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Abundance, diversity and distribution of coral reef fish families in the Egyptian Red Sea, at Hurghada, Egypt

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ABSTRACT

The present study was designed to investigate the coral reef fish community structure in Egyptian Red Sea waters, at Hurghada diving sites and the variations in abundance and diversity according to different seasons and depths. Twelve diving sites were selected to represent the variety of diving places around Hurghada. The current area covers about 720 km^2 including the coastal strip of Hurghada, the near shore islands and submerged reefs. Results recorded 47 species of coral reef fishes that belong to 24 genera of 8 families (Chaetodontidae: 10 species; Pomacentridae: 9 species; Acanthuridae: 6 species; Holocentridae: 5 species; Balistidae: 5 species; Pomacanthidae: 5 species; Serranidae: 3 species and Scaridae: 4 species). The total abundance of coral reef fishes in the study area during the period of study was 74859 individuals. Deshet El-Daba diving site has the highest diversity (41 species) of the coral reef fishes and Umm Gamar Island has the highest fish abundance (8160 individuals), while Banana Reef diving site has the lowest diversity (28 species) and lowest fish abundance (1967 individuals) of coral reef fishes. The present result indicated that there are variations in both of coral reef fish diversity and abundance during different seasons, different diving sites and different water depths of the studied diving sites.

INTRODUCTION

The distributions of animal populations and space used by individuals have been central issues in ecology for a long time. Several factors affect space used by individuals, including: presence of competitors **(Smith & Tyler, 1972; Robertson, 1996)**, food resources (**Gerking, 1994)**, presence of pedators **(Coleman& Wilson, 1996; Gregory & Anderson, 1997)**, and availability of habitat or microhabitat **(Robertson, 1996; Jones, 2005)**.

Understanding how environmental factors shape the diversity of biotic assemblages has always been a critical issue in ecology and an important prerequisite of successful biodiversity conservation **(Caley & Schluter, 1997; Gaston, 2000; Bellwood & Hugues, 2001; Fischer & Lindenmayer, 2006)**.

The importance of habitat in determining local species richness was recognized early on and for a variety of vertebrate groups **(Fischer & Lindenmayer, 2006; Herzog & Kessler, 2006)**. Both local (niche availability) and regional (biogeographical) habitat factors have been showed to shape the diversity structure of biotic assemblages **(La Sorte & Boecklen, 2005; Herzog & Kessler, 2006)**. Conservation management requires more understanding of how organisms are distributed through space to highlight anthropogenic impacts, like habitat fragmentation or resource exploitation, and their influence on species–habitat relationships described in landscape ecology studies **(Kareiva & Wennergen, 1995; Nakagiri & Tainaka, 2004; Fischer & Lindenmayer, 2006)**.

Thus, the present work was conducted to investigate the coral reef fish community structure in Egyptian Red Sea waters, at Hurghada diving sites. In addition to study the seasonal and spatial variation in abundance and diversity in these diving sites.

MATERIALS AND METHODS

1. Study area and selected diving sites:

The study area around Hurghada extended from as far north as Latitude 27.372154º and Longitude 33.680504º to the southernmost point at Latitude 27.044743º and Longitude 33.905912º. The current area covers about 720 km^2 including all the coastal strip of Hurghada as well as the near shore islands and submerged reefs **(Fig. 1)**.

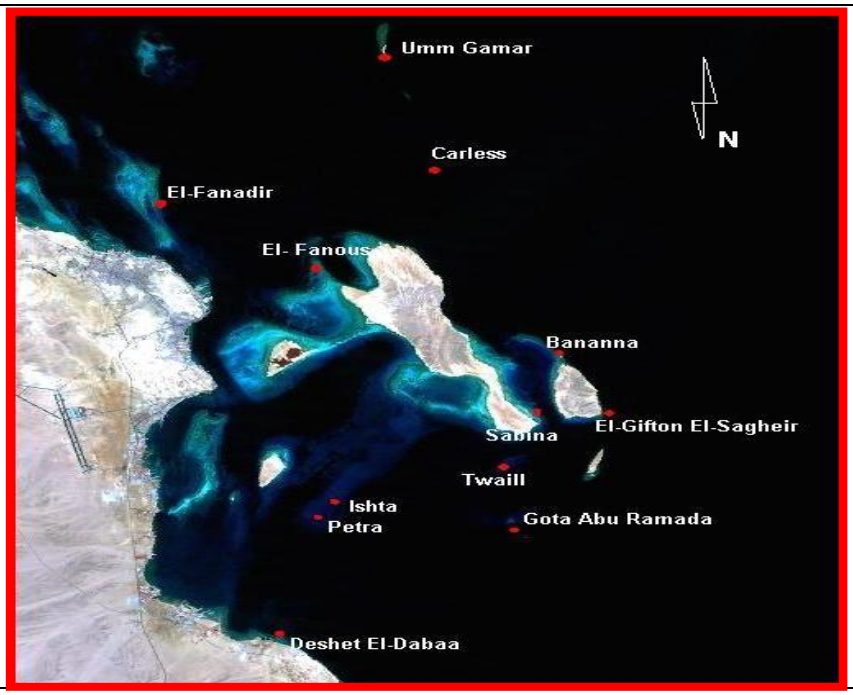

Fig. (1): Map showing the study area and selected diving sites around Hurghada

Among the 20 or more diving sites around Hurghada area, 12 sites were selected for conducting the current investigation **(Fig. 1)**. These sites were selected to represent the

variety of diving places around Hurghada from structure and functionality points of view. The exact location of the selected sites is indicated in **Table (1)**.

