INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCE AND ENGINEERING (IJESE)
Vol. 4: 55- 65 (2013)
http://www.pvamu.edu/texged Prairie View A&M University, Texas, USA

Adult and larval reef fish communities in a coastal reef lagoon at Hurghada, Red Sea, Egypt.

Mohamed A. Abu El-Regal
Marine Science Department, Faculty of Science, Port Said University.

ARTICLE INFO

Article History
Received: Jan. 3, 2013
Accepted: March 9, 2013
Available online: Sept. 2013

Keywords
Reef fishes.
Fish larvae.
Red Sea.
Hurghada.

ABSTRACT

The aim of this study was to explore the composition of reef fish community in a coastal lagoon in Hurghada, Red Sea, Egypt. Adult fishes were counted by visual censuses, whereas fish larvae were collected by 0.5 mm mesh plankton net. A total of 70 adult reef fish species and 41 larval fish species were collected. Only 16 species of the recorded adults had their larvae, where as 26 species were found only as larvae. It could be concluded that adult stages of the reef fish in the inshore areas are not fully represented by larval stages

1. INTRODUCTION

The investigation of fish fauna and flora of the Red Sea has attracted the attention of scientists for very long time. The fish fauna received the greatest attention since the Swedish naturalist Peter Forsskal (1761-1762). Many efforts have been done to study and explore fish community structure in the area since the early staff of the Marine Biological Station in Hurghada. Gohar (1948,) and Gohar and Latif (1959), and Gohar and Mazhar (1964) have made extensive studies on the adult fish community in front of the station. Recently, many studies and reports on the reef fish community in the Red Sea have been published (Al-Elwani, 1997; Farghal, 2009).

Despite the extensive work on the adult fish fauna in the area, a few studies have been carried out on the early stages of reef fish in the Egyptian waters (Abu El-Regal, 2000, 2008, 2009, 2012; Abu El-Regal *et al.*, 2008). Since the pelagic stage of most reef species probably has a broader range than the demersal sedentary adult stage (Sale, 1980), they could be widely used to determine the geographical distribution of fishes than the adult stage (Leis, 1986). The distribution of fish larvae can be determined by spawning behavior and spawning grounds of the adult, topography of the reef, duration of larval period, behavior of the larvae and their growth and mortality (Cushing, 1990; Leis, 1991a; Lazzari, 2001; Montgomery *et al.*, 2001; Abu El-Regal *et al*., 2008).

Recently, review of reef fish biology has emphasized the importance of understanding the early life history of fishes in order to progress in ecological studies and management of the very complex and diverse coral reef community.

Corresponding Author: m_abuelregal@yahoo.com
ISSN 2156-7530

This study was carried out in the aim of exploring the structure of both adult and larval fish assemblage in the coastal reef on the Egyptian Red Sea coast. It hypothesized that all adult reef fishes in the area have their larvae found in the same area.

2. MATERIALS AND METHODS

2.1 Site Description

This site lies directly in front of the National Institute of Oceanography and Fisheries about 5 km north of Hurghada city (Fig.1).

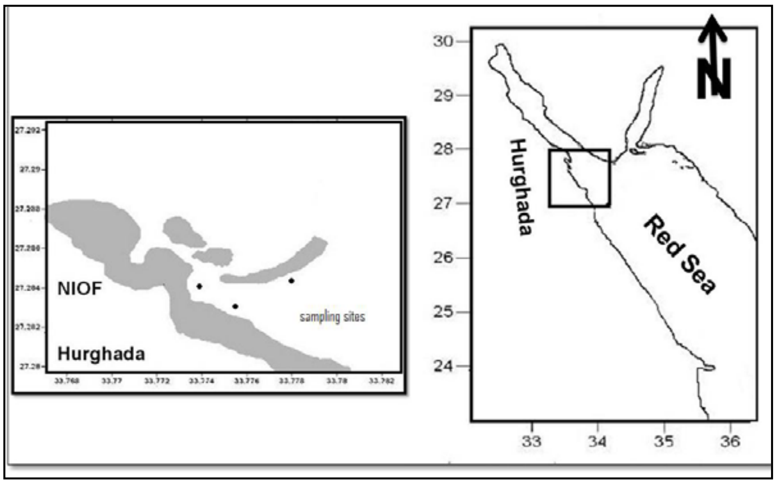

Fig.1. Map of the Red Sea, Hurghada and the sampling site

It lies at 27º 17´ 6´´ N and 33º 46´ 22´´E. It is a small area with about 7500m^2. The shore of the area is delimited by a narrow sandy strip and is mostly composed of an unsorted mixture of stones, gravel, sand and mud admixed with coral fragments and shell remains. The intertidal zone has a rocky fossil reef substratum covered with thin layer of soft deposits. This site contains fringing reefs extending from the shore for about 450 m and contains many lagoons. It extends to about 150 m seaward and ends with a lagoon of about 5 m depth whose bottom is covered with seagrass beds. Seagrasses are dominated by *Halophila stipulacea* and *Halophila ovalis.* Reef flat of about 10-80 m width follows the lagoon and again followed by another lagoon of 10 m depth. The reef of this site raised form the bottom for about 7-8m in the sheltered side and about 9m in the exposed side.

