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Identification and some biological characteristics of commercial sea cucumber in the Turkey coast waters

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Abstract
In this study, commercial sea cucumber identification and some biological characteristics were investigated between Ayvalık and Çeşme. Ayvalık, Aliağa, Foça, Şakran and İzmir were selected as main stations. In the investigation where 70 stations were studied between 0 and 50 m depth 6 sea cucumber species were found. These were *Holothuria tubulosa*, *Holothuria polii, Holothuria mammata, Holothuria forskali, Stichopus regalis* and *Holothuria sanctori*. Of these, however, 3 (*H.tubulosa*, *H.polii* and *H.mammata*) are commercially exploited. *H.tubulosa* and *H.polii* prefered to live on soft-muddy grounds and edge and space of posidonia meadows area whereas *H.mammata* was in the cleaner and harder grounds. Sea cucumbers were seen to distribute within the range of 0-20 m depths. A total of 1558 *H.polii,* 1288 *H.tubulosa* and 498 *H.mammata* were collected and measured. The total mean wet weight 46.3 g for *H.polii,* 83.7 g for *H.tubulosa,* 109.8 g for *H.mammata.*

Keywords: Aegean Sea, *Holothuria tubulosa*, *Holothuria polii, Holothuria mammata*, commercial sea cucumbers.

1. Introduction
The Holothuroidea, or sea cucumbers, is an abundant and diverse group of worm-like and usually soft-bodied echinoderms. They are found in almost every marine environment, but are most diverse on tropical shallow-water coral reefs. They range from the intertidal, where they may be exposed briefly at low tide, to the floor of the deepest oceanic trenches [1].
Sea cucumbers are fished worldwide, particularly in tropical regions [2, 3, 4]. Fisheries exist in warm waters from East Africa to South and Central America, and in temperate waters of the Mediterranean and in the North Pacific and North Atlantic Oceans. Most of these fisheries have existed for centuries, especially those in Asia [5], the Pacific Islands [6] and the Indian Ocean [7]. The Western Central Pacific and Asia are the predominant regions exporting beche-de-mer. Some fisheries are relatively new or in the process of development, such as those in Latin America [8], North America and Europe [9].
The family Holothuriidae represents 11% of the total diversity of the class Holothuroidea, and includes about 185 species. The species are classified into five genera: *Actinopyga* [10], *Bohadshia* [11], *Holothuria* [12], *Labidodemas* [13], and *Pearsonothuria* [14]. *Holothuria* comprises about 148 species, which are classified into 18 subgenera [15, 16].
It is thought that there are 37 holothuries species belonging to 9 families and 5 orders in the Mediterranean [17]. Holothuries species are distributed in the Aegean Sea, the Mediterranean Sea and in the Sea of Marmara of Turkey [18]. But no population surveys were done in Turkey. *Holothuria tubulosa* Gmelin, 1790 [19], *Holothuria mammata* Grube, 1840 [20] and Holothuria *polii* Delle Chiaje, 1823 [21] are considered commercial in Turkey [18].
Sea cucumbers have been consumed in many countries for hundreds of years. Their markets are available in Hong Kong, Singapore and Taiwan. However, nowadays their stocks have decreased in many countries. Commercially valuable species are available in South Pacific and Asia countries, being prevalent in those shores. They are consumed as different products in those regions [5, 18].
In Asia and America, their body walls are consumed in the form of dry tablets. Boiled skin extracts are drunk as tonic in Malaysia. Recently, many firms in Australia started to use sea cucumbers to prevent inflammation. The most important reason for a much higher demand for sea cucumbers is its aphrodisiac property. Sea cucumbers are rich in mucopolysaccharides and chondroitin sulphate. They also contain protein, vitamin A, thiamin, riboflavin, niacin, calcium, iron, magnesium and zinc [5, 18, 22].

In Turkey, sea cucumbers are not well known and they are not consumed as food. Only three processing plants are familiar to sea cucumbers. As commercial sea cucumber occurring in The Aegean Sea, The Mediterranean Sea and in The Sea of Marmara of Turkey is not domestically consumed, totally exported [18].

These species reproduce especially in the shore during summer in The Mediterranean (July, August and September) [23]. They live on rocky substrata, soft sediments and phanerogam sea grass beds, in depths that vary between 0 m and 100 m. The edge and space of posidonia meadows are very suitable areas for this species. They consume organic materials (protozoa, diatom, detritus etc.) as nutrients [17]. The animal sorts and introduces the edible organic substances, and rejects the elements not metabolize, particularly sand, in the form of lengthened excrements.

