Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 23(1): 185 -195 (2019)
www.ejabf.journals.ekb.eg

Sedimentary characteristics of some island beaches and their effects on nesting numbers of marine turtles, Red Sea, Egypt.

Abd El-Mohsen S. El Daba[1], Mohamed Abd El Wahab[2] and Mohamed Abd El Ghany[3]

1 , 2 - National Institute of Oceanography and Fisheries, Red Sea Branch
3- Egyptian Environmental Affairs Agency, Red Sea Protectorate
Corresponding Author: mohsenelshafei@yahoo.com

ARTICLE INFO

Article History:
Received: Dec. 25, 2018
Accepted: Jan. 29, 2019
Online: Feb. 2019

Keywords:
Marine turtles
Beach sediments
Grain size
Zabaragd Island
Giftun Island
Red Sea
Egypt

ABSTRACT

The impact of beach sands on nesting numbers (NN) of two species; the hawksbill *Eretmochelys imbricate* and the green turtle *Chelonia mydas* on three Egyptian Islands was syudied. The influence of grain size on nests number varied across the three island beaches. The study revealed that gravel fraction showed low values, sand fraction of sediments has heights values and lower abundance of the fine sediments at three studied beaches. Moreover, the average percentage of biogenic content (66.90%, 68.02%, and 60.17%) was recorded in small Giftun, big Giftun and Zabargad beaches respectively.

Correlations (Pearson's correlation) among sediment texture, mean grain size (Mz), sorting, biogenic content and number of nests of three studied islands showed that the NN have a positive correlation with biogenic content and no correlation was found between NN and Mz in the studied beach sediments at the three Islands.

The Hierarchal Cluster Analyses (HCA) dendrogram of sediment type, grain size characteristics, biogenic content and number of the nests (NN) in beach sediments along the three studied Islands are supported by Pearson's correlation coefficient.The condition of the offshore approaches seems to be important in choice of a nesting beach, for example, the tourism activities at Giftun Island make Hawksbill turtles vulnerable to these activities. In contrast, Green turtles at Zabaragd Island seem to prefer beaches of fine sediments or sub-tidal reefs.

INTRODUCTION

Marine turtles are long-lived reptiles that appeared on Earth in the late Triassic. Sea turtles nest on a variety of beach types, and it isnot usually obvious why they choose one beach overanother. In some instances, discontinuities occur because populations have become extinct (Ross and Barwani, 1982). Others most probably can be explained by characteristics of thebeaches themselves, among the basic requirements for a good nestingbeach is easy accessibility from the sea. The beachfacemust also be enough that it is not inundated by spring tide or flooded by the water table below (Mortimer, 1990). Some of the variables that have been considered are the nature of the offshore approach, the beach slope, and the texture of the sand (Mortimer, 1990). In the present study, two species of marine turtles lived on the three studied islands: 1) Green (*Cheloniamydas*) turtleis the most widely distributed in the tropical and subtropical waters, usually preferring near-shore bays and continental waters (Marquez, 1990). Green turtles are considered as one of the two most abundant species in the Red Sea and are known to nest and feed in the region (PERSGA/GEF, 2004).The green turtle is listed as endangered in the IUCN Red List of Threatened Species (IUCN, 2013).

2) Hawksbill (*Eretmochelysimbricata*) turtles have a circum-global distribution, inhabiting tropical and to a lesser extent subtropical waters of the central Atlantic and Indo-Pacific regions (Mortimer and Donnelly, 2008). Most nesting grounds of this species have been found on in-shore islands with Small Giftun andBig Giftun Islands being the most important sites, (Hanafy and Sallem, 2003).The hawksbills are listed as critically endangered at a global level, (CITES, 2013).

Few studies on marine turtles in the Red Sea were reported, where the first review was presented by Frazier and Salas (1984) followed by Moschis, 1985; Frazier *et al.*, (1987); Mortimer, 1990; IUCN/UNEP, 1996; Laurent et al., 1996 and 1998; Torok, 1997; Venizelos and Kallonas, 1999; Foley et al., 2006; Fadini et al., 2011; Péron et al., 2013; and Mancini et al., 2015. Also, recent studies on marine turtles of the Egyptian Red Sea was presented by Hanafy and Sallam, 2003; PERSGA/GEF, 2004; Hanafy, 2012; El-Sadek et al., 2013 and Attum et al., 2014). Therefore,this work aimsto throw the light on the Sedimentary characteristics and their effects on nestingpopulation.