2.2 Adult fish

Coral reef fish populations were assessed by counting fishes visually (visual census) during daylight hours using SCUBA for the reef slope and snorkeling for the reef edge and reef flat. The visual census technique was used to estimate names and numbers of fishes by swimming slowly along 100 m long, 5 m wide and 1 m high line transect with three replicates. Three reef zones, reef flat, reef edge and reef slope to depth of 10 m were surveyed for the adult reef fishes. Fishes were identified underwater using a waterproof guide of Randall, (1986) and identification was confirmed with different guides (Randall, 1983; Debelius, 1998, Lieske and Myers, 2001).

2.3 Fish larvae

Larval fishes were collected using a 50 cm mouth and 0.5 mm mesh size plankton net equipped with a flowmeter to quantify the volume of water filtered. The net was hauled horizontally at a ship speed of 1.5-2.5 knots at the early morning and in the evening for 5-10 minutes according to the weather and sea status. Samples were fixed in 4% seawater formalin solution for further analysis. In the laboratory all fish eggs and larvae were removed and counted. Fish larvae were identified to the highest possible taxonomic level (Leis and Rennis, 1983; Abu El-Regal, 1999; Leis and Carson-Ewart, 2002; Abu El-Regal, 2008).

2.4 Data analysis

Analysis of variance (ANOVA) and correlation coefficient were tested in SPSS v.17.0 to determine the statistical significance of association of adults and larvae. All data were tested for homogeneity of variance and where the samples were not homogeneous, data were either logarithmically or square root transformed or the non-parametric Kruskal-Wallis test was used (Zar, 1996; Dytham, 2003). The diversity indices (species richness, evenness and Shannon-Wiener), were calculated using PRIMER v 5 after standardization and square root transformation. Bray-Curtis similarity coefficients was used to derive similarity matrices of data, then non-metric, multi-dimensional scaling (MDS) ordination plot was applied to detect trends in similarity.

3. RESULTS

The present study recorded 97 fish species of which 71 species were adults and 41 species were recorded as larvae.

3.1 Adult fish

A total of 1513 adult fish representing 71 species and 37 families were recorded (Table 1). The most abundant 10 species formed about 70% of all fishes counted. Two pelagic species of family Atherinidae namely: *Hypoatherina temmincki* and *Atherinomorus lacunosus*, formed 17% and 14% of all fishes, respectively.

Table 1: abundance of adult fish species recorded during this study

Species	Mode	Winter	Spring	Summer	Species	Mode	Winter	Spring	Summer
Hypoatherina temmincki	D	83	93	77	*Pomacanthus maculosus*	P	2	1	2
Gerres oyena	P	12	15	13	*Pseudoanthias squamipinnis*	P	36	33	29
Acanthupagrus bifasciatus	P	1	1	1	*Pseudochromis sankeyi*	P	1	1	1
Mulloides flavolineatus	P	21	20	16	*Pterois volitans*	P	1	1	1
Zebrasoma desjardini	P	28	24	26	*Rhabdosargus sarba*	P	4	1	1
Pempheris vanicolensis	P	9	1	1	*Sargocentron spiniferum*	P	1	1	1
Sphyraena barracuda	P	1	1	1	*Saurida gracilis*	P	1	1	1
Ostracion cubicus	P	1	1	1	*Scarus ghobban*	P	2	1	3
Acanthurus sohal	P	23	48	19	*Scolopsis ghanam*	P	1	1	1
Adioryx diadema	P	2	2	2	*Stethojulis albovittata*	P	1	1	1
Adioryx ruber	P	2	2	2	*Synanceia verrucosa*	P	1	1	1
Amblyeteotris sungami	P	2	2	2	*Terapon jurba*	P	5	1	1
Amphiprion bicinctus	P	1	1	1	*Thalasoma klunzingeri*	P	33	31	9
Arothron stellatus	P	1	1	1	*Sphyraena flavicauda*	P	18	0	0
Bothus panthrinus	P	1	1	1	*Abudefduf saxatilis*	D	17	17	19
Chaetodon auriga	P	4	3	4	*Apogon taeniatus*	D	8	5	5
Chaetodon austriacus	P	3	2	2	*Atherinomorus lacunosus*	D	67	70	73
Chaetodon lineolatus	P	2	2	1	*Cheilodipterus quinquelineatus*	D	14	15	18
Chaetodon semilarvatus	P	4	3	4	*Hyporhamphus gamberur*	D	19	19	19
Chelinus abudjubbe	P	1	1	1	*Petroscirtes mitratus*	D	1	1	1
Chelinus fasciatus	P	2	3	3	*Platybelone argalus*	D	6	1	1
Chelinus lunulatus	P	3	1	1	*Hippocampus*	D	1	0	0
Diplodus noct	P	25	11	8	*Abudefduf sexfasciatus*	D	26	29	22
Epinephelus summana	P	1	1	1	*Canthigaster margritata*	D	2	2	1
Halichores hortulanes	P	1	2	1	*Canthigaster pygmaea*	D	2	1	2
Hemigymnus fasciatus	P	2	2	2	*Corythoichthys schultzi*	D	1	1	1
Hipposcarus harid	P	3	3	3	*Dascylus aruanus*	D	10	9	10
Lethrinus nebulosus	P	1	1	1	*Escenius gravieri*	D	1	1	1
Lutjanus monostigma	P	1	1	1	*Gobiodon citrinus*	D	1	1	1
Neoniphon sammara	P	2	1	1	*Meiacanthus nigrolineatus*	D	1		1
Oedalechilus labiosus	P	10	1	1	*Paraglyphidodon melas*	D	2	2	4
Papilloculiceps longiceps	P	1	1	1	*Pomacentrus trilineatus*	D	1	1	1
Parapercis hexaphtalma	P	1	1	1	*Rhinecanthus assasi*	D	3	1	1
Parupeneus forsskali	P	5	1	1	*Siganus rivulatus*	D	21	0	1
Parupeneus macronema	P	2	1	1	Schindleriidae	D	1	0	0
Plectrorhynchus gaterinus	P	1	1	1					