Reviews of the biology and ecology of commercial sea cucumbers are widely available [24, 25, 26]. Studies on sea cucumbers in Turkey are usually about their population and catch [27]. Few studies on processing of sea cucumbers, their chemical compositions and fatty acid can be found in the literature [28, 29, 22].

Commercial sea cucumber species in our country related information is quite complex. There is few study about identification of the species and biological properties. The aim of the present work was to identify and determine some biological characteristics of *Holothuria tubulosa, Holothuria polii and Holothuria mammata.*

2. Material and methods

In this study, commercial sea cucumbers were investigated seasonally in Aegean Sea region between Ayvalık and Çeşme in 2008-2012 (Fig. 1). Ayvalık, Aliağa, Foça, Şakran and İzmir were selected as main stations (between 39^0.23' N, 26^0.33' E and 38^0.02' N, 26^0.48' E). In this research where 70 stations were studied between 0 and 50 m depth 6 sea cucumber species were found. These were *Holothuria tubulosa*, *Holothuria polii, Holothuria mammata, Holothuria forskali, Stichopus regalis* and *Holothuria sanctori*. Of these, however, 3 (*H.tubulosa*, *H.polii* and *H.mammata*) are commercially exploited. *H.tubulosa*, *H.polii* and *H.mammata* had been collected by diving (SCUBA) from was used as a material.

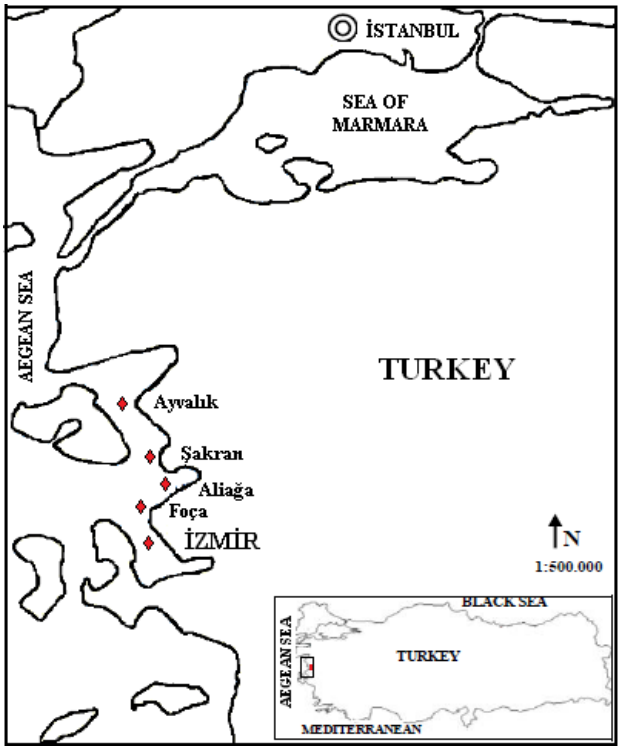

Fig 1: Sampling area

In this study, a total of 3344 commercial sea cucumbers were examined. The weights of all sea cucumbers were recorded with an electronic balance at the nearest 0.01 g. Measurements of total wet weight can vary owing to the presence or absence of the viscera and gonads, and differing amounts of sediment in the gut, etc. So total wet weight was measured as quickly as possible.

The sea cucumbers were transported to laboratory in seawater for morphological data. Morphological data were used to evaluate the taxonomic status of the species *H. tubulosa, H. mammata* and *H.polii.*

Calcareous structures have great importance for the systematic character of species identification of holothurians. The Holothurians are identified mainly on the basis of calcareous structures character and classified by their form, color, shape, length of bodies, calcareous ring and presence or absence of cuvierian tubules [30, 31, 32, 33, 34, 35, 17].

For spicule examination, cutting small pieces (approx. 0.5x0.5 cm2) in 3 positions of dorsal and ventral body wall, tentacles and tube feet were boiled in 10% NaOH for dissolving the tissues and leaving the calcareous spicules intact. These were then washed with distilled water for 3 times and finally dehydrated in 95% ethanol. The samples were then examined under the microscope and photos taken [36].

