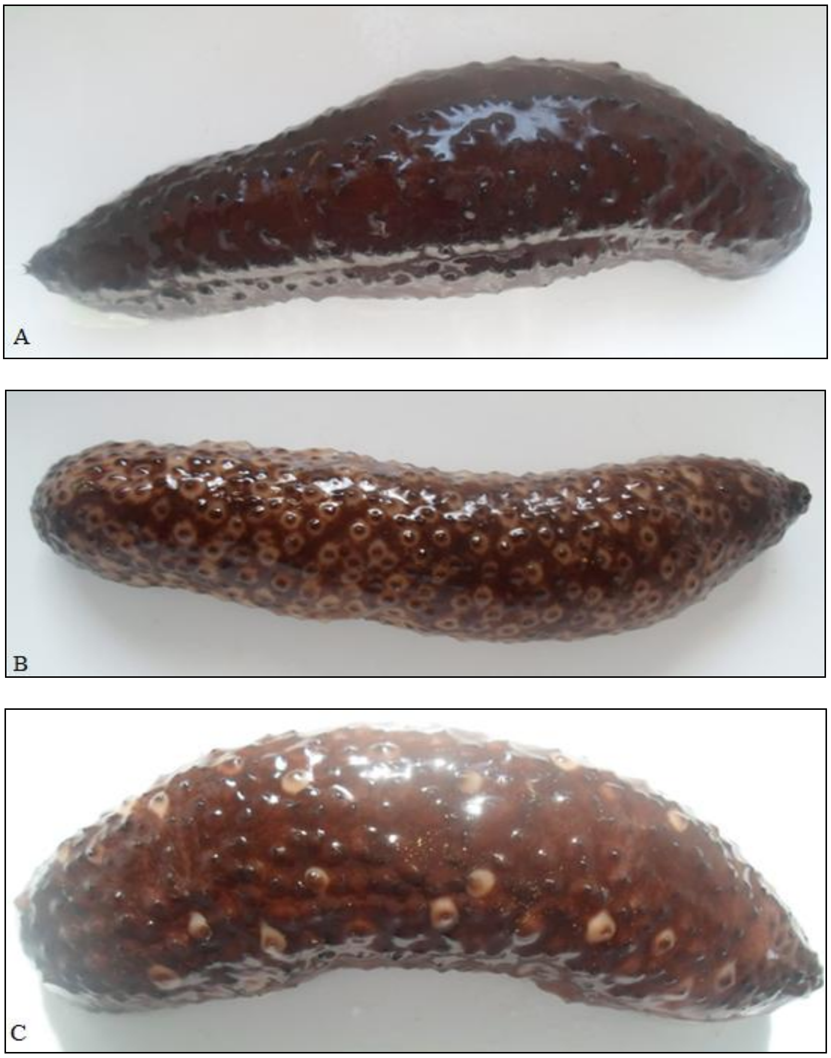

Fig 1: Morphology of *Holothuria (Platyperona) sanctori* Delle Chiaje, 1823.

Ossicles were in the form of buttons, tables, plates and rods. Dorsal and ventral buttons were smooth with median longitudinal line, small knobs on the centre and 4 - 9 pairs of holes (Figs. 2B, 2F), sometimes knobs were absent dorsally (Fig. 2A). Dorsal and ventral tables were moderate in height (Figs. 2D, 2H); disc was rectangular and smooth with one large central hole and 10-12 small peripheral holes; crown was rectangular with small dense spines (Figs. 2C, 2G). Ventral tables were absent in a few specimens. Perforated plates were oval with median longitudinal line and present in the dorsal and ventral surfaces (Figs. 2E, 2I). Tentacle rods were spiny with straight and curved shape; sometimes branched (Figs. 2J, 2L).