Table (1): Locations and description of selected diving sites.

No.	Diving centers	Location	Description
1	**Sha'ab El-Fanadir**	**N 27°15'54" E 33° 51' 59"**	A submerged reef island, there are four low small rocky patches arising over the reef flat.
2	**Umm Gamar Island**	**N 27°21'6.7" E 33° 54' 30"**	A small island surrounded with narrow reef flat. The reef slope at the southern side goes down to about 12m depth, where most of the diving activity takes place.
3	**Carless reef**	**N 27°18'42" E 33° 56' 12"**	It consists of two big reef ergs and several other small patches around them.
4	**El- Fanous reef**	**N 27°15'44" E 33° 53' 6.6"**	A light house is found over the top of this reef. It has two sides, the northern exposed reef side and the southern sheltered reef side.
5	**Sha'ab Sabina**	**N 27°12'49.7" E 33° 57' 12"**	It lies about 60 minutes away from Hurghada port to the south direction and to the north in-between the Gaftun Islands.
6	**El-Gifton El-Sagheir**	**N 27°11'09" E 33° 58' 53"**	It is a rocky island, surrounded with fringing reef with narrow reef flat. The popular diving sites found on the eastern and southern sides.
7	**Banana Reef**	**N 27° 13'16.4" E 33° 57' 6.84"**	It pokes out from the eastern side of Giftun Kebir island and has a coral garden extending 300-400m to the north. It is known for its beautiful coral landscape rather than its fish life.
8	**Gota Abu Ramada**	**N 27° 08'22" E 33° 57' 11.8"**	It is a submerged reef island, with many small coral patches around it. The site is popular most of the year due to its shallowness and protected conditions.
9	**Sha'ab Erok**	**N 27° 9'52.4" E 33° 57' 0.5"**	A cluster of a seven ergs laying in 10m – 15m of water. The whole area is home to sweetlips, blue spotted sting rays, and glassfish.
10	**Sha'ab Petra**	**N 27°07'39" E 33° 54' 15"**	It is a submerged reef like bile's in sheltered area of southern east island of shallow area between 15-30 m.
11	**Sha'ab Ishta**	**N 27°07'39" E 33° 54' 15"**	It is known for its attractiveness, rich coral and fish communities over the whole area. It contains three big reef ergs, the northern sides are exposed and the southern sides are sheltered.
12	**Deshet El-Daba**	**N 27°2'10" E 33° 53' 3.3"**	It has fringing reef with very narrow flat reef. The reef slope has moderate gradient level. The bottom is sandy with scattered coral heads and patches.

2. Identification of fish species:

Fish species were identified using the method of **Allen (1985)**, **Randall (1992), Allen and Steenem (2002)** and **Myers and Lieske (2004).** In addition, the International FISHBASE, the largest data base of fishes on the global level, was also used to confirm the information collected on each species.

3. Coral reef fish visual census:

Visual census technique used in this study is one of the most common quantitative and qualitative sampling methods used in coral reef surveys as recommended By **Halford and Thompson (1994)**. The survey team consists of 2 divers, and a person in the boat. The used equipment consists of a fiberglass measuring tapes (100 meters length) and a fixing strap on both ends of the tape.

The fish counting was performed at three different depths in each site (3, 6, and 9 m). At each site the measuring tape was laid straight following the depth contour of the reef at the designated depth. Transect was then left for at least 20 min. to allow fishes to resume normal behavior **(Carpenter *et al.,* 1981)**. The counting of fishes was performed during swimming along transect, and 1.5 meters on both sides was performed using diving equipment for at least 30 min. Underwater observations were recorded on underwater fish data plastic sheet prepared by the diver prior to the study. At the laboratory, the fish data, recorded in field, were transferred to a special sheet prepared by the author on Excel program.

4. Data Analysis:

Data collected during the current study were tabulated using Excel software and analyzed using all the available statistical software.

RESULTS

1. Fish population structure in selected diving sites:

During the present study, fishes of the most commonly present species in the coral reef around Hurghada were recorded in Table (2). The results showed that there are 47 species of coral reef fishes belonging to 24 genera of 8 families (Family: Chaetodontidae ,10 species belonging to 2 genera; Family: Pomacentridae, 9 species belonging to 5 genera; Family: Acanthuridae, 6 species belonging to 3 genera; Family: Holocentridae, 5 species belonging to 3 genera; Family: Balistidae, 5 species belonging to 5 genera; Family: Pomacanthidae, 5 species belonging to 3 genera; Family: Serranidae, 3 species belonging to 2 genera; Family Scaridae, 4 species of genus *Scarus*).

As shown in Table (3), the total number of fish species was greatly varied in the different diving sites under investigation. The highest fish diversity (41 species) was recorded in Deshet El-Daba; while the lowest fish diversity (28 species) was recorded in Banana Reef. Chaetodontidae was the highest diversified family containing 10 species in most diving sites, but the lowest number of chaetodontid fishes was recorded in Sha'ab Petra. The highest number of pomacentrid fishes (9 species) was recorded in Sha'ab Sabina, while the lowest (6 species) was recorded in both of Banana Reef and Sha'ab Ishta. The highest number of acanthurid fishes (6 species) was recorded in Umm Gamar Island, while the lowest (2 species) was recorded in Sha'ab Petra. Moreover,the minimum diversity to the rest families was recorded in Banana Reef (Table 3).