The third most abundant species was the scalefin anthias *Pseudanthias squamipinnis* of the family Serranidae formed 7% of all fishes counted. Family Acanthuridae represented by *Acanthurus sohal* and *Zebrasoma desjardinii* formed 11% with 6% and 5% for the two species, respectively. The majority of adult species counted in the area of study have pelagic eggs, where 49 species constituting 69% of all species were found.

3.2 Fish larvae

The present study resulted in sampling of 1801 larvae representing 41 species and 31 families of coral reef fishes (Table 2). The most abundant 10 species formed about 90% of all larvae whereas the other 31 species formed less than 10% of all larvae collected. Seasonal variations of abundance, diversity and diversity indices are shown in figures 2 and 3.

Table 2: Total and average and standard deviation of fish larvae.

Species	Mode	R1	R2	R3	Average	SD	Sum
Gerres oyena	Pelagic	148	56	8	71	71	213
Atherinomorus lacunosus	Demersal	95	39	14	49	41	148
Spratelloides delicatulus	Demersal	71	24	9	35	32	104
Hypoatherina temmincki	Demersal	70	25	8	34	32	103
Petroscirtes mitratus	Demersal	45	32	12	30	17	89
Hyporhamphus gambrur	Demersal	31	12	12	18	11	55
Eleoteridae	Demersal	23	14	17	18	5	54
Enneapterygius sp.	Demersal	37	7	0	15	20	44
Dinematichthys iluocoeteoides	Demersal	15	2	4	7	7	22
Gobiidae	Demersal	19	0	0	6	11	19
Clupeidae	Demersal	11	2	3	5	5	16
Mulloides flavolineatus	Pelagic	9	3	3	5	4	15
P. ancylodon	Demersal	11	2	0	4	6	13
Platybelone argalus	Demersal	6	4	2	4	2	11
Vinciguerria mabahiss	Pelagic	6	2	2	3	2	10
Syngnathidae	Demersal	6	1	2	3	3	9
Abudefduf saxatilis	Demersal	7	1	0	3	4	8
Mugilidae	Pelagic	3	4	1	3	2	8
Pempheris vanicolensis	Demersal	4	2	0	2	2	6
Scorpaenidae	Demersal	2	2	2	2	0	6
Hippocampus	Demersal	3	3	0	2	2	6
Acanthopagrus bifasciatus	Pelagic	6	0	0	2	3	6
Trachinotus sp.	Demersal	3	2	0	2	2	5
Gobiesocidae	Demersal	2	2	0	1	1	4
Haemulidae	Pelagic	2	1	0	1	1	3
Pomacentrus sp2.	Demersal	2	0	0	1	1	2
Sphyraena barracuda	Pelagic	2	0	0	1	1	2
Chelinus sp.	Pelagic	2	0	0	1	1	2
Triptrygiidae	Demersal	1	1	0	1	1	2
Exocoetidae	Demersal	2	0	0	1	1	2
Grammistes	Pelagic	1	1	0	1	1	2
Apogon taeniatus	Demersal	1	0	0	0	1	1
Pomacentrus sp1.	Demersal	1	0	0	0	1	1
Fistularia commersonii	Pelagic	1	0	0	0	1	1
Diodon hystix	Pelagic	1	0	0	0	1	1
Ostraciion sp.	Pelagic	1	0	0	0	1	1
C. quinquineatus	Demersal	1	0	0	0	1	1
Schindleriidae	Demersal	1	0	0	0	1	1
Caranax sp.	Pelagic	1	0	0	0	1	1
Zebrasoma desjardini	Pelagic	1	0	0	0	1	1
Callionymidae	Pelagic	2	0	0	1	1	2