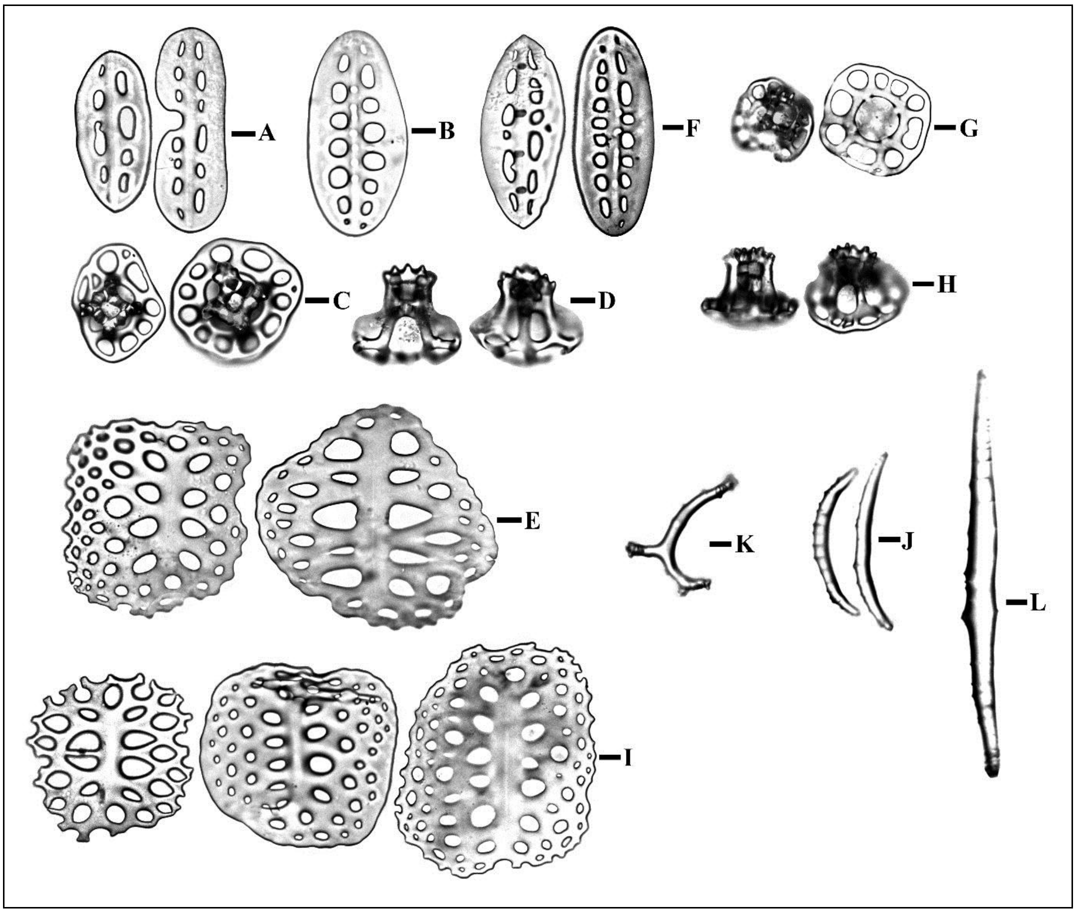

Fig 2: Ossicles of *Holothuria (Platyperona) sanctori* Delle Chiaje, 1823. A. smooth buttons from dorsal; B. knobbed button form dorsal; C & D. tables from dorsal (top & side view); E. plates from dorsal; F. knobbed button form ventral; G & H. tables from ventral (top & side view); I. plates from ventral; J – L. rods from tentacle.

Holothuria (Roweothuria) polii (Delle Chiaje, 1823)

Specimens were collected at 2-12 m depth on rocky and sandy substratum. Body was cylindrical, anterior end was narrower than posterior. Body colour was brown with lighter colour in ventral (Fig. 3). Dorsal papillae were white to yellowish with dark brown circle at the base, small and scattered over the surface. No spines on the skin. Ventral tube feet were white and dense. Peltate tentacles number was 20-22.

Fig 3: Morphology of *Holothuria (Roweothuria) polii* Delle Chiaje, 1823.