Geomorphology and the environmental setting

The studied area includes three islands (Small Giftun, Big Giftun and Zabargad). Both Small Giftun and big Giftun islandsare located off Hurghada at about 5km from the shoreline. They are founded on a NW-SE extended topographic high structures of about10 km long and 0.5-1.5 km wide (Big Giftun), and 2 km long and 1 kmwide (Small Giftun) respectively, (Fig. 1). Giftun Islands are sub-basins with trend parallel to the coastline of the Red Sea shelf and separated by structural ridges. The Giftun Islands sequence is about 120m high (Big Giftun) and about 85m high (Small Giftun), consisting of alternating coral reefs and sandstones deposited in littoral to beach zone during arid Pliocene period, (Mansour *et al.*, 2006).

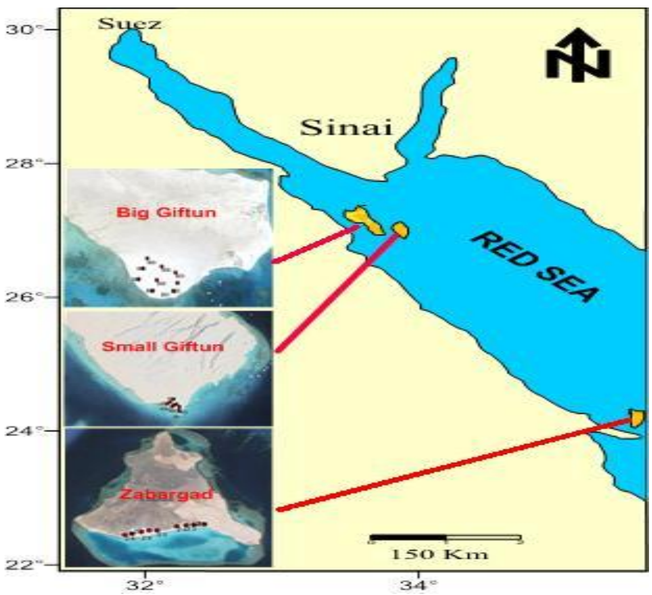

Fig. 1: Location map of the studied Islands on the Red Sea, Egypt.

Marine sediments of both Giftun Islands include coral reef debris, oolitic limestone and echinoid fragments deposited in thelittoral areas. Some faunas such a (Tridacna, echinoids,…etc) belong to Plio-Pleistocene age were recorded,(Mansour et al., 2006).

Zabargad Islands is a small (about 4.5 km^2) with sequence about 190m high,mostly consists of metamorphic rock hills and is located 70 km from the mainland that is a part of the Gebel Elba Protected Areas, (Hanafy, 2012). The island is roughly triangular in shape with each side about 3km long (Fig. 1). The west, eastand north sides are bounded by elevated ranges, while the southern side there is a sandy beach of approximately 2.5 km long that is used by green turtles as the most valuable nesting site. This island is surrounded by fringing reefs running roughly half a kilometer from the shoreline and enclosing a series of lagoons up to 5-6m deep.These reefs rest on older reefs forming a platform which deepens seaward abruptly to depths more than 100m. The offshore beaches of Zabargad Island are believed to be the largest nesting site for Green Turtles within the Egyptian boundaries of the Red Sea,the nesting season occurs between June to August with the yearly number of nests ranging from 438–1527(Hanafy, 2012).

MATERIALS AND METHODS

The present study was carried out in three nesting sites ofHawksbill and Green turtles, on the beaches of Zabargad, Small Giftun and Big Islands, on the Red Sea, Egypt between May to October, 2014.The nestingsites examined were at the Zabargad Island (23° 35′59″N and 36° 11′50″E), Small Giftun Island (27°11′15″N and 33°58′ 19″ E) and Big Giftun Island (27°10′50″N and 33°57′ 00″ E).

In geologic and geomorphologicterms, the beaches monitored in this study can be groupedinto two distinct regions: the northern area, which is underthe influence of the tourism activities, and receivesa significant load of biogenic sediments, from the reworking of the ofPleistocene sand-beach ridges. The southernarea, with abounding contribution of silica clastic sediments, which are in part formed by mineral grains from metamorphic rocks, while biogenic sediments are from organism debris like organic skeletons of mollusk shell, echinoderms and fragments of corals.

