



Some Aspects of Reproductive Biology of the Sea Cucumbers (*Holothuria scabra* and *Holothuria atra* (Echinodermata: Holothuroidea) from the Sudanese Red Sea Coast

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ABSTRACT

The reproductive biology of the sea cucumbers *Holothuria scabra* and *Holothuria atra* was studied from January to December 1998 at Abu Hashish area in the Sudanese Red Sea coast through the gonad index and macroscopic analysis of the gonads. *H. scabra* showed seasonal reproductive cycle with spawning time being at the end of summer: the higher gonadal index in July- August and the minimum in September, while *H. atra* showed annual reproductive cycle with tendency of partial spawning in July. First maturity for *H. scabra* occurred at drained weight of 450-500 g and for *H. atra* first maturity occurred at drained weight of about 77.5g. Five scale for maturation was noticed for both species. The female gonads become heavier than the male ones producing higher gonadal index. The present study also shed lights on the characteristics of mature gonads and their correlation with other body parameters. The results obtained could be useful towards a sustainable utilization of sea cucumber resources and would probably enable practical management programs.

KEY WORDS: Reproduction, *Holothuria*, Sudanese Red Sea coast.

INTRODUCTION

Holothurians, which had a very long history of consumption by Chinese, and a very long standing history as a fishery, are known in the western world as sea slug or sea cucumber. The processed individuals called (beche de mer or trepang); they have been eaten by the far eastern people for its delicacy and high nutritional value. There is a wide variety of forms made up of about 80 species belonging to 22 genera in the Red Sea (Vine, P., 1986). Although exploitation of marine resources along the Sudanese Red Sea coast is an old activity; attention has been drawn towards holothurain fishing only since 1980's as a fish export oriented industry (Marine Fishing Administration and Fishing research centre. 1999), which may be due to the growing beche-de-mer-related international market, supported by continuing demand of these organisms for aquaculture and biomedical research programs (Bordbar, 2011; Ghobadyan, 2012). Recently, overexploitation of this fishery have been reported in many countries (Kelso, 1996). This is related to increasing demand on processed sea cucumber (beche de mer) as food delicacy and health tonic agent. The critical importance of the sea cucumber as an artisanal fisheries from developing countries, and as a globally traded product, raises the interest in their biology, ecology and fisheries management (Ghobadyan, 2012). The knowledge of echinoderm reproduction in general is poor (Hyman, 1955). Most echinoderms have separate sexes although this can be unstable through its life. Only few are hermaphrodite (Mortensen, 1937) cited in (Conand, 1990). The majority of class Holothuroidea are dioecious; the sexes can be not be distinguished externally (Coe, 1972; Conand, 1993). A new quantitative analysis of ovarian development had been developed by Doyle *et al.*, (2012). Abdel-Razek *et al.*, (2005) studied the reproductive biology of sea cucumber from the Egyptian Red Sea coast.

From the same area Omran, (Omran, 2013) studied their nutritional value. The current study aimed to fill in gaps and to shed light in the knowledge about this group from the Sudanese Red Sea coast, towards a logical management. So the goals of the present study are to determine the maturation stages, the reproductive cycles, the size at first maturity for *H. scabra* and *H. atra* from Marsa Abuhashish at the Sudanese Red Sea coast.

MATERIALS AND METHODS

Conventional measurements:

A total of 230 Specimens of *Holothuria atra* and *Holothuria scabra* were collected monthly during a year from Marsa Abuhashish (37° 14 179 E; 19° 37 692 N) at the Sudanese Red Sea coast.

Specimens once out of the water, immersed in a plastic container with sea water and anesthesia (7% MgCl₂). In the lab, the total length (TL) was measured, from mouth to anus, with a metric tape to the nearest 0.5 cm. Each individual was then weighed (TW). Drained weight (DW) was weighed after making an incision down the inside of the back to drain the coelomic fluid. The ventral part of each animal was dissected and the entire gonad was removed, and then towel-dried and weighed (GW).

All gonads were fixed using 10% formalin and stored for later macroscopic analysis. Weight variables were done with an electronic scale to the nearest 0.01 g. The gonadal indices G1 (based on TW) and G2 (based on DW) were estimated following Conand, (Conand, 1990):

$$G1 = [GW \times 100] \div TW$$

$$G2 = [GW \times 100] \div DW$$

Egg and ovary tubule diameters were measured using light microscope supplied with a micrometer. Correlation between GW and TW, TL, DW, tubule diameter and egg diameter were estimated following Alder and Roessler, [14].

Stages of maturation were identified by colour and consistence as suggested by Conand, (Conand, 1990).

Size at First Sexual Maturity:

The DW has been used for estimating the 1st stage maturity on the curve representing the percentage of individuals. The point where 50% of individuals are considered mature is taken as index of first maturity following Conand, (Conand, 1990).