Ossicles were in the form of buttons, tables, plates and rods. Dorsal and ventral buttons were knobbed with holes in 1 - 3 pairs which were smooth, sometimes reduced (Figs. 4A, 4G). Rugose buttons were also present in dorsal and ventral, sometimes twisted (Figs. 5B, 5H). Large buttons were present ventrally (Fig. 4I). Dorsal tables were short, disc, rounded and spiny with four large holes centrally and 0 - 4 small holes peripherally, crown was spiny on each corner giving appearance of a maltese cross (Figs. 4C, 4D). Ventral tables were similar to dorsal but were relatively smaller (Figs. 4J, 4K), and rarely found. Dorsal rods were slim with 1 - 2 holes at the extremities (Fig. 4E). Plate-like rods were present in few specimens (Fig. 4F). Ventral rods were with perforated holes, sometimes with spiny rim (Fig. 4L). Perforated and spiny plates were present ventrally (Fig. 4M). Tentacle rods were spiny with few holes at the extremities (Fig. 5A), and occasional presence of branched rods (Fig. 5B).

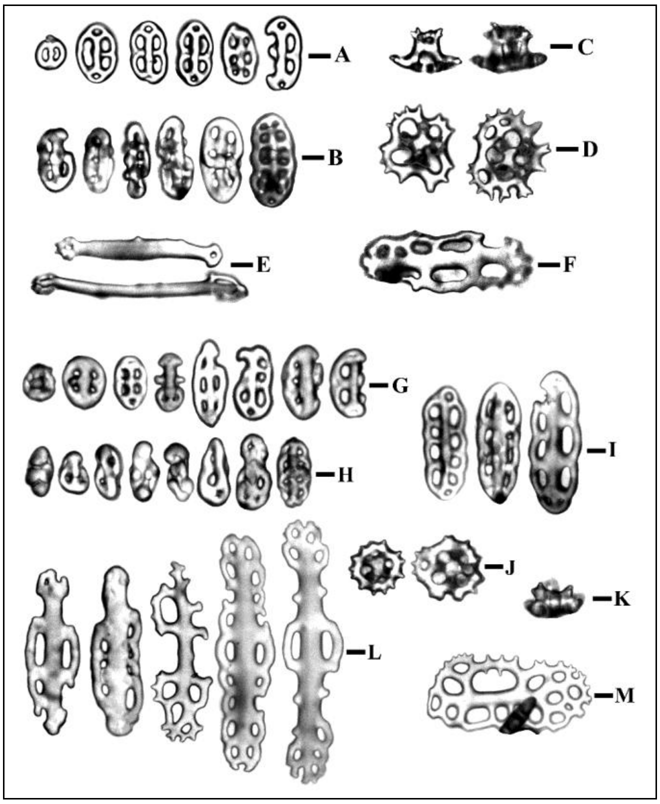

Fig 4: Ossicles of *Holothuria (Roweothuria) polii* Delle Chiaje, 1823. A. smooth and knobbed buttons from dorsal; B. rugosed button form dorsal; C & D. tables from dorsal (side & top view); E. rods from dorsal; F. plate-like rod form dorsal; G. smooth and knobbed buttons from ventral; H. rugosed button form ventral; I. large buttons from ventral; J – K. tables from ventral (top & side view); L. rods from ventral; M. plate from ventral.

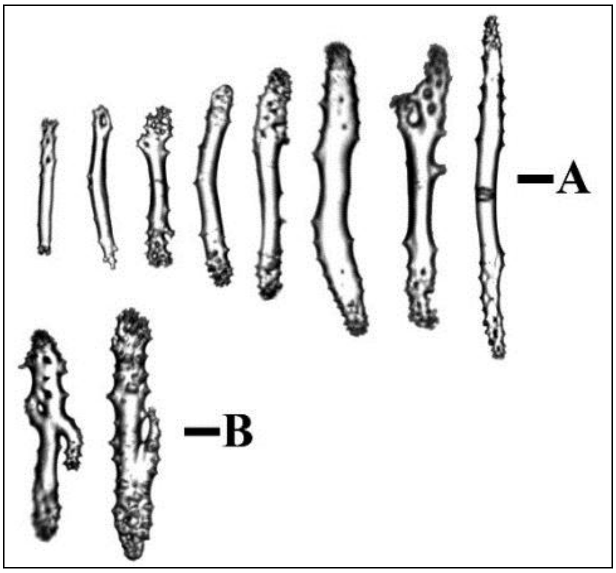

Fig 5: Tentacle rods ossicles of *Holothuria (Roweothuria) polii* Delle Chiaje, 1823. A. Spiny rods; B. branched rods

Weight frequency Distribution

H. sanctori was the dominant species in Miami. Its wet weight was in range of 30-150 g. Both of 51-70 g and 91-110 g size classes were the most frequent among the collected specimens (Fig. 6). The mean wet weight of *H. sanctori* was 84.1±27.0 g. The largest recorded specimen wet weight was 143.55 g.