Twenty sevensediment beachsamples were collected from May to October 2014 as following: (n = 9) from Small Giftun, (n = 9), Big Giftun, and (n = 9) from Zabargad (Fig. 1). The samples were taken by pushing a steel box about 30cm deep into the sediments. The grain size characteristics of collected sediments were determined by electric shaker of gravel, sand and mud (Folk and Ward,1957). The total carbonate content was determined by the indirect method according to Vogel (1978). The analyses were carried out in the National Institute of Oceanography and Fisheries, Hurghada. We recorded the number of nests and measured track length from water line to the nest of each beach at the three islands. All descriptive statistics and correlations were performed with Excel version 2010, and also,Hierarchal Cluster Analyses were carried out with SPSS Statistics, version 22.

RESULTS AND DISCUSSION

Nature of sediments

The influence of grain size on nests number(NN) variedacross the three island beaches. Grain size helps in determining the textural and depositional characteristics of the environment. Gravel fraction showed low values in three studied Islands (Table

1), this is due to increasing the sand fraction and lacking the fine grained size. The sand fraction of sediments has average values 97.58% at Zabargad beach, 89.45% at Big Giftun beach and 90.66% at Small Giftun beach (Table 1). The sand fraction is dominated and constituted more than 89% of the total studied samples. Mudfraction shows average values of 0.65%, 0.31% and 0.33% at Zabargad, Big Giftun and Small Giftun beaches respectively (Table1).

Table 1: Co-ordinates, sediment type and Grain size characteristics, biogenic content and nests number of studied beach sediments from three Islands.

Island	S. No.	Co-ordinates		Sediment type			Grain size characteristics		Biogenic content %	Nests no.
		Lat.	Long.	Gravel %	Sand %	Mud %	Mz	So		
Zabargad	Z 1	23° 36′ 22.24″	36° 12′ 16.56″	1.51	98.25	0.24	1.63	1.36	59.97	70
	Z 2	23° 36′ 19.48″	36° 12′ 13.13″	1.09	97.07	1.84	1.67	1.34	67.5	25
	Z 3	23° 36′ 16.77″	36° 12′ 8.63″	1.57	98.27	0.16	1.69	1.29	61.47	36
	Z 4	23° 36′ 14.32″	36° 12′ 5.22″	2.86	96.92	0.22	1.37	1.35	67.00	41
	Z 5	23° 36′ 4.91″	36° 11′ 55.72″	2.97	96.89	0.14	2.27	2.16	49.88	16
	Z 6	23° 36′ 1.43″	36° 11′ 50.71″	1.99	96.90	1.11	1.37	1.3	57.15	15
	Z 7	23° 35′ 58.01″	36° 11′ 47.13″	2.20	96.58	1.22	1.79	1.27	55.66	23
	Z 8	23° 35′ 55.63″	36° 11′ 43.65″	0.79	98.86	0.348	1.76	1.18	65.85	88
	Z 9	23° 35′ 52.68″	36° 11′ 40.04″	0.96	98.48	0.56	1.72	1.17	57.05	100
	Min.			0.79	96.58	0.14	1.37	1.17	49.88	15
	Max.			2.97	98.86	1.84	2.27	2.16	67.5	100
	Aver.			1.77	97.58	0.65	1.70	1.38	60.17	46
Big Giftun	BG 1	27°10′ 53.3″	33° 57′ 2.9″	23.33	76.67	0.00	0.15	1.1	60.32	4
	BG 2	27° 10′ 54.3″	33° 57′ 2.9″	6.12	93.88	0.00	0.88	0.96	72.91	5
	BG 3	27° 10′ 55.6″	33° 57′ 3.2″	1.38	98.61	0.00	0.85	0.81	82.49	5
	BG 4	27° 10′ 53 .6″	33° 56′ 59.9″	4.49	95.49	0.02	1.5	0.97	70.1	9
	BG 5	27° 10′ 54.96″	33° 57′ 0.08″	16.00	84.00	0.00	0.38	1.15	53.42	14
	BG 6	27° 10′ 55.8″	33° 57′ 0.2 ″	46.36	52.64	0.00	-0.16	1.17	65.6	16
	BG 7	27° 10′ 55.2″	33° 56′ 55.1″	0.00	100.00	0.00	1.55	0.78	66.38	10
	BG 8	27° 10′ 56.0″	33° 56′ 55.9″	4.33	95.67	0.00	1.31	1.02	65.81	16
	BG 9	27° 10′ 56.7″	33° 56′ 55.6″	6.84	90.37	2.79	0.72	1.33	75.11	12
	Min.			0.00	52.64	0.00	-0.16	0.78	53.42	0.78
	Max.			46.36	100.00	2.79	1.55	1.33	82.49	1.33
	Aver.			10.24	89.45	0.31	0.80	1.1	68.02	1.01
Small Giftun	SG 1	27° 11′ 14.2″	33° 58′ 19.0″	1.44	98.56	0.00	1.73	0.85	58.2	16
	SG 2	27° 11′14.58″	33° 58′ 19.20″	13.02	86.98	0.00	-0.22	0.54	68.48	22
	SG 3	27° 11′ 14.8″	33° 58′ 19.5″	6.13	92.32	1.55	1.31	1.23	53.16	19
	SG 4	27° 11′ 15.8″	33° 58′ 18.4″	9.52	98.47	0.00	0.87	1.08	54	25
	SG 5	27° 1′15.9″	33° 58″ 18.9″	14.79	83.80	1.41	0.73	1.48	54.4	40
	SG 6	27° 11′ 16.2″	33° 58′19.3″	12.73	87.26	0.00	0.52	1.3	80.71	21
	SG 7	27° 11′ 17.4″	33° 58′ 17.7″	7.99	92.00	0.00	0.44	1	77.13	29
	SG 8	27° 11′ 17.9″	33° 8′18.4″	5.66	87.83	6.51	1.35	1.46	74.04	44
	SG 9	27°11′ 18.5″	33° 58′ 19.4″	7.68	92.32	0.00	0.71	1.2	81.94	43
	Min.			1.44	83.80	0.00	-0.22	0.54	53.16	16
	Max.			14.79	98.56	6.51	1.73	1.48	81.94	44
	Aver.			9.01	90.66	0.33	0.83	1.13	66.90	28.77

