International Journal of Zoological Research

ISSN 1811-9778

Academic Journals Inc.

www.academicjournals.com

International Journal of Zoological Research 7 (4): 320-329, 2011
ISSN 1811-9778 / DOI: 10.3923/ijzr.2011.320.329

Abundance and Ecological Observations of the Black-Lip Pearl oyster, *Pinctada margaritifera* (L.) (Bivalvia: Pteriidae), in Red Sea Egyptian Waters

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ABSTRACT

This study was designed to investigate the current status of the black lip pearl oyster species in the reefs of the Egyptian Red Sea Coast as an attempt to fill the gap of information about this endangered species. During the last decade in Egypt, the collection of shells of pinctada increased to a great extent causing a sharp decrease in the density of the animals in the reefs. This decrease motivated the Egyptian Environmental Affairs Agency (EEAA) to add *P. maragaritfera* to the list of the threatened species by (IUCN). The present survey covered more than 600 km of the proper coast of the Egyptian Red Sea and the studied species was record in 29 stations out of the surveyed 65 which demonstrate the current distribution of 44.6% of the sites. Mostly found in the sub-tidal zone to depth of about 15 m, with habitat comprises dead corals and weeds (64%). Both sandy and living coral habitats included lower percentage being 14 and 20%, respectively. The species were found in a considerable numbers in the Northan and Southern part of the surveyed area, however, the density is one individual per 31.33 m^2 in Northern area which it was one individual per 10.7 m^2 in Southern area and the area in-between them along the coast have a very small numbers of individual due to the high fishing potential. The number recorded of this internationally distributed species during the present study in considered very low compared to other areas of the world.

Key words: Distribution, population, black lip pearl oyster, red sea coast

INTRODUCTION

The pearl oyster, like other shell fish and many other marine animals (e.g., abalone), has a long history of exploitation throughout the world. The black lip pearl oyster *Pinctada margaritifera* (Linnaeus, 1758) has long been an important species in the Indo-Pacific region including the Red Sea because of its beautiful shell which is lined with a shiny and iridescent coating called nacre. Traditionally, in addition of being a source of natural pearls, the shell was used to make jewelry, decorations and tools such as fishing hooks and knives. With the advent of international trade and "western contact," demand for the shell increased rapidly for use as buttons and decorative inlay. Such was their popularity that over-fishing to meet this foreign demand for the shell rapidly depleted the abundance of Black-lip pearl oysters in many places. As a result of this over-fishing, many areas of the Indo-Pacific still have very low populations of Black-lip pearl oysters today (Ellis and Haws, 1999).

Despite the international interest of this species revealed from the large number of studies conducted on its occurrence, distribution, standing stock and population structure Cook Islands (Sims, 1992), Hawaii (Rodgers *et al*., 2000), French Polynesia (Intes *et al*., 1986), the Indian Ocean (Alagarswami *et al*., 1987), Coastal Kenya (Kimani and Mavuti, 2002), the Mediterranean (Yassien *et al*., 2000) and the Arabian Gulf (Mohammed and Yassien, 2003; Al-Khayat and Al-Ansi, 2008) a relatively few studies were conducted in the Red Sea (Elnaeim, 1984; Nasr, 1984; El-Sayed *et al*., 2011).

According to the few earlier studies, the Red sea coast was one of those areas which host a considerable reasonable population of this species. However, recent studies on the coast (Kleemann, 1992; GEF, 1998; Zuschin *et al*., 2001; Mohammed and Yassien, 2008) revealed a low numbers of individuals of this species indicating a sharp decrease in the population of this species among other exploited molluscan species.

During the last decade, the collection of shells of *Pinctada* species increased to a great extent causing a sharp decrease in the destiny of the animals in the reefs (EEAA, 2007). This decrease motivated the Egyptian Environmental Affairs Agency (EEAA) for suggesting the black-lip pearl oyster *Pinctada margaritifera* among other species, to be added to the list of the threatened species in the red data book published by the International Union for Conservation of Nature (IUCN). Despite its appearance in most of the molluscan lists of the old expeditions to the Red sea area in the Egypt, the information did not indicate density or abundance of this species (Razek *et al*., 1998; Mohammed *et al*., 2000).