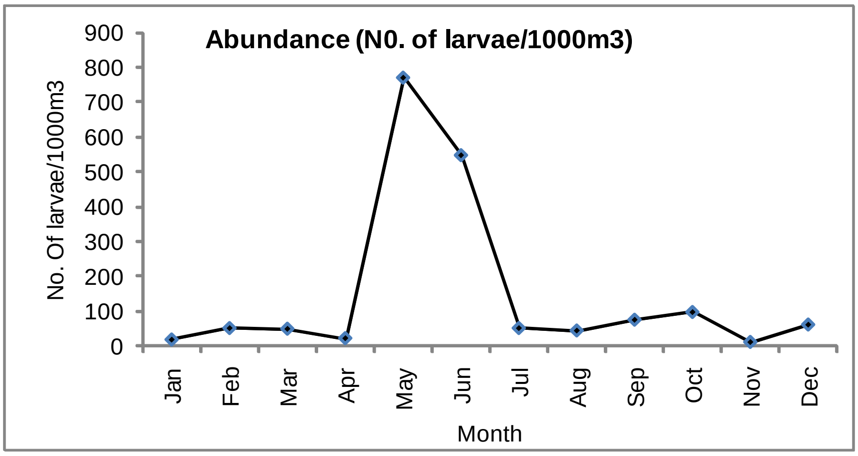

Fig.2: Abundance of fish larvae throughout a year of sampling

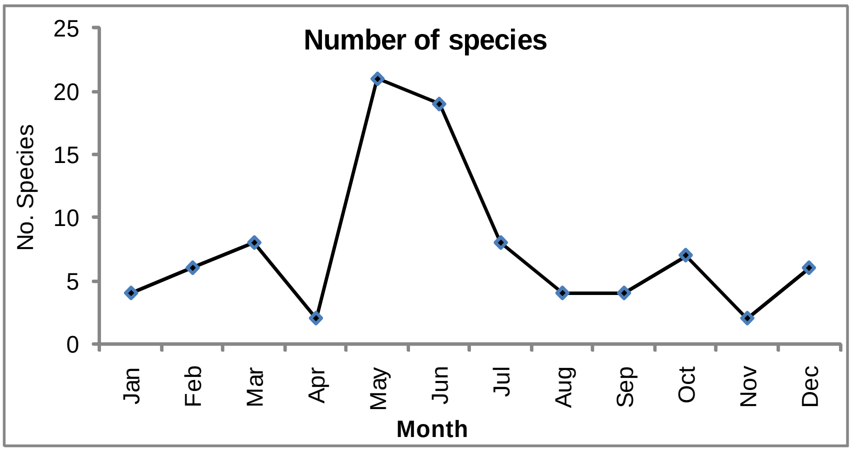

Fig.3: Diversity of fish larvae throughout a year of sampling

Atherinomorus lacunosus, *Spratelloides delicatulus*, *Petroscirtes mitratus*, *Gerres oyena*, *Petroscirtes mitratus*, Gobiidae and *Hypoatherina temmincki* were the most representative taxa (percentage contribution to total abundance) during the study period forming 84% of all larvae (Fig. 4). *Atherinomorus lacunosus* had the highest abundance of all species with 451 larvae forming 25%, of all fishes. The second most abundant species was the clupeid *Spratelloides delicatulus*, constituting about 18% of all larvae. Larvae of *Petroscirtes mitratus* and *Gerres oyena* constituted 13% and 11% respectively of all larvae collected.

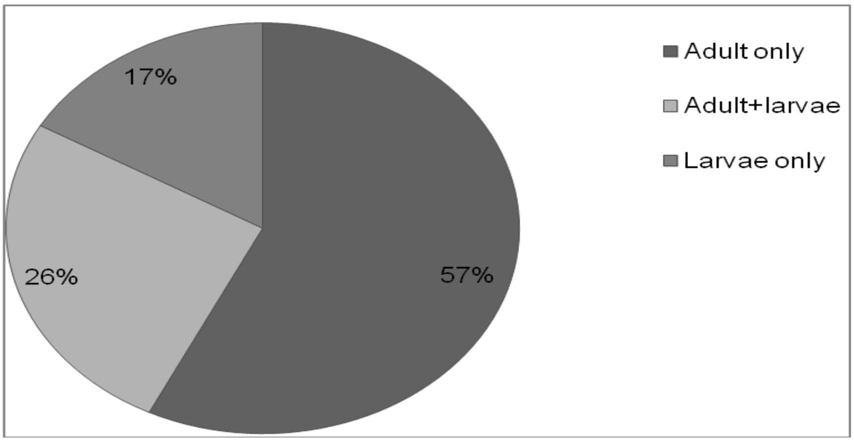

Fig. 4: Percentage contribution of the three categories of fishes

Larvae of demersal spawners dominated the collection where most of the larvae collected during the present work hatch from demersal eggs. A total of 25 species and 1523 fish larvae forming 60% of all species and 84% of all larvae were belonging to demersal. On the other hand, 278 larvae from 16 species were belonging to the pelagic spawners. The majority of larvae (213) form pelagic spawners belong to *Gerres oyena* that formed 77% of larvae from pelagic eggs and 11% of all collected larvae (Fig.4).

Similarity test using multi-dimensional scale showed that the recorded fishes could be divided into three groups according to composition. The first group, *the adult and larvae group*, was formed of adult stages and their larvae, the second group included fishes that were found as adults only whereas the third group was composed of larvae only. The adult only group was the largest group with 55 species (57% of all species) whereas the adult and larvae group was the smallest one with only 16 species (16% of all species). The larvae only group was composed of 26 species, constituting 26% of all species recorded. The majority of species in this group came from demersal eggs. The correlation test showed that there was a strong relationship between the presence of larvae from demersal spawners and their adults but a weak relationship between larvae from pelagic eggs and their adults (Figs.5 &6).