* NT: Mz = Mean Grain Diameter, So = Sorting

The significant progressive difference in the grain size of the Zabargad sediments from coarse to very fine-sized sand grains is apparently due to theaction of the weatheringanderosionfrom metamorphic nearby source, (Pettijohn,1975), while the lower abundance of the fine sediments in both Giftun Islandsmay be due to the fact that the beaches receive initially coarse sediments from the reworking effects (Table 2).

Grain size characteristics

Mean grain size (Mz) indicates the average kinetic energy of the depositing agent. Zabargad beach have Mz values ranging from 1.37 and 2.27ϕ with an average 1.7ϕ. Beach at Big Giftun have Mz fluctuate between-0.16 and 1.55ϕ averaging 0.80 ϕ,while the Small Giftun beach have Mz values vary from-0.22 to 1.73ϕ with an average of 0.83ϕ (Table 1). The obtained data show that the Mz values of beach samples at both Big and Small Giftun beaches are similar and they lesser than those recorded at Zabargad beach. Beach sediments of the three studied islandsare attributed tosiliciclastic supply invading the beach which rearranged by wave action mixed with sand of biogenic origin.

Sorting reflecting the variable velocities and conditions of the depositing rate.The beach sediments at Zabargad demonstrates poorly sorting, their values ranges between from 1.17 and 2.16ϕ averaging 1.38ϕ. Also, the beach sediments of both Giftun Islands show poorly sortin gwith average values of (1.1 and 1.13) at Big Giftun and Small Giftun,(Table 1). The poorly sorted sediments dominate in the all studies beach samples may be attributed to the breakdown of coral reefs and their indigenous fauna proved heterogeneous material is a great variety of particle shapes and size resulting in formation of multiple modes leading to any kind of textural characteristics (Pilkey et al., 1967).

Biogenic sediments

Biogenic sediments are defined as those in which carbonate deposition occurs so close to the shoreline and not just to the open sea facies, (Abd El Wahab, 1996). In the laboratory; the microscopic investigation shows that the sediments are most composed of skeletal fragments such as corals, gastropods, pelecypods, echinoids and spins of sponges in addition to small amounts of quartz and rock fragments.

The amount of biogenic sediments varied among beaches, they are the main source for carbonates.The averages of biogenic sediments (66.90%, 68.02%, and 60.17%)of the studied Islands were found in Small Giftun, Big Giftun and Zabargad beaches respectively (Table 1). The abundance of biogenic sediments in the three studied beaches explains the relatively low terrigenous input produced from nearby source rocks, plus the large contribution of carbonate sediments produced from fragments such as shells, echinoderms, corals and coralline algae. This results agree with Hughes (1974) and Hirth and Carr (1970)whose observed that the beaches range in composition from fine sand to coral pebbles and all are used by green turtles,whilenesting media of Hawksbill turtles range from fine siliceous sand to coarse shell and coral fragments.