According to the previously introductory remarks, the present study was designed to investigate the current status the gap of information about this endangered species.

MATERIALS AND METHODS

In order to determine the distribution of *P. margaritifera* over the intertidal zone, Coastal fringing reefs, offshore reefs and lagoons along the Coast of Red Sea, a coastal survey was carried out during the period from March 2005 to April 2007. The survey included all the accessible areas between Ras Elbahar 60 km north of Hurgada (Lat. 27° 43' 45" and Long. 33° 32' 58") to Wadi-Elhour south of Shalatein (Lat. 22° 43' 14.0" and Long. 35° 54' 57.8") covering a total of 65 sites (Fig. 1).

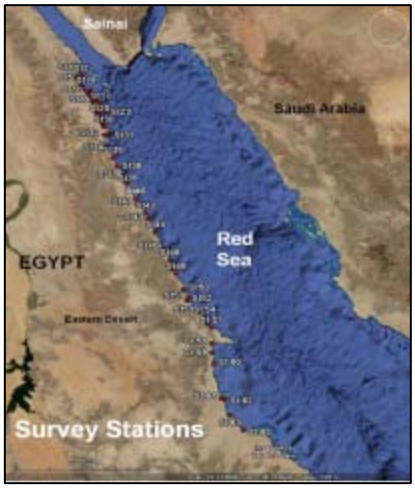

Fig. 1: Map showing the surveyed stations at the coast of the Egyptian red sea

At each of the surveyed sites, snorkeling and/or SCUBA diving were used for two hours of swimming a Zigzag pattern over the reef for collecting the needed data and information. The collected data was recorded on a special under water sheet prepared especially for the present survey. The sheet included information about the location name, co-ordinates (latitude and longitude), structural profile (depth) as well as types o f habitats (e.g., reef, sea grasses beds and sea weeds). In addition, number of *P. margaritifera* individuals m^{-2} and its shell dimensions (length, depth in mm) measured using plastic Vernier caliper were recorded for determination of the status of the species. Also, both, human activities and pollution status were noted for each site. The data of the field sheets where transferred to the laboratory computer and analyzed using different computer software's available including Statistical, Excel and Surfer.

RESULTS

Occurrence and habitat preference: The current survey covered more than 600 km of the proper coast of the Egyptian Red Sea. The surveyed species *P. margaritifera* was recorded in 29 stations out of the surveyed 65 stations which demonstrate the current distribution of the species along the coast being represented in 44.6% of the sites. The results of the survey also showed that total number of individuals recorded was 481 individuals in all sites, 416 of them were living and 65 were dead.

The examination of the field data sheets revealed that *P. margaritifera* species were recorded from different types of habitat during the survey (Fig. 2a-d) and each of these habitats have unique characters. Shells of *P. margaritifera* were commonly found attached to hard substrate such as living or dead corals and in the second case it is always surrounded by seaweeds. The presence of the shells in this habitat was recorded in Eash Elmalaha, Malaha2, Shoab El-dair, Marine Station, Abau Sadaf, Marsa Shaab, Kalawi, Abou Gnena, and Umm Elabus (Fig. 2a, b). In some