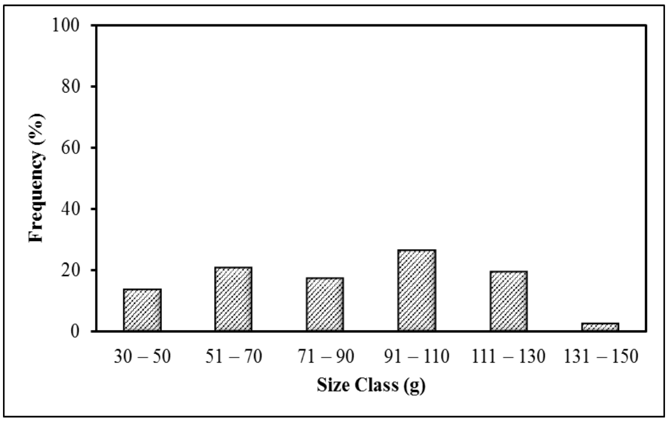

Fig 6: Wet weight frequency distribution of *Holothuria sanctori* from Egyptian Mediterranean coast.

In Abu-Qir, *H. polii* was the dominant species. *H. polii* wet weight was ranged from 20 to 70 g. The most frequent size classes were 31- 40 g and 41-50 g (Fig.7). The mean wet weight was 44.3±11.7 g. The largest collected *H. polii* specimen weighed 65.65 g.

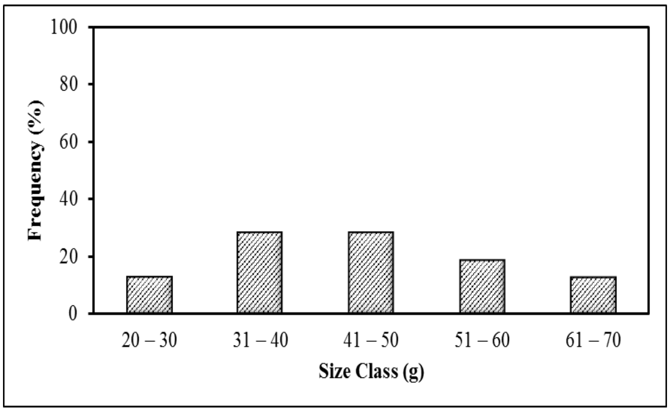

Fig 7: Wet weight frequency distribution of *Holothuria polii* from Egyptian Mediterranean coast

4. Discussion

Mediterranean Sea has a diverse sea cucumber population with great potential for fishery development and aquaculture activities. Sea cucumber economic value reflects its importance to Mediterranean coastal communities. The common sea cucumber species inhabiting the Egyptian Mediterranean Sea are *H. arenicola*, *H. polii*, and *Bohadschia argus* [26, 27]. However, detailed studies on the identification of commercial Egyptian sea cucumbers are lacking, hence this study.

H. sanctori is geographically distributed in Turkey [1], Canary Islands [28], Cape Verde [29], Boka Kotorska Bay [30], Algerian coast [30], Sea of Marmara and Aegean Sea [32], Continental shelf of the Montenegrin coast [33], Northern Aegean sea [34]. Also, it can be found in the Biscayan Gulf, Portugal, Azores, Madeira, Savage Islands, Saint Helena, Croatia, France, Italy, and Mexico [34]. However, *H. polii* was first recorded from Red Sea [36]. Thereinafter, it was recorded in Turkey [1], Boka Kotorska Bay [30], Sea of Marmara [32], and the Continental Shelf in the South-eastern Adriatic Sea [37]. Moreover, it can be found in the Biscayan Gulf, Portugal, Azores, Madeira, Savage Islands, Saint Helena, Croatia, France, Italy, and Mexico [38]. In the present study, *H. sanctori* was discovered at 5-22 m depth in rocky substratum and cavities of Egyptian Mediterranean coast. Similar to previous reports, this species was found in cracks and crevices [33, 34] inhabiting the soft bottoms [32]. Additionally, it was reported to be found at depths of 0 – 50 m in Turkish coasts [32]; 4 – 35 m in Montenegro (Adriatic Sea) [33]; 2 – 30 m in the Azorean Archipelago [39], and 1 – 25 m in Mljet National Park (Adriatic Sea, Croatia) [40].