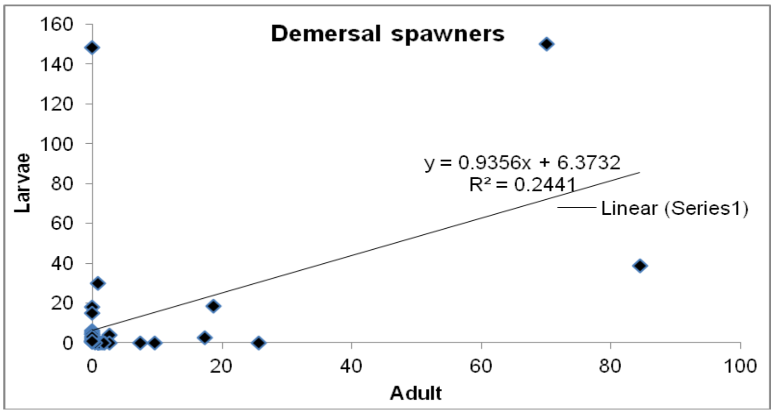

Fig. 5: The correlation coefficient of the demersal spawners

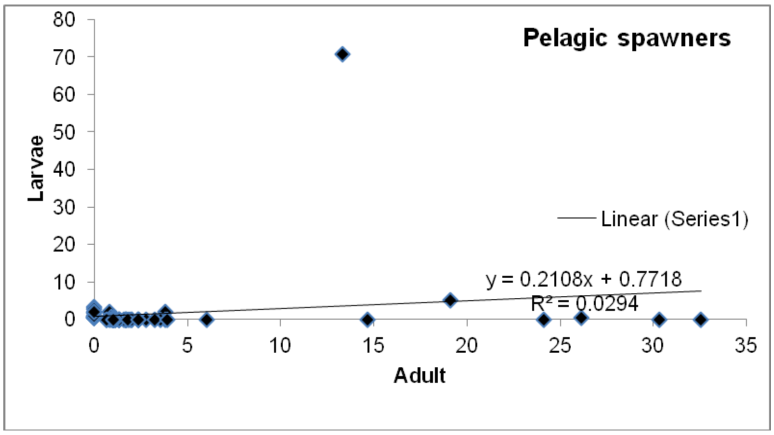

Fig. 6: The correlation coefficient of the pelagic spawners

Chi square test showed that there was a relationship between the presence of the adult fish and their larvae. The association between the presence of adult and larvae was significant as indicated by the Pearson correlation test for the demersal spawners (Fig.5), whereas no significant relationship was observed for the pelagic spawners (Fig.6).

3.3 *Adult only group*

This group was the largest among the three groups with 55 species and 670 fishes. Fishes of this group work only as adult and lack their larvae in the area. Most fishes in this group were pelagic spawners and small fraction lay demersal eggs. In total, 42 species forming 76% of all fishes in this group are pelagic spawners whereas, 13 species forming 24% of fishes in this group are demersal spawners. The most abundant species in this group were *Pseudanthias squamipinnis* (98 fish) and *Acanthurus sohal* (91 fish) followed by damselfishes of *Abudefduf sexfasciatus* (77) and the Red Sea wrasse *Thalassoma klunzingeri* (72).

3.4 *Adult with larvae group*

Fishes in this group were the least abundant and diverse with 16 species constituting 17% of all species recorded in the area. This group was dominated by demersal spawners that constituted 62% of all species and 75% of fish larvae. The dominant species in the group included the demersal spawners *Atherinomorus lacunosus* and *Hypoatherina temmincki* and the pelagic spawner *Gerres oyena*.

3.5 *Larvae only group*

This group formed 26% of all fishes recorded, where 25 species are found in the area as larvae and the adults are absent and were not recorded in the area during the period of study. The most abundant species in this group were *Spratelloides delicatulus*, Eleotridae and Tripterygiidae.

Most larvae were concentrated in late spring and summer months with the highest value in May and June, where 771 and 548 larval fish were recorded, respectively. Fish larvae were less abundant in March with only 9 fish larvae collected.

4. DISCUSSION

Fish assemblages in the area of study have been divided into three groups according to their composition. The first and the largest group included fishes that were found only as adults. Most fishes in this group are pelagic spawners that disperse their eggs in the water column. Hence, their larvae are more vulnerable for dispersal away from the parent's reef. The second group included larvae that lack adults in the coastal reef. Most of these larvae belong to pelagic spawners. The third group was composed of adults that have their larvae in the area. Despite the high abundance of larvae from the demersal spawners in this group, larvae of the pelagic spawner *Gerres oyena* were also abundant in the collection. It seems that *G. oyena* spawn in the area as indicated by the large number of small preflexion larvae in the collection.

Larvae of many adults recorded in the area were absent in the ichthyoplankton samples. The absence and rarity of reef fish larvae of the majority of reef fishes from the coastal reefs although adults are common have been reported by many studies (Miller, 1974, 1979; Young *et al*. (1986); Leis, 1994; Abu El-Regal, 2008). This may be attributed to the dispersal of pelagic larval stages away from the parent's reef (Leis, 1994). Leis and Miller (1976) found larvae of some inshore fishes that were missing inshore 5-12 km away from the shore. So, it is highly believed that the inshore larval assemblages may not be representative of that of the adult fish because the propagules originating from a fish population on a given reef do not settle to this reef but settle to another reef.