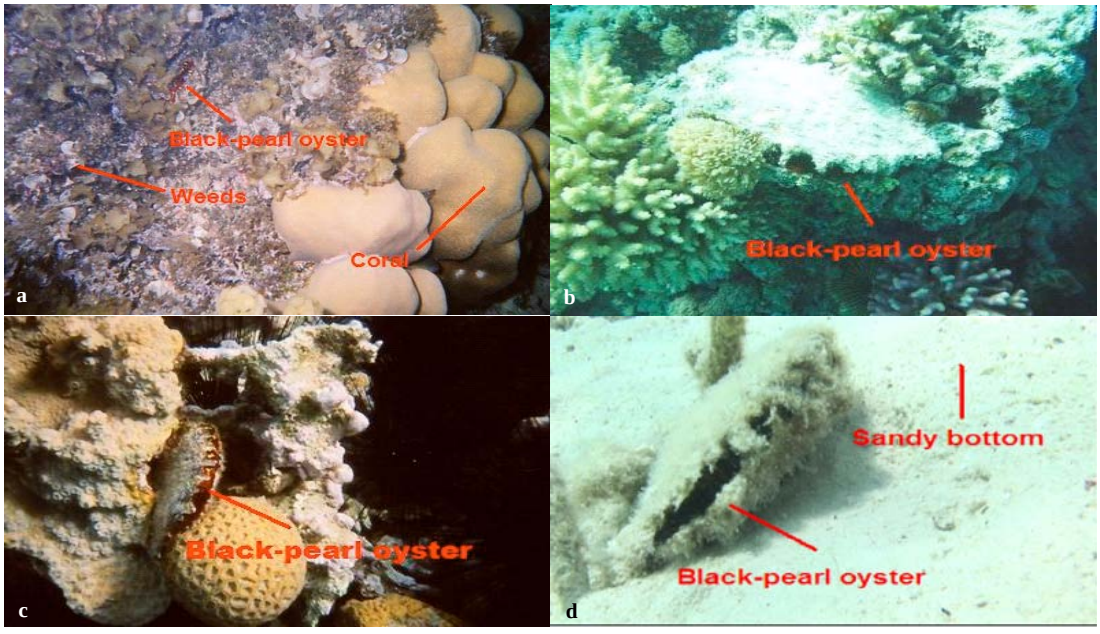

Fig. 2 (a-d): Underwater photos of *P. margaritifera* in its different habitats (a) Weeds, (b) Sponges, (c) Spaces of hard cords and (d) Sandy bottom

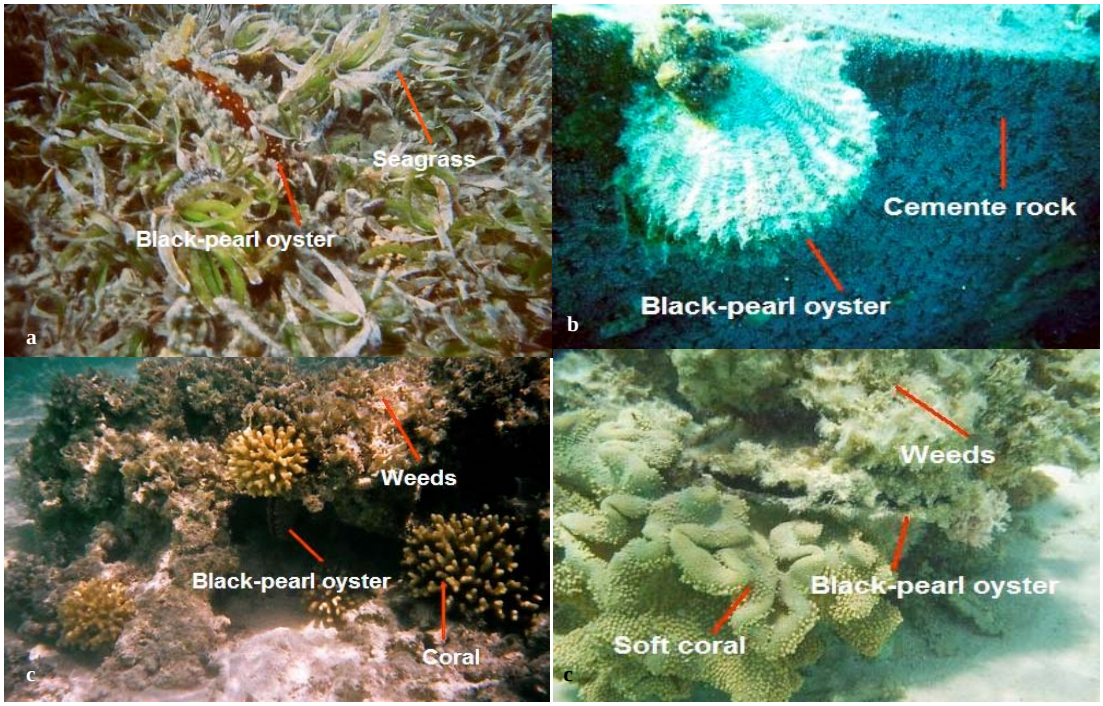

Fig. 3 (a-d): Underwater photos of *P. margaritifera* in different habitats (a) Leaf of seagrass, (b) byssal threads, (c) Small crevies and (d) Soft corals proximity

sites, the shells were also found in the space separating two different species of hard corals (Fig. 2c). However, in areas with sandy bottoms or seagrass meadows the shells were found embedded in sand (Fig. 2d) and/or in between leaf of the seagrass (Fig. 3a) to about one third of its size. However, the color of the mantel could be easily recognized.