The taxonomic scheme used in this paper follows those of Gmelin [19], Delle Chiaje [21], Rowe [33] and Grube [20].

3. Results

During the sampling period, 70 stations in different depths were studied within the 5 main stations between Ayvalık and Çeşme. Within the study, 6 commercially species (*Holothuria tubulosa, Holothuria polii, Holothuria mammata, Holothuria forskali, Stichopus regalis* and *Holothuria sanctori*) have been identified, but 3 species traded in our country were assessed. Amount of calcareous structures inside body wall of sea cucumbers explain their commercial value. Sea cucumbers with high calcareous ratio are not preferred species. *S.regalis* that is no commercial value exists on sandy and muddy zones in deeper waters compared to other species, *H. sanctori* and *H. forskali* prefers to live on rocky, hard grounds, and in dark places such as rock cavities and caves. *H.tubulosa* and *H.polii* show high densities, especially, on soft-muddy grounds and edge and space of posidonia meadows and on grounds where dead bodies of posidonia communities accumulate intensively. *H.mammata* shares identical environments with *H.tubulosa,* but also prefers cleaner and harder grounds. During the SCUBA dives conducted by the research, it was determined that sea cucumbers show high density distribution in 0-20 m depth interval.

In this study, a total of 1558 *H.polii,* 1288 *H.tubulosa* and 498 *H.mammata* were collected and measured. The total mean wet weights were 46.3 g (±21.2) for *H.polii,* 83.7 g (±34.9) for *H.tubulosa, 109.8* g (±30.5) for *H.mammata* (Fig. 2).

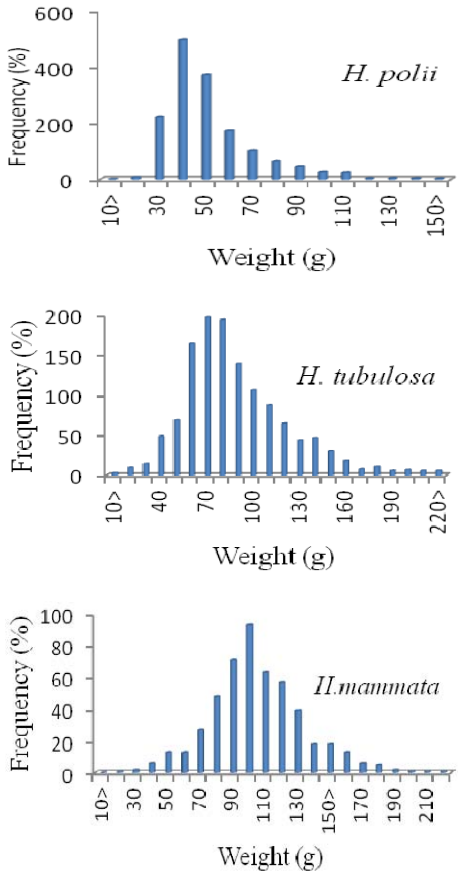

Fig 2: Weight frequency distribution

3.1. *Holothuria polii* Delle Chiaje, 1823

Kingdom: *Animalia* Phylum: *Echinodermata* Subphylum: *Eleutherozoa* Class: *Holothuroidea* Order: *Aspidochirotida* Family: *Holothuriidae* Scientific name: *Holothuria polii*

H.polii species is the most abundant in this study. It is smaller than the other two species and has a darker color. There are no spines on the skin (Fig. 3). They prefer to live on the edge of plant communities and on soft ground. They eviscerate easily when it is disturbed.

Fig 3: *Holothuria polii*

H.polii is easy to distinguish from other species by external surface characteristic but *H.tubulosa* and *H.mammata* are very similar. Calcareous structures forms are very smooth but *H.mammata* and *H.tubulosa* are very rough (Fig. 4).