In the present study, the total abundance of coral reef fishes was 74859 individuals. This abundance of coral reef fishes was greatly varied in different studied diving sites. The first site (Umm Gamar Island) recorded the maximum abundance (8160 individuals) of coral reef fishes, while the minimum number (1967 individuals) was recorded in Banana Reef (Table 4).

The family Pomacentridae was the most abundant coral reef fish family in the studied area, having a total number of 58303 individuals. Family Holocentridae was the second abundant coral reef fish family with 8224 individuals. Nevertheless, Balistidae, Pomacanthidae and Serranidae had the lowest number of fish (Table 4).

2. Seasonal variation in diversity of coral reef fishes:

The results indicated that the number of coral reef fish species was seasonally varied in different diving sites (Table 3). During spring, the highest number of species (36 species) was recorded in Sha;ab Sabina, and the lowest number of species (22 species) was recorded in Banana Reef. The chaetodontid fishes had the maximum diversity that ranged from 7 to 9 species; followed by pomacentrid fishes ranging between 5 and 9 species.

During summer, the diversity of coral reef fishes increased in most of the diving sites, ranging from 31- 38 species, except for Banana Reef, which recorded only 21 species. The family Chaetodontidae had the highest diversity represented by 7 - 10 species; followed by the family Pomacentridae which represented by 5 - 8 species (Table 3).

During autumn, the diversity of coral reef fish species decreased again, and the highest number of species recorded only 34 species in Umm Gamar Island diving site. Whereas the lowest diversity of coral reef fishes greatly decreased and recorded only 16 species in Banana Reef. Moreover, the number of species in most coral reef fish families reduced; where the family Chaetodontidae had only 5 - 9 species and Pomacentridae ranged between 2 and 8 species (Table 3).

During winter, Deshet El-Daba diving site recorded the highest coral reef fish diversity, being 36 species, while Sha'ab Ishta diving site recorded the lowest coral reef fish diversity. Furthermore, the chaetodontid fishes had the maximum diversity that ranged from 5 to 10 species; followed by pomacentrid fishes ranging between 3 and 8 species (Table 3).

3. Seasonal variation in abundance of coral reef fishes:

Results indicated that the number of coral reef fish individuals recorded in various diving sites was greatly varied during different seasons (Table 4). During spring, the total abundance of coral reef fishes was represented by 19700 individuals. The highest abundance (1967 individuals) was recorded in Deshet El-Daba, and the lowest abundance (440 individuals) was recorded in Banana Reef. The family Pomacentridae had the maximum abundance (15979 individuals); followed by family Holocentridae and Chaetodontidae, being 1469 and 1015 individuals, respectively.

During summer, the total abundance of coral reef fishes was represented by 20563 individuals. The highest abundance (2274 individuals) was recorded in Umm Gamar Island diving site and the lowest abundance (568 individuals) was recorded in Banana Reef. The

family Pomacentridae had the maximum abundance (15476 individuals); followed by family Holocentridae and Chaetodontidae, being 2954 and 1132 individuals, respectively (Table 4).

During autumn, the total number of coral reef fishes was 19198 individuals. The highest abundance (2157 individuals) was recorded in Deshet El-Daba diving site and the lowest abundance (237 individuals) was recorded in Banana Reef. The family Pomacentridae had also the maximum abundance (15333 individuals); followed by family Holocentridae and Acanthuridae, recording 1632 and 939 individuals, respectively, as shown in Table 4.

During winter, the total abundance of coral reef fishes decreased greatly which was represented by only 15398 individuals. The highest abundance (2205 individuals) was recorded in Umm Gamar Island diving site, and the lowest abundances (722 and 765 individuals) were recorded in Banana Reef and Sha;ab Sabina diving sites, respectively. The family Pomacentridae had also the maximum abundance (11515 individuals); followed by family Holocentridae and Achanthuridae, being 2169 and 772 individuals, respectively,as in Table 4.

4. Abundance variation of coral reef fishes according to water depth:

Results indicated that the abundance of coral reef fishes recorded in various Red Sea diving sites was greatly varied according to the water depth as shown in Table 5.

At 3 meters of water depth, the total abundance of coral reef fishes was represented by 29515 individuals. The highest abundance (3377 individuals) was recorded in Umm Gamar Island diving site and the lowest abundance (1076 individuals) was recorded in Banana Reef diving site. The family Pomacentridae had the maximum abundance (24059 individuals); followed by family Acanthuridae and Holocentridae, being 2018 and 1681 individuals, respectively, as in Table 5.

At 6 meters of water depth, the total abundance of coral reef fishes was represented by 27052 individuals. The highest abundance (3176 individuals) was also recorded in Umm Gamar Island diving site and the lowest abundance (579 individuals) was also recorded in Banana Reef. The family Pomacentridae had the maximum abundance (20617 individuals); followed by family Holocentridae, Acanthuridae and Chaetodontidae, being 3648, 1231 and 1225 individuals, respectively, as in Table 5.