This was recorded at Eash Elmalaha, Malaha2, South El-Malaha, Abu Galawa, Marine Station, Abu Monkar, North Safaga and Marsa Alam and in the Southern stations.

The data also showed that in some of the stations, specially where only rocky substrate were available, the shells were found attach by its byssal threads or even cemented to the rocks by one valve (Fig. 3b). Shells were found in small crevices with large coralline rocks while others were found in close proximity with soft corals (Fig. 3c, d).

The analysis of the occurrence data showed that the highest percentage of animals was found associated with habitat comprises dead corals and weeds (64%). Both sandy and living coral habitats included lower percentages being 14 and 20%, respectively. The lowest percentage recorded within crevices and attached to rocky substrate where it did not exceed 1% of the recorded number of individuals (Fig. 4).

The examination of the records also demonstrated that despite the high number of individuals recorded in the dead coral and weeds habitat the highest percentage of dead shells compared to the living individuals was recorded in sandy habitat (Fig. 5) both hving and dead corals have the lowest percentage of dead shells while those occurred in crevices were always found alive.

Distribution and zonation of *P. margaritifera*: Data in Fig. 6 represents the distribution of *P. margaritifera* over a typical cross section of the red sea coast from zonation point of view. The

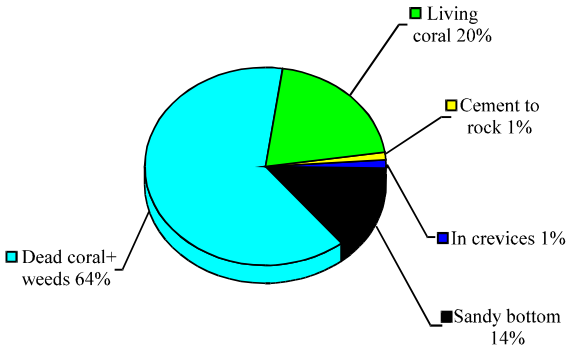

Fig. 4: The abundance percentage of *P. margaritifera* in the different types of habitat

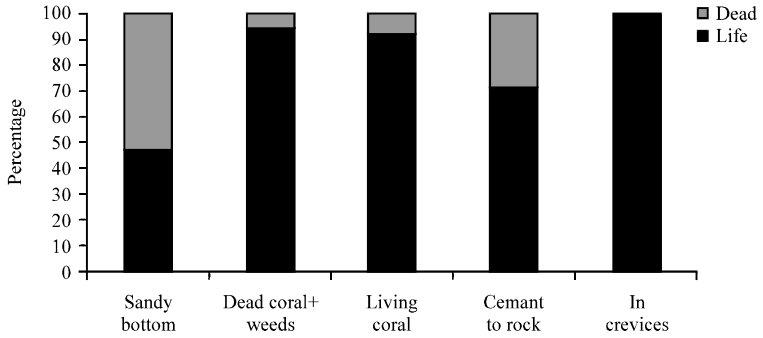

Fig. 5: The percentages dead shells and living individuals of *P. margaritifera* in the different types of habitat