Most larval fish species collected during the current study belong to commercially important fish. Mullidae, Gerreidae Serranidae, Carangidae, and Sphyraenidae are important constituents of the fishery in the Red Sea in general and in Hurghada in particular. Although the study of the spawning seasons and grounds was out of the scope of this study, it presents important information on the spawning seasons and grounds of reef fishes in the area that form baseline data concerning the seasons and areas of spawning of commercial fishes. It reflects the importance of the eggs and larvae survey in fisheries management. However, the larvae of some fishes whose adults are important constituents of Egyptian fisheries were rare or even missing in the collection. This may be due to the behaviour of the adult or the behaviour of the larvae (Leis, 1991b; Montgomery *et al*., 2001). Larvae of lethrinid fishes were absent in the ichthyoplankton samples during the present study and previous studies in the Egyptian Red Sea (Abu El-regal, 1999, 2008, 2009). Lethrinid larvae were found to preferentially settle near the seagrass-replete reef (Olney and Boehlert, 1988). These findings may confirm that these fishes migrate to areas more favourable for their spawning (Johannes, 1978).

The seasonal trend of fish larval distribution was the same for other areas in the Red Sea where the majority of fishes spawn in the warmer months of the year in late spring and summer. The deviation from this trend was found during August, where larvae of only 4 species were found compared to 21 species and 19 species in May and June respectively. This may be because most reef fishes that spawn in August are pelagic spawners.

The larval fish assemblages in the tropical waters are a result of spawning activities of two communities, reef fish and open water fish that were dominated by mesopelagic fishes (Ahlstrom, 1971; 1972; Leis & Goldman, 1987). Despite the presence of larvae of the mesopelagic *Vinciguerria mabahiss* in the area, they are weakly represented compared to previous studies in the Red Sea (Abu El-Regal, 1999, 2008). Larvae of *V. mabahiss* are believed to be drifted by water currents to the coral reefs near the coast.

With the presence of most coral reef families such as Chaetodontidae, Pomacanthidae, Scaridae, Labridae, Acanthuridae, the composition of reef fish community in the study area is identical to be configured in any other coral reefs. Ideally, the adult reef fish assemblages are composed mainly of pelagic spawners. Forty-two species of pelagic spawners forming 76% of all fishes are found compared to 13 species forming 24% of demersal spawners. However, the larval fish assemblages are composed mainly of larvae from demersal spawners. Most of the demersal spawners in the area have their larvae. Hence, the larval fish assemblages in the coastal reefs may be representative of the demersal spawners but not the whole fish community.

The larval fish assemblage was composed mainly of larvae that hatched from demersal eggs whereas, larvae hatched from pelagic eggs were very few except for *Gerres oyena*. The few larvae of pelagic spawners are thought to be brought to the coastal location by currents. About 85% of fish larvae collected in the area came from demersal spawners. However, this high abundance of demersal spawner’s larvae was due to only few families, mainly Atherinidae, Blennidae, Gobiidae, Clupeidae and Tripterygiidae larvae. The data obtained throughout the present study coincide with findings of other studies in the Red sea (Abu El-Regal, 2008, 2009) and other tropical areas (Leis 1982; Suthers and Frank, 1991; Leis and McCormic, 2002; Paris and Cowen, 2004).

The composition of larval fish assemblages in the area of study is more or less typical for any coastal area in the Red Sea, dominated by larvae from demersal spawners. Abu El-Regal (1999) studied the abundance and diversity of larvae reef fishes at three coastal bays in Sharm El-Sheikh and found that the majority of larvae belong to demersal spawners. Similarly, larvae collected from other coastal sites on the Red Sea (Abu El-Regal, 2009) were also dominated by the demersal spawners atherinids, blennids and tripterygiids. There is evidence that larvae of reef fish are retained nearshore and that the inshore fish larval assemblages are dominated by larvae from demersal spawners (Smith *et al*., 1987; Brogan, 1994). Larvae of pelagic spawners recorded as adults in the area are believed to be dispersed offshore tens of kilometers away from the shore. In the offshore waters of Oahu, Clark (1991) found that larvae from the pelagic spawners dominated the collection and those from demersal spawners were rare or completely absent.

This result is also in a full agreement with findings of Leis, 1982; Smith *et al*., 1987; Clarck, 1991; Suthers & Frank, 1991; Leis & McCormic, 2002; Abu El-Regal, 2008. Brogan (1994) noted that taxa with distributions most suggestive of larval retention had demersal larvae. In the same context, Leis (1978, 1982) showed that, the dominance of larvae of demersal species nearshore was due to a few species. In the present study, the high abundance of larvae of demersal spawners was due to the high larval density of families with demersal eggs such as Atherinidae and Clupeidae. Larvae of *Atherinomorus lacunosus* (Atherinidae) and *Spratelloides delicatulus* (Clupeidae) were very highly abundant. Demersal spawners attach their eggs to corals, rocks or floating objects and they prefer the shallow, rocky, inshore areas near to the adult habitat (Azeiterio *et al*., 2006). This may explain the richness of demersal spawners compared to that of the pelagic spawners.