Results:

Males and females cannot be differentiated externally. Five-stage maturity scale has been identified based on colour and consistency (Table 1). During the study period higher number of *H. atra* individuals found in post-spawning stage, while higher percentage of *H. scabra* individuals were found at mature stage. (Table 1).

Table 1: Percentage of the population of each species in the five maturation stages.

Stages	Gonadal Condition	(%)from population of <i>H. atra</i>	(%)from population of <i>H. scabra</i>
1	Undetermined	15.99	06.65
2	Growing	20.00	8.00
3	advanced growth	14.54	26.82
4	Mature	22.11	46.34
5	Post-spawning	27.36	12.19

It is apparent from Fig 1 and Fig 2 that members of *H. scabra* with higher gonadal index began to appear from April, and thence process of maturation seems to continue throughout the summer to be completed by September, while individuals of *H. atra* were found throughout the year, and the process of maturation seems to start from April.

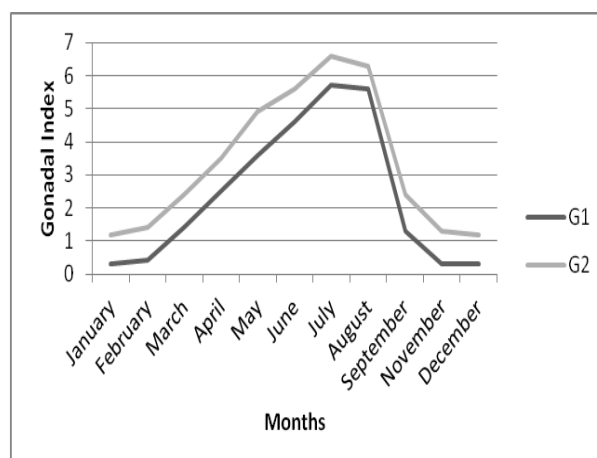


Fig. 1: Gonadal Index (G1, G2) for *H. atra*.

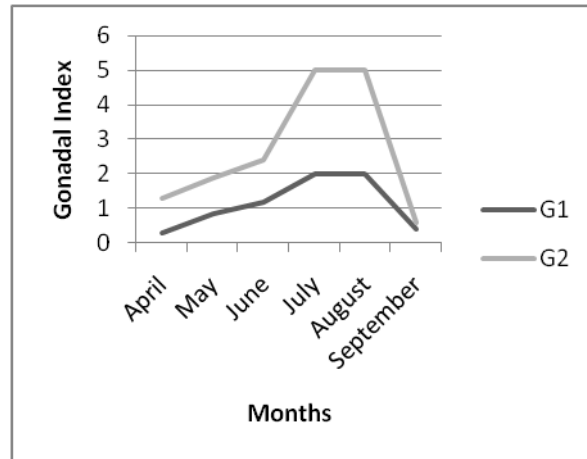


Fig. 2: Gonadal Index (G1, G2) for *H. scabra*

Spawning seems to take place during mid August -September this is confirmed by the decrease in gonadal index. It is noticed that the female gonads become heavier than the male ones producing higher gonadal index (Table 2). The correlation between GW and other measurements ranged from highly significant ($p < 0.01$) to extremely highly significant ($p < 0.000$) (Table 3)

Table 2: Characteristics of mature gonads of *H. atra* and *H. scabra*

Species	Sex	Gw (gm)	Tubule Diameter (μ)	Egg Diameter (μ)	Gonadal index	
					G1	G2
<i>H. atra</i>	Male	8.69	1242.16	-	4.70	9.32
	Female	10.38	1592.50	122.00 \pm 11.05	5.42	11.20
<i>H. scabra</i>	Male	26.41	758.40	-	3.35	5.06
	Female	43.84	1079.41	139.71 \pm 1.26	5.44	7.86

Table 3: Correlation between gonad weight and different body parameters for *H. atra* and *H. scabra*

Correlates	<i>H. atra</i>		<i>H. scabra</i>	
	Correlation coefficient	p- value	Correlation coefficient	p- value
GW vs. TW	0.319	0.001	0.455	0.003
GW vs. DW	0.419	0.000	0.545	0.000
GW vs. TL	0.229	0.016	0.414	0.007
GW vs. Tubule diameter	0.657	0.000	0.732	0.000
GW vs. Egg diameter	0.385	0.000	0.597	0.000

The drained weight at first maturity (DW_{50}) is obtained from graphical representation (Fig 3 and 4), showed that first maturity for *H. scabra* occurred at drained weight of 450-500 g. First maturity for *H. atra* occurred at drained weight of about 77.5g