The factors affecting sediment distribution pattern in the three studied islands are as follows: shore morphology, presence of corals and other biogenic producing communities, terrestrial materials derived from nearby geological structures and activity of waves and currents (Meylan,1988).

Nests number

The nesting sites for many major sea turtles population are islands, which are usually characterized by relative freedom from mammalian predators, at least prior to man's arrival, (Mortimer, 1990). Field survey shows that; Zabargad beach has 2000m long including 414 nests and tracks length varies between 7- 90 m, Small Giftun beach is 1500m long, contain 259 nests, its tracks length ranged from 3-137 m and Big Giftun beach is 1000m long with 90 nests, and the length of tracks varies from 3 to 100 m (Table 2). The condition of the offshore approaches seems to be important in choice of a nesting beach, for example, the tourism activities at both Giftun Island make Hawksbill turtles vulnerable to these activities. In contrast, Green turtles at Zabaragd Island seem to prefer beaches of fine sediments or sub-tidal reefs.

Table 2: Nests numbers, tracks length and grain size parameters of the three studied beaches.

Variable		**Zabargad Island**	**B. Giftun Island**	**S. Giftun Island**
Nest number		414	90	259
Tracks length **(m)**		7- 90	3-100	3-137
Average Grain Size	**Gravel %**	1.77	10.24	9.01
	Very coarse sand %	8.43	12.32	20.41
	Coarse sand %	26.99	31.71	28.41
	Medium sand %	21.94	29.03	25.46
	Fine sand %	23.83	14.80	13.54
	Very fine sand %	16.40	1.59	2.83
	Mud %	0.65	0.31	0.33

Statistical analyses

Data gathered from beach sediments at three studied Islands showed the following:-

Correlation coefficient results illustrate that the NNhave a negative correlation with both of gravel (-0.65), mud (-0.37) and sorting (-0.48), also, the NN correlated positively with sand (0.86) and biogenic sediments (0.24) at Zabargad beach. At Big Giftun beach; the NN shows a positive correlation with gravel (0.33), mud (0.15), sorting (0.42) and biogenic sediments (0.39). Also, correlated negatively correlation with sand (-0.35). The correlation coefficient of the small Giftun beach indicates that NN has a positivecorrelation with gravel (0.17), mud (0.54), sorting (0.59), and biogenic sediments (0.35) and,also a weak negative correlation with sand (-0.43). No correlation coefficient was found between NN and Mz in the studied sediment at three Islands.

The HierarchalCluster Analyses (HCA) dendrogram of sediment types, grain size characteristics, biogenic content and number of the nests (NN) in beach sediments along the three studied Islands yielded the following clusters (Fig. 3).

At Zabargad Island; the beach sediments are classified into two main clusters: the first cluster containing Mz, sorting, gravel, and mud has lower linkage distances, but greater similarity compared to the second cluster,which contains NN, biogenic content and sand. The lowest linkage distances which observed in the first cluster are supported by Pearson’s correlation coefficient (Table 3). Strongly positive correlations were observed between these four variables of the cluster 1, e.g., Mz and mud ($r = 0.81$), sorting and mud ($r = 0.97$), gravel and sorting ($r = 0.56$), sorting and Mz ($r = 0.72$), indicating joining sediment type with grain size characteristics. The second cluster includes NN, biogenic content and sand. Stronglypositive correlation was found between NN and sand ($r = 0.86$), indicating a highly percentage of sand (97.58%), (Table 1),while weaklypositive correlation was recorded between NS and biogenic content ($r = 0.24$) of this cluster.

Table 3: Correlations (Pearson's correlation) among sediment type, mean grain size, sorting, biogenic content and number of nests (NN) of three studied Islands.

Nests number (NN)	1	**Zabargad**					
Gravel (%)	-0.65	1					
Sand (%)	0.86	-0.55	1				
Mud(%)	-0.37	0.45	-0.99	1			
Mz	-0.07	0.04	-0.76	0.81	1		
Sorting	-0.48	0.56	-0.98	0.97	0.72	1	
Biogenic content (%)	0.24	-0.35	0.65	-0.65	-0.60	-0.59	1
Nests number (NN)	1	**Big Giftun**					
Gravel (%)	0.33	1.00					
Sand (%)	-0.35	-0.99	1.00				
Mud(%)	0.15	-0.13	0.07	1.00			
Mz	-0.09	-0.86	0.86	-0.05	1.00		
Sorting	0.42	0.51	-0.55	0.64	-0.61	1.00	
Biogenic content (%)	0.39	-0.42	0.40	0.32	0.32	-0.31	1.00
Nests number (NN)	1	**Small Giftun**					
Gravel (%)	0.17	1.00					
Sand (%)	-0.43	-0.70	1.00				
Mud(%)	0.54	-0.22	-0.33	1.00			
Mz	-0.04	-0.78	0.49	0.40	1.00		
Sorting	0.59	0.10	-0.34	0.55	0.39	1.00	
Biogenic content (%)	0.35	0.07	-0.29	0.04	-0.39	0.03	1.00

Mz = Mean grain Size.