At 9 meters of water depth, the total abundance of coral reef fishes decreased and represented by only 18292 individuals. The highest abundance (2226 individuals) was recorded in Carless Reef diving site and the lowest abundance (312 individuals) was also recorded in Banana Reef. The family Pomacentridae had also the maximum abundance (13681 individuals); followed by family Holocentridae and Chaetodontidae, being 2949 and 993 individuals, respectively, as in Table 5.

Table (2): The coral reef fish species and their families recorded from the diving sites during the present study.

Family	Scientific name	Family	Scientific name
Chetodontidae	*Chaetodon semilarvatus* Cuvier, 1831	Holocentridea	*Sargocentron diadema* (Lacepède, 1802)
	Chaetodon lineolatus Cuvier, 1831		*Sargocentron rubrum* (Forsskål, 1775)
	Chaetodon melannotus Bloch & Schneider 1801		*Sargocentron caudimaculatum* (Rüppell, 1838)
	Chaetodon austriacus Rüppell, 1836		*Neoniphon sammara* (Forsskål, 1775)
	Chaetodon auriga Forsskål, 1775		*Myripristis murdjan* (Forsskål, 1775)
	Chaetodon larvatus Cuvier, 1831		Total: 5 species
	Chaetodon paucifasciatus Ahl, 1923	Balistidea	*Rhinecanthus assasi* (Forsskål, 1775)
	Chaetodon fasciatus Forsskål, 1775		*Balistapus undulatus* (Park, 1797)
	Chaetodon trifascialis Q & G, 1825		*Pseudobalistes flavimarginatus* (Rüppell, 1829)
	Heniochus intermedius Steindachner, 1893		*Odonus niger* (Rüppell, 1836)
	Total: 10 species		*Abalistes stellatus* (Bloch & Schneider 1801)
Pomacentridae	*Pomacentrus sulfureus* Klunzinger, 1871		Total: 5 species
	Dascyllus trimaculatus (Rüppell, 1829)	Pomacanthidae	*Pomacanthus maculosus* (Forsskål, 1775)
	. Dascyllus aruanus (Linnaeus, 1758)		*Pomacanthus asfur* (Forsskål, 1775)
	Amphiprion bicinctus Rüppell, 1830		*Pomacanthus imperator* (Bloch, 1787)
	Chromis dimidiata (Klunzinger, 1871)		*Centropyge multispinis* (Playfair, 1867)
	Chromis viridis (Cuvier, 1830)		*Pygoplites diacanthus* (Boddaert, 1772)
	Abudefduf sexfasciatus (Lacepède, 1801)		Total: 5 species
	Abudefduf saxatilis (Linnaeus, 1758)	Serranidae	*Variola louti* (Forsskål, 1775)
	Amblyglyphidodon leucogaster (Bleeker, 1847)		*Cephalopholis argus* Bloch & Schneider 1801
	Total: 9 species		*Cephalopholis sexmaculata* (Rüppell, 1830)
Acanthuridae	*Zebrasoma xanthurum* (Blyth, 1852)		Total: 3 species
	.Zebrasoma desjardinii (Bennett, 1836)	Scaridae	*Scarus rubroviolaceus* Bleeker, 1847
	Acanthurus gahhm (Forsskål, 1775)		*Scarus sordidus* (Forsskål, 1775)
	Acanthurus sohal (Forsskål, 1775)		*Scarus ghobban* Forsskål, 1775
	Naso lituratus (Forster, 1801)		*Scarus psittacus* Forsskål, 1775
	Naso unicornis (Forsskal, 1775)		Total: 4 species
	Total: 6 species		
Totals: 47 species			

Table (3): Seasonal variation in diversity of different fish families recorded in selected diving sites.