On the other hand, *H. polii* remained the most commonly cultured sea cucumber species in the Mediterranean region. Although *H. polii* is thinner compared to other holothurian species, its higher dry weight has made it more profitable and popular [41]. Its first recording was in the Red Sea [42]. Thereafter, it was recorded in Turkey [6], Boka Kotorska Bay [30], Aegean Sea [32], and South-eastern Adriatic Sea [33]. It was also reported to be widely distributed in Algeria, Croatia, Italy, Spain, and France [38]. In this study, *H. polii* samples were collected at 2-12 m depth in the rocky and sandy substratum of Mediterranean Sea, though previous reports have suggested its presence at 0-100 m depth of the soft substratum in Turkish coasts [32, 25] and muddy substratum in the South-eastern Adriatic Sea, Montenegro [37].

It is suggested that *H. polii* was introduced to Mediterranean by shipping traffic through Suez Canal which could favour the dispersal during the settled pentacula stage. Suez Canal crossing for any lessepsian species does not guarantee its establishment and colonization; however, its geographical expansion towards greater latitudes is attributed to the temperature increase. Therefore, distribution of *H. polii* and also *H. sanctori* in Mediterranean Sea may be due to either human impacts or climate changes. The fact of being thermophilic species preferring the warm water allows them to adapt in warmer environment colonizing Mediterranean Sea.

Few studies have described some of the calcareous structures such *H. polii* buttons and rods [11, 23] and *H. sanctori* buttons, tables [1, 11] and rods [11]. The present study provides detailed description of their various calcareous structures. The calcareous structures of *H. polii* have the form of tables, rods and perforated plates. *H. polii* has rugose buttons and short tables with maltese crown ossicles which are similar to subgenus *Roweothuria* that described by Thandar [43]. The ossicle structures of *H. sanctori* are in the form of buttons with various sizes, smooth edge and different numbers of holes that are arranged in two rows as mentioned by Aydin [1].

Due to the difficulty of attaining the complete relaxation of sea cucumber that lead to more error of body length estimation than weight [44], the present study estimated the weight frequency distribution. The present recorded weight of *H. polii* was ranged between 22.6 -65.65 g with 44.7 mean total wet weights. On the other hand, Aydin *et al*. [7] mentioned that collected *H. polii* population from Turkish coast of Aegean Sea was at 59.2 g mean total weight, and then Aydin and Erkan [23] reported lower mean weight of 46.3 g. Similarly, the present recorded weight range of *H. sanctori* of 37.8 - 143.55 g was greatly differ from that of the previous studies; it was 34.4 - 175.7 in Canarian Archipelago, Spain [45] and 47.2 - 90.7 in Antalya Gulf Coast, Turkey [46]. The existed weight differences for both species among localities may be attributed to the variability in food availability, the species biology, and fishery pressures. The low measured weight values *H. polii* and *H. sanctori* in the present study as compared to the previous studies reflect the heaviest fishery impact which result in the loss of individuals belonging to larger size classes in particular to *H. polii.* Therefore, it is of maximum priority to direct the future studies to gain more detailed information on their population stocks status, population dynamics and reproductive biology for achieving sustainable economic and ecological benefits.

5. Conclusion

The present study firstly reports the presence and spreading of *H. sanctori* along Alexandria coast, Egypt. The loss of large size class of the most abundant species *(H. polii*) and the most recently spreading species (*H. sanctori*) indicates the current significant overexploitation.

6. Acknowledgment

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