At Big Giftun Island; the studied beach sediments were grouped into three main clusters based on the number of nests (Fig. 3). The first cluster including Mz, sorting, mud and NSshows the lowest linkage and greatest similarity in comparison with both second and third clusters. It revealed weak positive correlation betweenNNand mud (r = 0.15) and NSwith sorting (r = 0.42).No correlation was found between NN and Mz (r = -0.09) in this cluster. Cluster 2 consists of gravel illustrating positive correlation between gravel and NN (r = 0.33), and gravel and soring (r = 51) in addition to negative correlation between gravel and mud (r = -0.13) and gravel with Mz (r = -0.85). Cluster 3 containing sand and biogenic content has moderate linkage distances with NN (Fig. 3).

At Small Giftun Island; based on nest numbers, 6 variables (Gravel, sand, mud, Mz, sorting and biogenic content) from the beach sediments are divided into three main clusters (Fig. 3). Cluster 1 consists of 4 variables represent the lowest cluster, positive correlations were found between gravel and sorting (r = 0.10), mud and sorting (r = 0.55).Cluster 2 includes NN, which has moderate linkage distances, indicating that there is positive correlation between NN and mud (r = 0.54), NN and sorting (r = 0.59) and NN and biogenic content (r= 0.35). No correlation was found between NN and Mz (r = -0.04). Cluster 3 contains 2 variables: sand fraction and biogenic content representing the high percentage of sand fraction (90.66%) which includes 66.90% biogenic content of thissandfraction (Table 1). This cluster shows negative correlation between NN and sand(r =-0.43). Biogenic content is weaklypositive correlated with NN and no correlation was found between Mz and NN in all studied beach sediments at three Islands (Table 3).