Season	Family	Diving sites											
		Umm Gamar Island	Sha'ab El-Fanadir	Carless reef	El- Fanous reef	Bannana Reef	Sha'ab Sabina	El-Gifton El-Sagheir	Sha'ab Erok	Gota Abu Ramada	Sha'ab Ishta	Sha'ab Petra	Deshet El-Daba
Spring	Chaetodontidae	9	8	8	9	7	9	7	8	8	9	8	8
	Pomacentridae	7	6	6	6	5	9	6	9	8	6	6	7
	Acanthuridae	5	4	2	3	2	5	5	5	5	3	2	2
	Holocentridae	0	3	3	2	3	4	2	4	3	3	2	2
	Balistidae	3	2	0	1	1	3	2	2	1	1	1	1
	Pomacanthidae	2	2	0	0	1	1	0	1	1	1	0	1
	Serranidae	3	3	0	2	0	2	2	2	2	2	2	3
	Scaridae	4	4	4	4	3	3	4	3	4	4	4	4
	Total	**33**	**32**	**23**	**27**	**22**	**36**	**28**	**34**	**32**	**29**	**25**	**28**
Summer	Chaetodontidae	10	10	9	10	9	7	10	10	9	9	8	7
	Pomacentridae	8	7	7	7	5	8	7	7	7	6	7	7
	Acanthuridae	6	6	4	4	2	5	6	2	6	3	3	6
	Holocentridae	4	5	3	4	0	3	4	4	5	3	2	3
	Balistidae	2	1	2	2	1	2	2	3	2	2	1	3
	Pomacanthidae	1	2	3	2	1	2	3	4	1	2	3	3
	Serranidae	3	3	2	3	0	2	2	3	2	2	3	3
	Scaridae	4	4	4	4	3	4	4	4	3	4	4	4
	Total	**38**	**38**	**34**	**36**	**21**	**33**	**38**	**37**	**35**	**31**	**31**	**36**
Autumn	Chaetodontidae	**7**	**7**	**9**	**9**	**6**	**9**	**5**	**6**	**8**	**7**	**7**	**7**
	Pomacentridae	**8**	**8**	**5**	**6**	**2**	**7**	**4**	**7**	**7**	**6**	**7**	**6**
	Acanthuridae	**5**	**5**	**2**	**2**	**2**	**4**	**5**	**2**	**4**	**2**	**2**	**4**
	Holocentridae	**4**	**4**	**4**	**4**	**0**	**2**	**0**	**4**	**3**	**2**	**2**	**3**
	Balistidae	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**1**
	Pomacanthidae	**2**	**2**	**2**	**3**	**2**	**1**	**0**	**3**	**2**	**1**	**0**	**2**
	Serranidae	**3**	**3**	**2**	**2**	**1**	**2**	**3**	**2**	**2**	**2**	**2**	**3**
	Scaridae	4	3	4	4	3	2	3	4	3	4	4	4
	Total	**34**	**33**	**29**	**31**	**16**	**27**	**20**	**29**	**29**	**25**	**24**	**30**
Winter	Chaetodontidae	9	10	9	9	6	10	10	9	10	5	7	10
	Pomacentridae	8	8	6	6	6	7	3	8	6	5	6	8
	Acanthuridae	4	4	4	3	2	4	3	2	4	2	3	4
	Holocentridae	2	2	3	2	3	2	4	5	4	3	2	4
	Balistidae	2	1	1	0	1	1	0	1	1	0	1	1
	Pomacanthidae	2	2	2	1	1	1	1	3	0	1	2	2
	Serranidae	3	3	2	3	2	3	3	3	3	2	2	3
	Scaridae	4	3	2	2	3	1	4	3	1	1	2	4
	Total	**34**	**33**	**29**	**26**	**24**	**29**	**28**	**34**	**29**	**19**	**25**	**36**
Totals	Chaetodontidae	**10**	**10**	**9**	**10**	**9**	**10**	**10**	**10**	**10**	**9**	**8**	**10**
	Pomacentridae	**8**	**8**	**7**	**7**	**6**	**9**	**7**	**9**	**8**	**6**	**7**	**8**
	Acanthuridae	**6**	**6**	**4**	**4**	**2**	**5**	**6**	**5**	**6**	**3**	**3**	**6**
	Holocentridae	**4**	**5**	**4**	**4**	**3**	**4**	**4**	**5**	**5**	**3**	**2**	**4**
	Balistidae	**3**	**2**	**2**	**2**	**1**	**3**	**2**	**3**	**2**	**2**	**2**	**3**
	Pomacanthidae	**2**	**2**	**3**	**3**	**2**	**2**	**3**	**4**	**2**	**2**	**3**	**3**
	Serranidae	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**3**
	Scaridae	**4**	**4**	**4**	**4**	**3**	**4**	**4**	**4**	**4**	**4**	**4**	**4**
	Total	**40**	**40**	**35**	**37**	**28**	**40**	**39**	**43**	**40**	**31**	**32**	**41**

Table (4): Seasonal variation in abundance of different fish families recorded in selected diving sites.