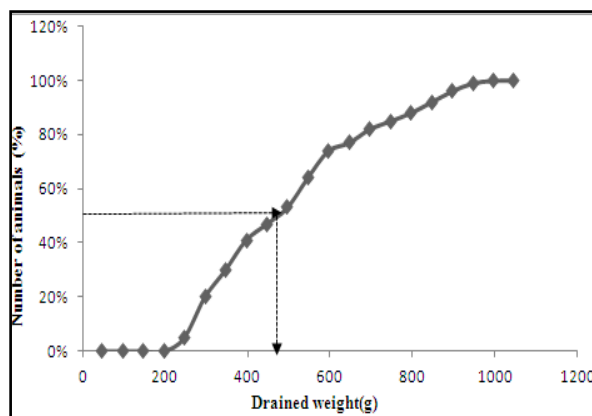


Fig. 3: First stage maturity of *H. scabra*.

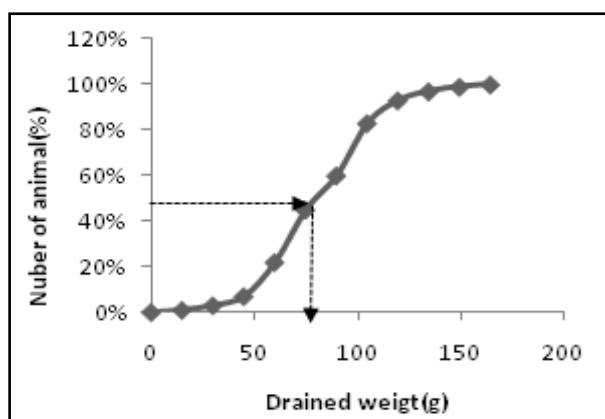


Fig. 4: First stage maturity of *H. atra*.

Discussion:

The majority of the Holothuroidea are dioecious and little is known about their reproductive behaviour (Hyman, 1955). During the current study five stages of gonadal development have been recognized this is in consistency with Navarro, (Navarro, 2012) findings at Gran and Conand, (Conand, 1993) in New Caledonian lagoon. Various stages of reproductive cycle in Holothuroidea may appear more clearly defined in habitat further from the equator (Shelley, 1985; Morgan, 2000).

From the results, it is apparent that maturation took place during summer season (June-sept). This is in harmony with Engstrom (Engstrom, 1980), who found *H. mexicana* and *H. floridana* spawned in late summer, and Kazanidis *et al.*, [19] when studied *H. tubulosa* in Aegean Sea . And also consistent with the findings of Chao *et al.*, (1995), Tuwo and Conand (1992). However, this is the case in many tropical invertebrates (Hyman, 1955; Vine, 1986).

The drop in gonadal index confirms that spawning apparently takes place during mid-August – September for *H. atra*. However, the abrupt decrease of gonadal index during July might suggest partial spawning which may be attributed to physical factors such as any interference in the environment by pollutants that collection area is open or may be attributed to some biological factors such as migration. This case seems to agree with Conand, (Conand, 1993) who suggested an annual cycle for *H. atra* and *A. echinites*. Ong che and Gomez, (Ong Che, 1985) have described a semi-annual reproductive cycle in *H. scabra*, and existence of a secondary reproductive season in this species has been observed by Krishnaswa and Guen, (Krishnaswamy, 1967) in India, Harriot, (Harriot, 1980) in Australia, shelly, (Shelley, 1985) in Pupua New Guinea and Tuwa, (Tuwo, 1999) in Saugi Island.

According to Navarro, (Navarro, 2012) estimation of size at first maturity is necessary to limit capture sizes, which has biological justification in maximizing the yield per recruit, allowing individuals to spawn before harvest. A similar suggestion had been made by Kazanidis *et al.*, (Kazanidis, 2014).

The relationship between a size parameter (length or weight) and the weight of mature gonads is variable, depending on the species and the comparative method used; also it might be due to shrinkage during handling and the weight variability according to internal water. This agrees with Harriot, (Harriot, 1980), shelly, (Shelley, C.C., 1981) and Conand, (Conand, 1990). This phenomenon makes estimation of recruitment for management purposes not easy. Little difference between diameters obtained during the present study and that in literature was attributed to the fixative used as suggested by Conand, (1993). The results would help to establish a harvest season and a closure during the spawning of animals, this is in line with Guzman *et al.*, (2003) Abdel-Razek *et al.*, (2005), Kohler *et al.*, (2009) and Purcell *et al.*, (2013).

Conclusion:

The calculated parameters during the present study along with the reproduction cycles data from *H. scabra* and *H. atra* at the Sudanese Red Sea coast can be useful to achieve a sustainable utilization of this resource, The size at first maturity is also a pertinent parameter for managing this type of fisheries, since it helps to limit capture sizes. However, in order to effectively manage these resources, other parameters such as fecundity and length-weight relationship should also be studied.

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