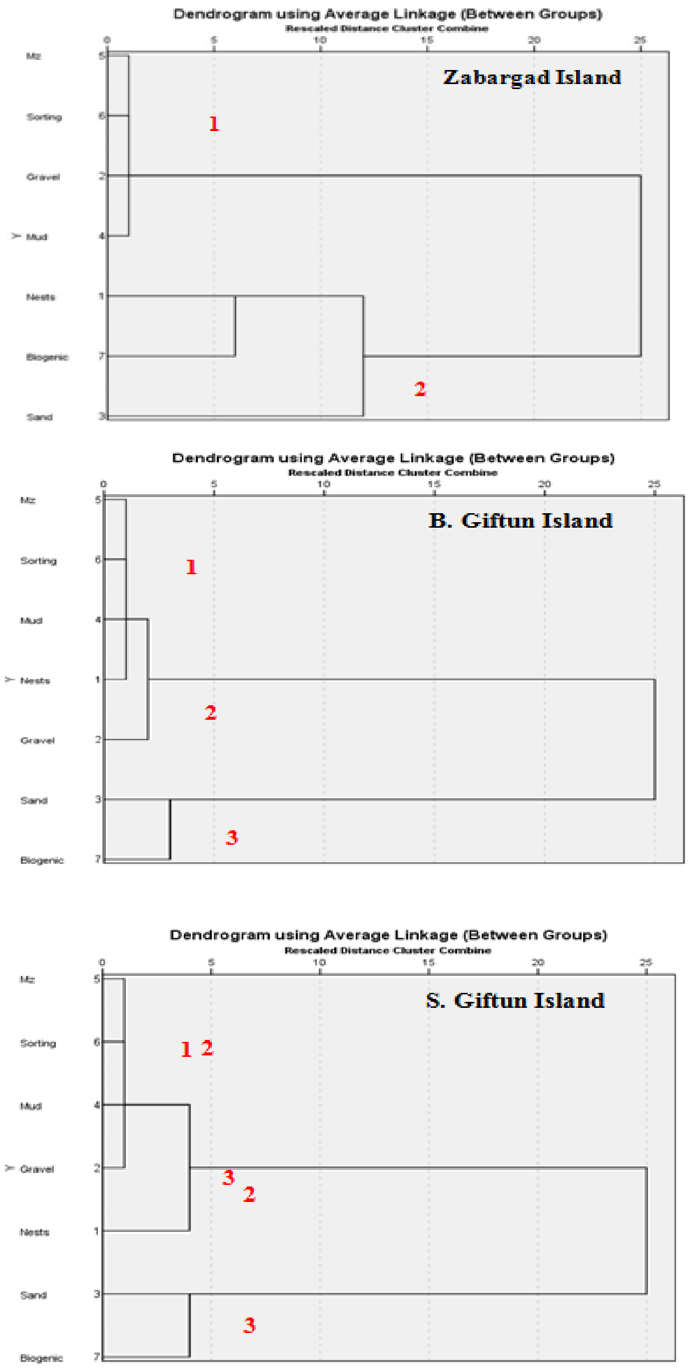

Fig. 3: Dendrogram for hierarchalcluster analyses of beach sedimentsamples collected from three studied Islands.

CONCLUSION

In the present study; the differences in the results between the analyzed beach samples at three islands may be due to the nature of the shore, especially the composition of the sediments.Considering sediment size, although some correlations between grain fractions and the nesting numbers were negative correlation, the volumetric contribution of biogenic fractions to sediment size is high, which makes it easy to predict how they could lead to changes in nest environment and affect embryo survival.

In Zabaragd Island; the texture of the sand might account for the selection of beach by green turtles which is mainly contains low percentage of gravel and high percentage of very fine sand size, in contrast at both Giftun Island in addition to high percentage of biogenic which are probably caused by reworking and erosion of the Pleistocene terraces. Field observations showed that Hawksbills turtles commonly dig their nests on beach amongst solid waste and garbage especially at Big Giftun Island due the tourism activities.

Our results on the influence of most sediment characteristics and nesting numbers differed depending on beaches were analyzed individually. The factors affecting sediment distribution pattern in the three studied islands are as follows: shore morphology, presence of corals and other biogenic producing communities, terrestrial materials derived from nearby geological structures and activity of waves and currents.

REFERENCES

Abd El Wahab, M. (1996). Studies on the recent sedimentary environments and the benthic foraminifera in the intertidal zone of the area between Gemsha and Marsa Alam, Red Sea Egypt. M.Sc. Thesis, Faculty of Science, South Valley University, 172pp.

Attum, O.; Kramer, A.; Mahmoud, T. and Fouda, M. (2014). Post-nesting migrations patterns of green turtles (*Cheloniamydas*) from the Egyptian Red Sea. Zool. Middle East., pp.1–7.

CITES, (2013). Convention on International Trade of Endangered Species. Available online: www.cites.org. Consulted on 2013.

El-Sadek, I.; Ahmed, M. I.;Amer, M. A.; Mancini, A., and Mahmoud, H.(2013). Nesting activities of Green turtles (*Cheloniamydas*) on the beaches of Zabargad Island, southern Egyptian Red Sea. Egypt. J. Aquat. Biol. & Fish., 20 (4):29–37.

Fadini, L. S.; Silva, G. A. and Ferreira-Júnior, P. D. (2011). Sedimentary characteristics and their effects on hatching success and incubation duration of *Carettacaretta* (Testudines: Cheloniidae) in Espirito Santo, Brazil, Zoologia, 28 (3):312–320.

Foley, A. A.; Peck, S. A. and Harman, G. R. (2006). Effects of Sand Characteristics and Inundation on the Hatching Success of Loggerhead Sea Turtle (*Carettacaretta*) Clutches on Low-Relief Mangrove Islands in Southwest Florida. Chelonian Conservation and Biology, 5(1): 32–41.

Frazier, J.; Bertram, G.C. and Evans, P. G. (1987). Turtles and marine mammals. pp. 288-314. In: Key Environments: Red Sea. (A.J. Edwards and A.M. Head, eds.) Pergamon Press, Oxford.

Frazier, J. and Salas, S. (1984). The status of marine turtles in the Egyptian Red Sea. Biol. Conserve., 30(1): 41–67.

Folk, R. and Ward, W. (1957). Brazos river bar. A study in the significance of grain size parameters. J. Sediment Petrol, 27: 3–26.

Hanafy, M. H. (2012). Nesting of marine turtles on the Egyptian beaches of the Red Sea.Egyptian Journal of Aquatic Biology & Fisheries, 16:59– 71.