Family	Season	Diving sites												Totals
		Umm Gamar Island	Sha'ab El-Fanadir	Carless reef	El- Fanous reef	Bannana Reef	Sha'ab Sabina	El-Gifton El-Sagheir	Sha'ab Erok	Gota Abu Ramada	Sha'ab Ishta	Sha'ab Petra	Deshet El-Daba	
Chaetodontidae	Spr.	127	86	99	60	26	81	134	107	106	62	33	94	**1015**
	Sum.	156	136	106	88	28	58	108	90	60	120	68	114	**1132**
	Aut.	59	52	69	59	17	94	88	93	114	63	53	108	**869**
	Win.	68	61	51	36	28	82	53	40	56	20	18	98	**611**
	Total	**410**	**335**	**325**	**243**	**99**	**315**	**383**	**330**	**336**	**265**	**172**	**414**	**3627**
Pomacentridae	Spr.	1373	1386	1932	2210	353	1068	1142	1403	1328	1499	699	1786	**15979**
	Sum.	1747	1004	1331	905	513	1028	1720	1172	1255	1918	1476	1607	**15476**
	Aut.	1616	961	1566	913	189	912	1785	1429	1297	1716	1423	1726	**15333**
	Win.	1851	1004	759	559	576	569	790	958	1219	770	932	1618	**11515**
	Total	**6587**	**4355**	**5588**	**4587**	**1631**	**3577**	**5437**	**4962**	**5099**	**5903**	**4530**	**6737**	**58303**
Acanthuridae	Spr.	121	48	21	40	22	135	107	51	110	28	12	40	**735**
	Sum.	167	122	80	56	20	107	120	38	115	50	42	192	**1109**
	Aut.	164	123	23	28	23	82	150	48	75	37	23	163	**939**
	Win.	144	74	98	62	39	24	14	28	74	15	30	170	**772**
	Total	**596**	**367**	**222**	**186**	**104**	**348**	**391**	**165**	**374**	**130**	**107**	**565**	**3555**
Holocentridae	Spr.	0	329	339	108	33	57	124	133	137	128	73	8	**1469**
	Sum.	153	528	503	287	0	63	239	277	337	275	192	100	**2954**
	Aut.	132	195	226	155	0	18	0	253	342	77	98	136	**1632**
	Win.	99	119	230	144	69	73	283	190	381	314	93	174	**2169**
	Total	**384**	**1171**	**1298**	**694**	**102**	**211**	**646**	**853**	**1197**	**794**	**456**	**418**	**8224**
Balistidae	Spr.	12	6	0	2	1	4	5	4	2	2	1	4	**43**
	Sum.	9	6	2	3	1	5	8	5	5	3	1	9	**57**
	Aut.	2	3	2	4	0	0	0	4	0	1	0	1	**17**
	Win.	7	6	7	0	1	2	0	2	1	0	1	4	**31**
	Total	**30**	**21**	**11**	**9**	**3**	**11**	**13**	**15**	**8**	**6**	**3**	**18**	**148**
Pomacanthidae	Spr.	8	7	0	0	1	6	0	8	8	2	0	10	**50**
	Sum.	1	7	10	7	3	4	12	32	2	12	6	17	**113**
	Aut.	4	4	4	9	2	3	0	21	3	1	0	4	**55**
	Win.	2	6	6	1	1	4	2	6	0	4	4	9	**45**
	Total	**15**	**24**	**20**	**17**	**7**	**17**	**14**	**67**	**13**	**19**	**10**	**40**	**263**
Serranidae	Spr.	14	10	0	2	0	2	6	4	4	7	7	10	**66**
	Sum.	14	10	2	5	0	3	2	5	4	7	8	12	**72**
	Aut.	10	6	2	2	1	4	6	2	2	4	4	9	**52**
	Win.	14	7	3	4	2	9	12	9	6	2	3	16	**87**
	Total	**52**	**33**	**7**	**13**	**3**	**18**	**26**	**20**	**16**	**20**	**22**	**47**	**277**
Scaridae	Spr.	28	4	12	14	4	11	9	4	5	15	22	15	**143**
	Sum.	27	4	15	17	3	11	9	10	5	10	11	18	**140**
	Aut.	11	9	13	9	5	5	3	9	6	11	10	10	**101**
	Win.	20	7	2	2	6	2	10	8	4	2	3	12	**78**
	Total	**86**	**24**	**42**	**42**	**18**	**29**	**31**	**31**	**20**	**38**	**46**	**55**	**462**
Total abundance	**Spr.**	**1683**	**1876**	**2403**	**2436**	**440**	**1364**	**1527**	**1714**	**1700**	**1743**	**847**	**1967**	**19700**
	Sum.	**2274**	**1664**	**1942**	**1335**	**568**	**1259**	**2152**	**1557**	**1672**	**2341**	**1730**	**2069**	**20563**
	Aut.	**1998**	**1353**	**1905**	**1179**	**237**	**1118**	**2032**	**1859**	**1839**	**1910**	**1611**	**2157**	**19198**
	Win.	**2205**	**1284**	**1156**	**808**	**722**	**765**	**1164**	**1241**	**1741**	**1127**	**1084**	**2101**	**15398**
	Total	**8160**	**6177**	**7406**	**5758**	**1967**	**4506**	**6875**	**6371**	**6952**	**7121**	**5272**	**8294**	**74859**

Table (5): Variation in abundance of coral reef fish families in different diving sites according to water depth.