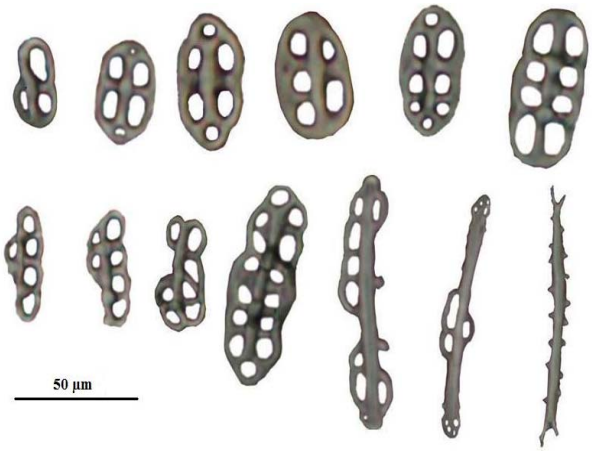

Fig 4: Calcareous structures from the body wall of *H.polii*

3.2. *Holothuria tubulosa* Gmelin, 1790

Kingdom: *Animalia* Phylum: *Echinodermata* Subphylum: *Eleutherozoa* Class: *Holothuroidea* Order: *Aspidochirotida* Family: *Holothuriidae* Scientific name: *Holothuria tubulosa*

H.tubulosa which is bigger than *H.polii* is a very common benthic species on the rock funds covered with algae, within the meadows of posidonies, on sand and mud. The majority is brown (Fig. 5).

Fig 5: *Holothuria tubulosa*

The size and shape of dorsal papillae are very similar to *H.mammata* and *H.tubulosa*. But the dorsal surface of *H.tubulosa* has less spines (papillae) than *H.mammata*. Another characteristic of *H.mammata* is the large dorsal papillae. Size of the ossicles of *H.tubulosa* are smaller than

H.mammata. *H.tubulosa* doesn't have any cuvierian tubules.
Holothuria tubulosa is also clearly distinguishable from *Holothuria tubulosa* is also clearly distinguishable from *H.mammata* by the sharp colour contrast between the dorsal and ventral sides, the latter being lighter.
The tables in two (*H.mammata* and *H.tubulosa)* species show discs perforated by four large central holes (rarely *H.mammata* has more than four central holes) and four pillars forming the spire (rarely three pillars) (Fig. 6).

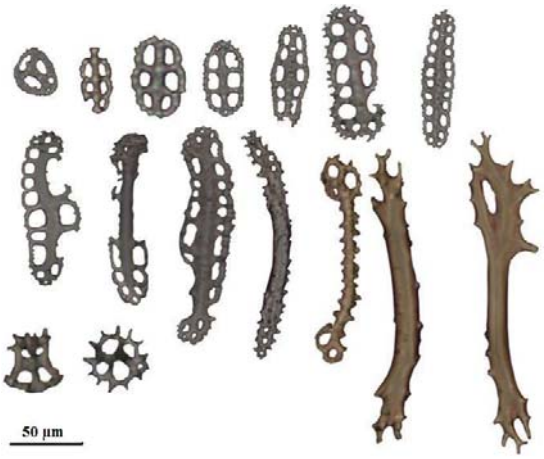

Fig 6: Calcareous structures from the body wall of *H.tubulosa*

3.3. *Holothuria mammata* Grube, 1840
Kingdom: *Animalia* Phylum: *Echinodermata* Subphylum: *Eleutherozoa* Class: *Holothuroidea* Order: *Aspidochirotida* Family: *Holothuriidae* Scientific name: *Holothuria mammata*
H.mammata is more purple and darker than the others. There are thick podia at the outer surface of *H.mammata* (Fig. 7).

Fig 7: *Holothuria mammata*

H.mammata has a larger table than *H.tubulosa* (Fig. 8).

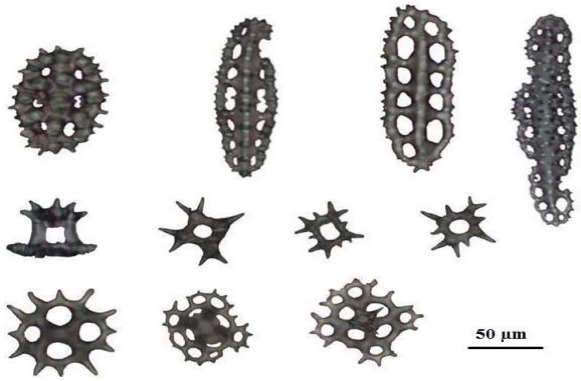

Fig 8: Calcareous structures from the body wall of *H.mammata.*
Some sea cucumbers possess cuvierian tubules organs. In most species, these are apparently defensive structures. They can be expelled through the anus, whereupon they dramatically expand in length and become sticky, entangling or deterring the predators, such as crabs and gastropods. The presence of the cuvierian tubules in *H.mammata* is the clearest character to distinguish it from *H.tubulosa,* but these cuvierian tubules are few in number, small and never expelled.