Most fishes on the reef are pelagic spawners (Leis, 1991a); they formed 78% of all fishes on the reef and that of demersal spawners form 14% of all reef fishes in the Red Sea. Despite this high diversity, pelagic spawners are weakly represented by larvae and most species lack larval stages in the area.

It is worth mentioning that most of the larvae of the missing adults belong to cryptic fish species that are likely present in the study area but their small size and the hiding in the reef made them difficult to be detected. The cryptic species include blennids, gobiids, tripterygiids, and gobiesocids. The difficulty of identification of larvae of some species may be another reason of misinterpreting of some data.

Gerres oyena seems to be the only pelagic spawner among all species collected to spawn in the coastal area as indicated by the high abundance as well as large number of yolk sac and preflexion larvae. Surprisingly, larvae of *Vinciguerria mabahiss* were also abundant in the coastal site although the species is known to be a deep-water species. Larvae of this species are believed to be drifted by water currents to the coral reefs near the coast.

5. ACKNOWLEDGMENT

The author wishes to thank the National Institute of Oceanography and Fisheries, Hurghada, Red Sea, Egypt for support and providing boats for sampling of the ichthyoplankton samples. Also thanks are due to Mr. Mahmoud Maaty, the body system during the diving and counting of the adult fish. Thanks are due to Dr. Edwin Cruz Rivera of the American University in Cairo for readingof the manuscript.

6. REFERENCES

Abu El-Regal, M. A. (1999). Some biological and ecological studies on the larvae of coral reef fishes in Sharm El-Sheikh (Gulf of Aqaba-Red Sea). M.Sc. Thesis. Mar. Sci. Dept. Fac. Sci. Suez Canal University. Unpublished.

Abu El-Regal, M. A. (2008). Ecological studies on the ichthyoplankton of coral reef fishes in Hurghada, Red Sea, Egypt. PhD thesis. Mar. Sci. Dept. Fac. Sci. Suez Canal University. pp. Unpublished

Abu El-Regal, M. A.; Ahmed, A. I.; El-Etreby, S. G.; El-Komi, M.; Elliott, M. (2008). Abundance and diversity of coral reef fish larvae at Hurghada, Egyptian Red Sea. Egyptian Journal of Aquatic Biology and Fisheries. 12(2): 17-33

Abu El-Regal, M. A. (2009). Spatial distribution of larval fish assemblages in some coastal bays along the Egyptian Red Sea coast. J. Egypt. Acad. Soc. Environ. Develop., 10 (4): 19-31

Abu El-Regal, M. A. (2012). Larval development of two atherinid fish species from the Red Sea, Egypt. Egyptian Journal of Aquatic Biology and Fisheries. 16(1): 61-71

Ahlstrom, E. H. (1971). Kinds and abundance of fish larvae in the eastern tropical Pacific, based on collection made on EASTROPAC I. Fish. Bull. 69(1): 3-77.

Ahlstrom, E. H. (1972). Kinds and abundance of fish larvae in the eastern tropical Pacific on the second multivessel EASTROPAC survey and observations on the annual cycle of larval cycle of larval abundance. Fish. Bull. 70(4): 1153-1242.

Azeiterio, U. M. b.-N., L.; Resende, P.; Goncalves, F.; Pereira, M. J. (2006). larval fish distribution in shallow coastal waters off North Western Iberia (NE Atlantic). Estuarine, Coastal and Shelf Sciences 64: 544-566.

Brogan, M. W. (1994). Distribution and retention of larval fishes near reefs in the Gulf of California. Mar. Ecol. Prog. Ser., 115:1-13.

Clarke, T. A. (1991). Larvae of nearshore fishes in oceanic waters near Oahu, Hawaii. NOAA, Technical report NMFS, 101:1-19.

Cushing, D. H. (1990). Plankton production and year class strength in fish populations: an update of the match/mismatch hypothesis. *In*: Blaxter, J. H., Southward, A. J. (Eds.), Advances in Marine biology, Academic Press, San Diego, 26: 249-293.

Debelius, H. (1998). Red Sea reef guide. IKAN-Unterwasserarchiv. Frankfurt., 321 pp.

Dytham, C. (2003). Choosing and using statistics. A biologist's guide. Blackwell Publishing, Oxford, 248 pp.

Farghal, T. K. (2009). Studies on the impact of human activities on the structure and population of the coral reef fish families at hurghada. m.sc. thesis. zoology department, faculty of science. alazhar university., 180 pp.

Gohar, H. A. F (1948). On the relation between fish and anemone with a description of eggs of *Amphiprion bicinctus* (Rüppell). Publication of the Marine Biological Station, Al-Ghardaqa, Red Sea. 6: 35-44.

Gohar, H. A. F. and Latif, F. A. (1959). Morphological studies on the some scarid and labrid fishes. Publication of the Marine Biological Station, Al-Ghardaqa, Red Sea. 10:145-190.

Gohar, H. A. F. and Mazhar, F. (1964). Elsmobranchs in the north western Red Sea. Publication of the Marine Biological Station, Al-Ghardaqa, Red Sea, 13: 3-144

Johannes, R. E. (1978). Reproduction strategies of coastal marine fishes in the tropics. Envir. Biol. Fish. 3: 141-160.