Family	Depth (m)	Diving sites												Totals
		Umm Gamar Island	Sha'ab El-Fanadir	Carless reef	El- Fanous reef	Bannana Reef	Sha'ab Sabina	El-Gifton El-Sagheir	Sha'ab Erok	Gota Abu Ramada	Sha'ab Ishta	Sha'ab Petra	Deshet El-Daba	
Chaetodontidae	**3**	164	125	123	103	63	148	136	139	154	94	70	150	**1481**
	6	146	108	107	83	32	98	119	116	87	103	59	143	**1225**
	9	100	102	95	57	4	69	128	75	95	68	43	121	**993**
	Total	**410**	**335**	**325**	**243**	**99**	**315**	**383**	**330**	**336**	**265**	**172**	**414**	**3699**
Pomacentridae	**3**	2776	1712	1827	1623	937	1675	2273	1982	2410	2376	1985	2474	**24059**
	6	2435	1658	2190	1680	415	1392	1693	1625	1324	2262	1618	2307	**20617**
	9	1376	985	1571	1284	279	510	1471	1355	1365	1265	927	1266	**13681**
	Total	**6587**	**4355**	**5588**	**4587**	**1631**	**3577**	**5437**	**4962**	**5099**	**5903**	**4530**	**6047**	**58357**
Acanthuridae	**3**	377	224	114	82	61	182	198	82	249	50	43	347	**2018**
	6	207	125	82	72	41	112	132	65	91	55	40	191	**1231**
	9	12	18	26	32	2	54	61	18	34	25	24	27	**360**
	Total	**596**	**367**	**222**	**186**	**104**	**348**	**391**	**165**	**374**	**130**	**107**	**565**	**3609**
Holocentridae	**3**	0	361	199	84	0	66	178	122	369	182	111	0	**1681**
	6	326	449	598	277	79	116	209	374	458	304	199	241	**3648**
	9	58	361	501	333	23	29	259	357	370	308	146	177	**2949**
	Total	**384**	**1171**	**1298**	**694**	**102**	**211**	**646**	**853**	**1197**	**794**	**456**	**418**	**8278**
Balistidae	**3**	13	6	3	5	0	2	4	4	2	4	2	1	**55**
	6	8	10	3	3	3	6	6	4	1	1	0	7	**70**
	9	9	5	5	1	0	3	3	7	5	1	1	10	**77**
	Total	**30**	**21**	**11**	**9**	**3**	**11**	**13**	**15**	**8**	**6**	**3**	**18**	**202**
Pomacanthidae	**3**	4	6	4	4	5	6	4	7	2	4	2	8	**65**
	6	7	12	6	8	2	7	6	21	7	8	6	14	**122**
	9	4	6	10	5	0	4	4	39	4	7	2	18	**130**
	Total	**15**	**24**	**20**	**17**	**7**	**17**	**14**	**67**	**13**	**19**	**10**	**40**	**317**
Serranidae	**3**	18	4	1	2	2	5	7	7	4	13	12	11	**95**
	6	15	14	0	4	0	4	4	4	5	7	6	16	**97**
	9	19	15	6	7	1	9	15	9	7	0	4	20	**139**
	Total	**52**	**33**	**7**	**13**	**3**	**18**	**26**	**20**	**16**	**20**	**22**	**47**	**331**
Scaridae	**3**	25	2	19	11	8	1	1	8	2	19	19	12	**136**
	6	32	12	11	15	7	12	21	13	10	10	10	21	**192**
	9	29	10	12	16	3	16	9	10	8	9	17	22	**188**
	Total	**86**	**24**	**42**	**42**	**18**	**29**	**31**	**31**	**20**	**38**	**46**	**55**	**516**
Total abundance	**3**	**3377**	**2440**	**2290**	**1914**	**1076**	**2085**	**2801**	**2351**	**3192**	**2742**	**2244**	**3003**	**29515**
	6	**3176**	**2388**	**2997**	**2142**	**579**	**1747**	**2190**	**2222**	**1983**	**2750**	**1938**	**2940**	**27052**
	9	**1607**	**1502**	**2226**	**1735**	**312**	**694**	**1950**	**1870**	**1888**	**1683**	**1164**	**1661**	**18292**
	Totals	**8160**	**6330**	**7513**	**5791**	**1967**	**4526**	**6941**	**6443**	**7063**	**7175**	**5346**	**7604**	**74859**

DISCUSSION

The present study recorded 47 species of coral reef fishes that belong to 24 genera from 8 families (Chaetodontidae: 10 species; Pomacentridae: 9 species; Acanthuridae: 6 species; Holocentridae: 5 species; Balistidae: 5 species; Pomacanthidae: 5 species; Serranidae: 3 species and Scaridae: 4 species). **Randall (1992)** and **Khalf and Abdallah (2005)** recorded a total of 14 species belonging to 2 genera of butterfly fishes (Chaetodontidae) in the Red Sea and the Gulf of Aden. This means that the diversity of chaetodontid fishes decreased in the study area. This decline in diversity of Chaetodontidae may be due to the distribution of those butterfly fishes in different areas of the Red Sea as described by many authors **(Bouchon-Navaro, 1980;Roberts & Ormond, 1987;Roberts *et al*., 1992)**.

Roberts *et al*. (**2016**) suggested that overall fish community assemblages do not differ greatly among reefs at the edge of the continental shelf. A slight shift in community composition in the central-northern portion of the Red Sea was attributed, in part, to the influence of few taxa with narrow range limits and with relatively low abundances. The butterfly fishes (Chaetodontidae) and angel fishes (Pomacanthidae) are good examples of groups with species following this pattern. Surveys of inshore reef crests from the Gulf of Aqaba to the Gulf of Aden revealed a shift in these taxa in the central Red Sea **(Roberts *et al.*, 1992; Khalaf & Abdallah, 2005)**.

The habitat variables which structuring fish assemblage have greater change from inshore to offshore sites than they do from north to south. Patterns of prevalent cross-shelf effects have been found in other reef systems **(Aguilar-Perera & Appeldoorn, 2008; Malcolm *et al*., 2010)**. This is also seen in Red Sea reefs, characterized by an increase in herbivore and planktivorous fish diversity in the offshore reefs compared to inshore reefs **(Khalil *et al*., 2017)**. Mechanisms driving the fish assemblage changes are likely associated with distance from shore **(Khalil *et al*., 2017;Coker *et al*., 2018)**.

Comparing the data of current study with that obtained by **Riegl and Piller (1997)**, we concluded that the number of fishes per site didn't show any significant difference. However, regardless of the change in total number of fishes recorded per transect, we should take into consideration the changes occurred in the average number recorded from each family. Despite the domination of Pomacentrid fishes in both studies by a number ranged from 204 $\pm$ 174 fishes/200 in 1997 to 501 + 196 fishes/100m, the present study indicated that members of this family have almost doubled their number during that period. Comparing the numbers of individuals recorded from other families revealed a significant reduction in number per transect for families Serranidae, Scaridae, Acanthuridae, Balistidae, and Pomacanthidae. Meanwhile, the number of Chaetodontidae showed a remarkable increase in the present study (Fig. 2**)**.