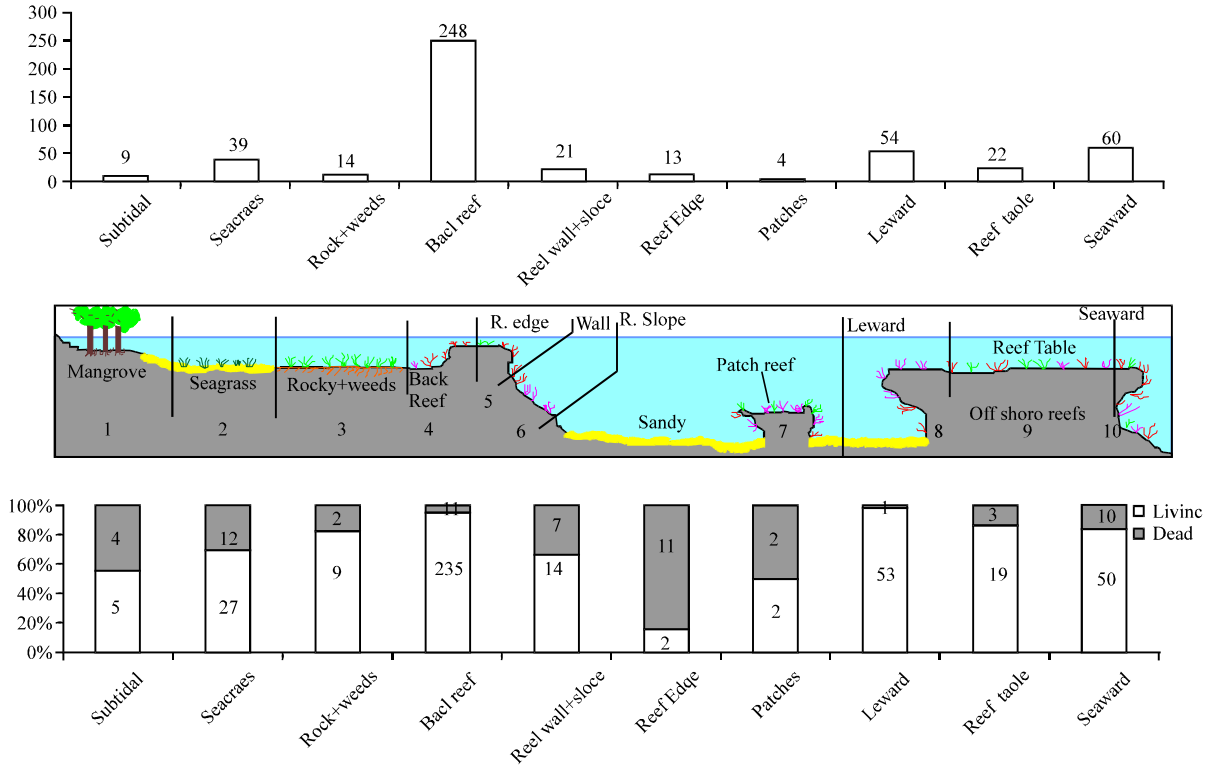

Fig. 6: Distribution and zonation of *P. margaritifera* over a typical red sea fringing reef area

data in Fig. 6 showed that the majority living of *P. margaritifera* were recorded from zone number 4 or the back reef area. Also a considerable numbers were recorded from the seagrass and reef edge area (zone 2 and 5). However, in sites representing the offshore reefs both leeward and seaward sides have individuals more than the reef table.

The data also indicated that the highest percentage of dead shells was recorded in the reef wall and edge (zone 6) where most of the diving and snorkeling occur. However, as a general trend, most of the shallow reef area contains higher percentages than the offshore reefs where the lowest percentage of dead animals (shells) were recorded (2%) (Fig. 6).

Coastal abundance of *P. margaritifera*: The distribution of the *P. margaritifera* individuals along the coast of the studied area is presented in Fig. 7. As indicated that *P. margaritifera* is found in a considerable numbers in the Northern and Southern parts of the examined area at the proper Red Sea coast. However, the area between in them along the coast have a very small number of individuals.

Despite the fact that the most northern stations seems to have higher number of individuals compared to the southern stations, the examination of the number recorded and the area surveyed revealed the opposite. The maximum number of individuals recorded for this species was at the area 60 km north of Hurghada included 7 stations. In this area 241 individuals were recorded inside area of 7550 m^2 which mean that the density of this species is one individual per area of 31.33 m^2. Meanwhile, the total number of individuals recorded in the southern three stations was 140 individuals in an area of 1500 m^2 which mean that one individual of this species could be found every 10.7 m^2. This comparison indicated a higher density in the south than north.