Lazzari, M. A. (2001). Dynamics of larval fish abundance in Penobscot Bay, Maine. Fish. Bull. 99:81-93

Leis, J. M. (1982). Nearshore distributional dradients of larval fish (15 taxa) and planktonic crustaceans (6 taxa) in Hawaii. Marine Biology. 77:89-97.

Leis, J. M. (1986). Vertical and horizontal distribution of fish larvae near coral reefs at Lizard Islands, Great Barrier reef. Marine Biology. 90:505-516

Leis, J. M. (1991a). The pelagic stage of reef fishes: The larval biology of coral reefs.. In: Sale, P. F. the ecology of fishes on coral reefs. Academic press, INC. pp. 183-230

Leis, J. M. (1991b). Vertical distribution of fish larvae in the Great Barrier Reef lagoon, Australia. *Marine biology*. 109: 7-166.

Leis, J. M. (1994). Coral Sea atoll lagoons: closed nurseries for the larvae of coral reef fishes. *Bull. Mar. Sci*., 54(1): 6-227.

Leis, J. M. and Goldman, B. (1987). A preliminary distribution study of fish larvae near Ribbon coral reef in the great barrier reef. Coral reefs., 2:197-203.

Leis, J. M. and McCormick, M. I. (2002). The biology, behaviour, and ecology of the pelagic larval stage of coral reef fishes. In: Sale, P.F. (Ed), Coral reef fishes: dynamics and Diversity in a complex ecosystem. Academic press, San Diego., pp. 171-199.

Leis, J. M. and Miller, J. M. (1976). Offshore distributional patterns of Hawaiian fish larvae. Marine Biology, 36(3): 359-367.

Leis, J. M. (1982). Nearshore distributional gradients of larval fish (15 taxa) and planktonic crustaceans (6 taxa) in Hawaii. Marine Biology., 77: 89-97.

Leis, J. M. (1993). Larval fish assemblages near Indo-Pacific coral reefs. Bulletin of Marine Science., 53(2):362-392.

Leis, J. M. and Rennis, D. S. (1983). The larvae of Indo-Pacific coral reef fishes. New South Wales Univ. Press, Sydney, Australia., 269 pp.

Leis, J. M. and Trnski, T. (1989). The larvae of indo-pacific shorefishes. Honolulu, Hawaii. University of Hawaii., 371 pp.

Leis, J. M. and B. M. Carson-Ewart. (2002). Larvae of Indo-Pacific coastal fishes. An identification guide to marine fish larvae. (Fauna Malesiana Handbooks 2). E. J. Brill, Leiden, 850 pp.

Leis, J.M. and B. Goldman. (1987). Composition and distribution of larval fish assemblages in the Great Barrier Reef Lagoon near Lizard Island, Australia. Australian Journal of Marine and Freshwater Res., 38(2): 211-223.

Leis, J.M. and McCormick, M.I. (2002). The biology, behaviour, and ecology of the pelagic larval stage of coral reef fishes. In: Sale, P.F. (Ed), Coral reef fishes: dynamics and Diversity in a complex ecosystem. Academic press, San Diego., pp. 171-199.

Lieske, E. and Myers, R. (2001). Coral reef guide; Red Sea to Gulf of Aden south Oman. Harper Collins Publishers.

Lowe-McConnell, R. H. (1979). Ecological aspects of seasonality in fishes of tropical waters. Symp. Zool. Soc. London, 44: 219-241

Miller, J. M. (1974). Nearshore distribution of Hawaiian marine fish larvae: effects of water quality, turbidity and currents. In: “the early life history of fish” (J. H. S. Blaxter, ed), pp. 217-231. Springer-Verlag, New York.

Montgomery, J. C.; Nicholas, T. and Haine, O.S. (2001). Active habitat selection by presettlement reef fishes. Fish and Fisheries, 2: 261-277.

Paris, C. and Cowen, R. K. (2004). Direct evidence of biophysical retention mechanism for coral reef fish larvae. Limnology and Oceanography, 49: 1964-1979.

Olney JE, Boehlert GW (1988). Nearshore ichthyoplankton associated with seagrass beds in the lower Chesapeake Bay. Mar Ecol Prog Ser., 45:33-43

Randall, J. (1986). Red Sea Reef Fishes. IMMEL Publishing, London., 192 pp.

Sale, P. F. (1980). The ecology of fishes on coral reefs. Oceanogr. Mar. Biol., 18: 367-421

Smith, C. L.; Tyler, J. C. and Stillman, L. (1987). Inshore ichthyoplankton: a distinctive assemblage? Bull. Mar. Sci., 41: 432-440.

Suthers, M. and Frank, K. T. (1991). Comparative persistence of marine fish larvae from pelagic versus demersal eggs off south-western Nova Scotia, Canada. Mar. Biol., 108: 175-184

Young, P. C.; Leis, J. M. and Hausfeld, H. F. (1986). Seasonal and spatial distribution of fish larvae in waters over the North West Continental Shelf of Western Australia. Mar. Ecol. Prog. Ser., 31: 209-222.

Zar, J. H. (1996). Biostatistical analysis. Fourth Edition. Prentice Hall International (UK), London