Moreover,the present data demonstrated the effect of season on the population size of the studied families. The data indicated seasonal changes in the number of individuals representing the same family. Such changes could be attributed to the migration of certain families away from the reef during the breeding season. On the other hand, some authors tended to explain these changes as an effect of habitat structure disturbance. **Brokovich *et al.* (2006)** concluded that the coral reef fish communities at the northern tip of the Gulf of Aqaba (Red Sea) were at the extreme of their distribution range. Their results did not agree with the current study on the seasonal changes in population structure. They reported that reef fish assemblages varied between habitats and sites, but not between seasons.

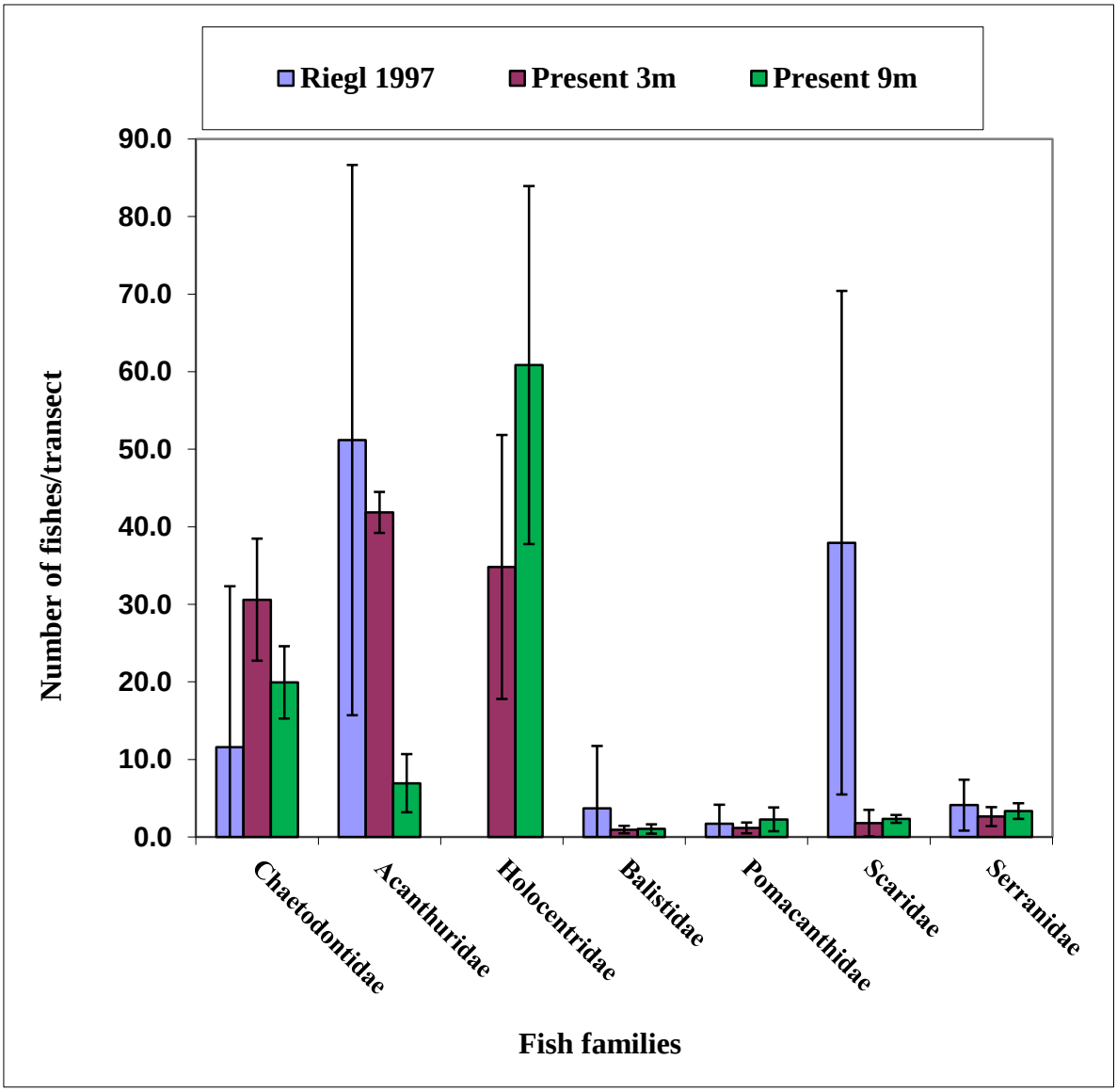

Fig. (2) Comparison of fish abundance averages in different fish families between the present results and that collected by Riegl (1997)

Another reason for these changes in the seasonal structure of fish population is the isolation of the sites. This was clear in the similarity between sites with similar or close structure. The same results were also reported by **Atsushi and Moritaka (2002)** where they provided evidence that seasonal changes in fish community structure were relatively large at the isolated habitat site indicating that the fish community structure was relatively stable at the continuous habitat site but unstable at the isolated habitat site.

In agreement with the work of **Brokovich *et al.* (2006)** the statistical analysis of the present data showed that the effect of depth on the structure of fish assemblages was highly significant. However, the interaction between site and depth showed no significant values. This could be attributed to the distance between sites and their topographic nature and living coverage.

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