Coastal density of *P. margaritifera*: The results of the survey data revealed differences in the density of the shells of *P. margaritifera* all over the studied areas. The density calculated as number of individuals divided by the area surveyed in each site or to the number of individuals per square meter is presented in Fig. 8.

The data in Fig. 8 indicated that the density of *P. margaritifera* ranged from 0 to 0.15 individuals m^{-2} with an average of 0.030±0.045 individuals m^{-2}. In another ward, the intensity of individuals ranged from one individual per 6.7 m in station number 3 (South El-Malaha) to about one individual per 2000 m in station number 12 (Kalawi). Despite the fact that most of the visited sites were expected to have a higher number of individuals the survey showed that the species was completely removed from the reef. The only areas where the life shells were found were areas inside the protected places in the north and the south.

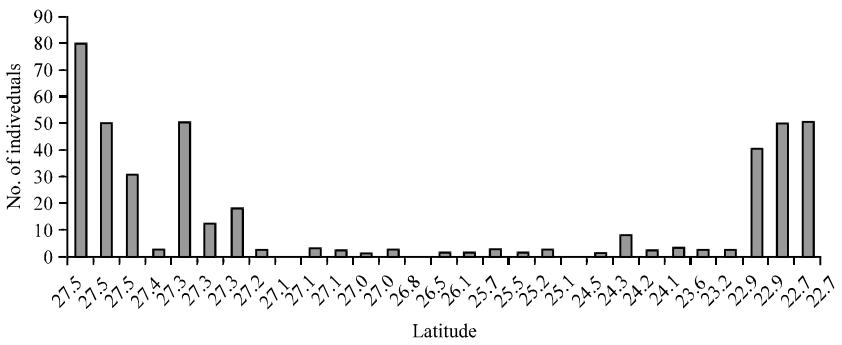

Fig. 7: The distribution of *P. margaritifera* along the surveyed coastal area

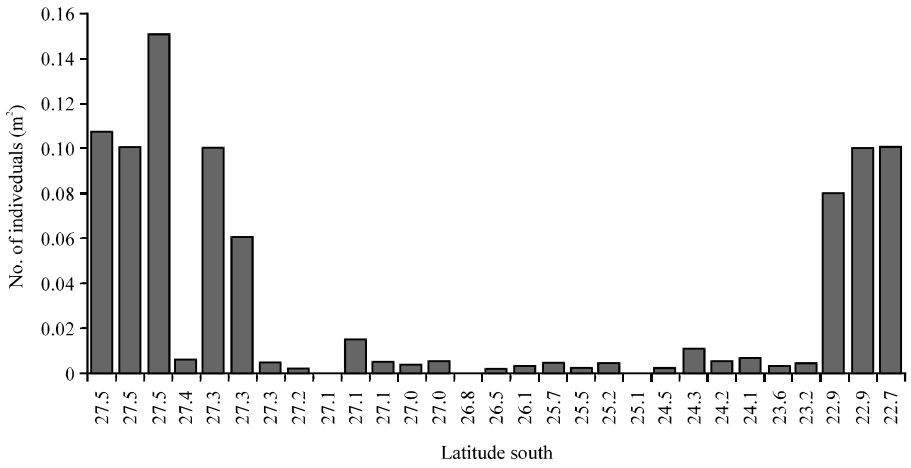

Fig. 8: The density of *P. margaritifera* along the surveyed coastal area

DISCUSSION

Pearl oysters have been exposed to exploitation due to the considerable value of the pearls and the nacre, or "mother of pearl", of the shell and because of the animal's sessile nature and tendency to occur in sufficient densities at shallow depths for relatively easy collection. They are found attached to hard substrates as deep as 40 m, usually in association with reef habitats.

With the advent of international trade and "western contact," demand for the shell increased rapidly for use as buttons and decorative inlay. Such was their popularity that over-fishing to meet this foreign demand for the shell rapidly depleted the abundance of Black-lip pearl oysters in many places especially the Red Sea. As a result of this over-fishing, many areas of the Indo-Pacific still have very low populations of Black-lip pearl oysters today (Ellis and Haws, 1999).