3.4. Reproductivy
During this study it is observed that the commercial sea cucumbers are reproductive in June, July, August and September. During this period a migration towards shallow waters occurs. There are two standard genders (male and female) of these creatures. Sea cucumbers reproduce sexually (outside of the body). The male releases large amounts of sperm into the water, while the female releases great quantities of eggs (Fig. 9). There is usually a kind of "signal" that tells the creatures when this spawning should occur. This signal can be in various forms such as a plankton bloom.

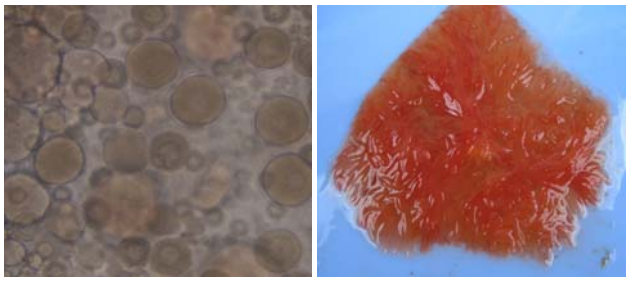

Fig 9: Sea cucumber (*H.tubulosa*) gonad and gamets

During the study, shelter fish of the *Carapus* kind were often observed in sea cucumbers. Totally, 3344 sea cucumbers were examined where 68 *Carapus sp*. were found to be hosted (Fig. 10).

Fig 10: *Carapus Sp*.

4. Discussion
One of the goals of the present study was the identification of commercial sea cucumbers. In addition, in the literature, there is no study about the identification of commercial sea cucumbers in Turkey. The previous studies is about processing of sea cucumbers of *H.tubulosa* in the Aegean Sea [29]. *H.polii*, *H.mammata* and *H.tubulosa* were studied by Aydın *et al*. [22], this study is important, as it is the first work on the identification and biology of these species.
In this study, commercial sea cucumbers were seen to distribute within the range of 0-20 m depths. A total of 3344 commercial sea cucumbers were examined. The total mean wet weights were 46.3 g for *H.polii,* 83.7 g for *H.tubulosa,* 109.8 g for *H.mammata.* Except of Aydın *et al*. [22], no data is available about the average weight of *H. polii*, *H. tubulosa*, *H. mammata* in Turkey. Aydın *et al*. [22] reported that the mean weights were 59.2 g for *H.polii*, 78.6 g *H.tubulosa* and 105.9 g *H.mammata*.
In the Mediterranean Sea, the spawning phenomenon occurs during the summer months, specifically between July and September for *H.tubulosa* in the Adriatic [23]. In another study conducted in the Mediterranean, *H.tubulosa* species were reported to be reproductive in August [37]. During the research period, reproductive period for these species has been observed to be in June, July, August and September which is

similar to previous studies.

Asha [38] reported that 10 *Carapus* sp were found within 294 *Holothuria spinifera*. In this study, 34 *Carapus* sp. in 1558 *H.polii*, 26 *Carapus* sp. in 1288 *H.tubulosa*, 8 *Carapus* sp. in 498 *H.mammata* were found.

It is easy to seperate *H.polii* from the others by external appearance. The surface of *H.polii* is *d*arker, smaller and smoother, but for *H.tubulosa* and *H.mammata* the external appearances are very similar to each other.

Calcareous ring and spicules of *H. mammata*, *H. tubulosa* and *H. polii* are given figures 4, 6 and 8. These results are almost same with Fischer *et al*. [17] For *H.mammata* and *H.tubulosa* morphological character of body, size, color, shape, calcareous ring and spicules are very similar to those described by Perez *et al*. [16]

Calcareous structure of *H.polii* is smoother than the others. Calcareous structure *H.tubulosa* and *H.mammata* are similar to each other, but differs only in size. In addition, tables of *H. mammata* are larger than *H.tubulosa.* However, if it is possible to verify the presence of the cuvierian tubules, this is the clearest way to distinguish *H.mammata* from *H.tubulosa*. The cuvierian tubules of *H.mammata are* few in number, small and never expelled but completely absent in *H.tubulosa.*

5. Conclusions

As a result, sea cucumbers and commercially valuable organisms and have important roles in marine ecosystems. Consequently, further studies in detail should be carried out in future to guide a sustainable stock management for commercial sea cucumbers.

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