Hanafy, M. H. and Sallam, A. (2003). Status of marine turtles nesting on the Egyptianbeaches of the Red Sea. National Report to PERSGA, 45pp.

Hirth, H. F. and Carr, A. (1970). The green turtles in the Gulf of Aden and the Seychelles Islands. Verbandelingen der Koninklijke Nederlandse Akademie van Wetenscabappen., 58:1-44.

Huges, G. R. (1974). The sea turtles of southeast Africa. I. Status, morphology and distributions. Oceanographic Research Institute Investigational Report. Durhan., 35:1-144.

IUCN.(2013). IUCN Red List of threatened species. Available online: http://www.redlist.org. Consulted on 12 Feb 2013.

IUCN/UNEP. (1996). Status of sea turtle conservation in the western Indian Ocean, (S.L. Humphrey and R.V. Salm.eds), Proc. Western Indian Ocean Training Workshop and Strategic Planning Session on Sea Turtles, Sodwana Bay, South Africa, November, 1995. UNEP Regional Seas Reports and Studies No. 165.

Laurent, L.; Abd El-Mawla, E. M.; Bradai, M. N.; Demirayak, F. and Oruc,A. (1996). Reducing sea turtle mortality induced by Mediterranean fisheries. Trawling activity in Egypt, Tunisia and Turkey. Report for the WWF International Mediterranean Program. WWF Project E0103. 32pp.

Laurent, L.;Guglielmi, P. and Leonardi, E. (1998). Marine turtle conservation management in the Mediterranean. Recommendations for a new approach. WWF International. 17pp.

Mancini, A.; Elsadek, I. and El-Alwany, M. A. (2015). Marine Turtles of the Red Sea, (N.M.A. Rasul and I.C.F. Stewart.eds),Springer Earth System Sciences, chapter 31.

Mansour, A. M.; Mohamed, A. W. and Osman, M.; Naser El Dien, A. and Tahoen, M. A.(2006). Sedimentological and geochemical studies on some island sediments of the Red Sea, Egypt. Egypt. J. Aquat. Res., 32, special issue:105-130.

Marquez, R. (1990) Marine turtles of the world. An annotated y illustrated catalogue of sea turtle species known to date. FAO species catalogue, FAO fisheries synopsis, vol 11(125), 81pp.

Meylan, A. (1988). Spongivory in hawksbill turtles: a diet of glass. Science 239(4838):393–395.

Mortimer, J. A. (1990). The influence of beach sand characteristics on the nesting behavior and clutch survival of green turtles (*Cheloniamydas*). Copeia. (3):802–817.

Mortimer, J.A. and Donnelly, M. (2008).Eretmochelysimbricata. In: IUCN red list of threatened species, version 2010.1. Available at www.iucnredlist.org

Moschis, G., (1985). The role of family communication in consumer socialization of children and adolescents. Journal of Consumer Research, pp. 898-913.

Péron, C.; Chevallier, D. D.; Galpin, M. M.; Chatelet, A.; Anthony, E. J.; Le Maho, Y. and Gardel, A. (2013). Beach morphological changes in response to marine turtles nesting: a preliminary study of Awala-Yalimapo beach, French Guiana (South America). Journal of Coastal Research, Special Issue No. 65.

PERSGA/GEF.(2004). Regional Action Plan for the Conservation of Marine Turtles andtheir Habitats in the Red Sea and Gulf of Aden. PERSGA, Jeddah.

Pettijohn, F.J. (1975). Sedimentary rocks, 3rd ed. Harper and Row, New York, 628pp.

Pilkey, O. M; Morton, R. W. and Luternauer, J. (1967). The carbonate fraction of beach and dune sands. Sedimentology, 8: 311-327.

Ross, J. P. and Barwani, M. A. (1982). Review of marine turtles in the Arabian Area. In: Bjorndal KA (ed) Biology and conservation of marine turtles. Smithsonian Institution Press, Washington, DC., pp. 373–382.

Torok, M., (1997). Strategic Planning. Hopkins Non-Profit Training Network. The Norwegian Agency for Development Cooperation,the Logical Framework Approach (LFA), third edition.

Venizelos, L. and kallonas, M. (1999). The exploitation of sea turtles continues inEgypt. Testudo, the Journal of the British Chelonia Group, 5(1): 53-58.

Vogel, M. L. (1978). Textbook of quantitative inorganic analysis, 4th ed. printed in Great Britain by William Clowes Limited Beccles and London, 92: 492–493.