The current survey covered more than 600 km of the proper coast of the Egyptian Red Sea. *Pinctada margaritifera* was recorded in 29 stations out of the surveyed 65 which demonstrate the current distribution of the species along the coast being represented in 44.6% of the sites. The results of the survey also showed that total number of individuals recorded was 481 individuals in all sites 416 of them were living and 65 were dead. The pearl oysters were found from wading zones to depths of about 1 to 15 m. *P. margaritifera* species were recorded from different types of habitat each of unique characters which support the potential of this species for culturing in different areas of the Egyptian Red Sea coast.

Despite the presence of the current species in different habitat types the highest percentage of animals were found associated with habitat comprises dead corals and weeds (64%). This result come in agreement with that of Gervis and Sims (1992) where they reported that *P. margaritifera* is typically found in coral reef waters characterized by oligotrophy and low turbidity. It lives attached by byssal threads to hard substrata on the coral reef. The same habitat characters were also recognized for *P. margaritifera* by Yukihira *et al.* (1999).

The results of the present study also showed that the majority of *P. margaritifera* were recorded from the back reef area. The data also indicated that the highest percentage of dead shells was recorded in the reef wall and edge. However, as a general trend most of the shallow reef area contains higher percentages than the offshore reefs where the lowest percentage of dead animals (shells) were recorded (2%). The previous results come in agreement with the findings of Gallager *et al.* (1996) and Tomaru *et al.* (1999) were they stated that the abundance of pearl

oysters is higher in the shallow sub-tidal depth range (1-5 m) and this is most probably because larvae of marine bivalves tend to be concentrated near the water surface.

The distribution of *P. margaritifera* along the Egyptian Red Sea coast revealed that *P. margaritifera* is found in a considerable numbers in the Northern and Southern part of the examined area. However the area in-between them along the coast have a very small number of individuals. Such distribution is normal for many areas especially where fishing potential is high. The number of individuals inside the 100 m^2 transect in the current study ranged between 0 and 10.67 shell/100 m^2 with an average of 2.91±3.67 shell/100 m^2. The same results were also obtained in Kenya coast by Kimani and Mavuti (2002) where they reported a highest density of oysters to be 75/100 m^2 in certain areas and as low as 1/100 m^2 in other areas of the coast. Also similar results were reported from Cook Islands atoll lagoons, being 2.0±4.0 and 0 per 100 m^2 (Sims, 1992) and in French Polynesia being 1.0±0.8 per 100 m^2 (Zanini and Salat, 2000).

Such differences in the abundance of this species could be attributed to the collection of the species by the local fisherman for ornamental trade purposes. As most of the information obtained from the local fishermen in the area (Personal communication) indicated that large number of the *P. margaritifera* shells were collected and sold for its mother of pearl usage in hand crafts. Also some of the local collectors indicated that this species was over exploited during the period when the Egyptian Government restricted the import of Japanese Abalone shells.

Despite the fact that this species still exist in the area of the Egyptian coast of the Red Sea, the number recorded of this internationally distributed species during the present study is considered very low compared to other areas of the world. For example, Sims (1992) reported in his results of belt transects take across the lagoons at Cook Island Australia, the estimation of the stock for Manihiki lagoon as 2.0±3.2 million pearl oysters while for Penrhyn lagoon the number was 5.0±4.1 million and for Suwarrow lagoon around 400000 shell of *P. margaritifera* which were estimated from average densities.

Another factor which may be the cause of limiting the distribution of *P. margaritifera* is the substrate availability. Many authors have suggested that *P. margaritifera* is scarce or absent in some lagoons due to limited substrate availability (Fisheries Servic, 1970; Intes and Coeroli, 1985a; Intes, 1988; Intes and Coeroli, 1985b; Intes *et al*., 1986). In the present study, many of the areas suffered from the impact of land filling and dredging have no records of such species. This may be due to the coverage of the available substrate by soft sediments which limit the ability of larval settlement. This assumption is supported by the findings of Nayar *et al*. (1978) and Nayar and Mahadevan (1987) which they reported a dense growth of pearl oysters in areas where large rocky surfaces were available.

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