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Ecological and Biological Assessment of a Wild Mullet Fish Fry Collection Station at the Egyptian Mediterranean Water

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Abstract: The hydrographic parameters, nutrient concentrations, plankton abundance and fry density were monthly investigated from August 2008 to April 2009 in a wild Mullet fish fry collection station called El-Kasara located in the Egyptian Mediterranean coast. This station is dedicated by *Mugil cephalus* and *Liza ramada* fry. Great variations were observed in all measured parameters due to the influence of tides and the mixing of marine and fresh water in this area. pH (7-7.9, turbidity (14.35-44.5 NTU), dissolved oxygen (0.86-8.02 mg/L), salinity (3.26-9.26 ppt) and chlorophyll-a (45.01-159.45 µgm/L). Also the concentrations of nutrients showed wide monthly variations: 15.17-43.36 µgm/L for silicate, 215-1195 µgm/L for total phosphorus, 11.66-172.7 µgm/L for ammonia and 33.31-309.54 µgm/L for nitrite. Similarly, the plankton abundance showed pronounced temporal variability, whereas the monthly phytoplankton production fluctuated between 39 x 10^3 and 58 x 10^3 cells/L and zooplankton between 19.5 x10^3-63.5 x 10^3 organisms/m^3. Significant positive correlation ($P< 0.05$_) was found between phytoplankton and both chlorophyll *a* and temperature; zooplankton and dissolved oxygen; nitrite with both dissolved oxygen and salinity; on the other hand significant negative correlation was found between zooplankton and both temperature($P< 0.05$_) and turbidity($P< 0.01$); phytoplankton with salinity; chlorophyll *a* with both salinity and nitrite; dissolved oxygen and the parameters temperature and turbidity; also between temperature and nitrite. As for the fish fry of the two dominant species in this station, highly significant positive correlation ($P< 0.01$) was found between *Liza ramada* fry and zooplankton and highly significant negative correlationwith pH ($P< 0.01$) and turbidity($P< 0.05$_); while for *Mugil cephalus* fry no correlation was found with any of the measured parameters. In conclusion the continuous discharge of agricultural and domestic waste water into El-Kasara station has caused drastic changes in the hydrographic conditions, but till now the main environmental factor attracting *Liza ramada* was the food (zooplankton abundance) which is high all the year round and for *Mugil cephalus* no relations were found.

Key words: El-Kasara station % Hydrography % Nutrients % Plankton abundance % Mullet fry

INTRODUCTION

El-Kasara station, west of Damietta Governorate, is one of the most ecologically and biologically important stations along the Mediterranean coast of Egypt. The ecological importance of this station is attributed to the fact that it receives various types of agricultural and domestic wastes which causing continuous changes in its water quality, also it considered as a highly fertile region providing a good environment for wild Mullet fry especially *Liza ramada* and *Mugil cephalus*. The two species considered as important commercial fishes in Egypt, also they play an important role in world fishery and aquaculture [1-3].

Due to its importance as one of the highest productive Mullet fish fry collection stations in Egypt, it is necessary to study its water quality and inhabiting biota. In this context, few investigations were conducted including water quality [4] and zooplankton abundance [5], but these studies were based upon seasonal sampling. Therefore, the present study was conducted on monthly base to follow up the temporal pattern in ecological and biological characteristics of this station, especially during the period of collection of this fry, also to estimate the main environmental conditions attracting *Liza ramada* and *Mugil cephalus* fry in their natural habitat.

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MATERIALS AND METHODS

The study area (El-Kasara) is located on the Mediterranean Sea coast, west of Damietta Governorate (Fig. 1). This area receives mainly agricultural and domestic wastes directly through El-Kasara Drain. Also it is exposed to rapid changes in environmental characteristics due to the manipulation of tides and the mixing of marine and fresh water.

The study was carried out monthly from August 2008 to April 2009 on the surface water, this time represented the time of collection the fry of the two dominant Mullet species in the studied station, whereas *Liza ramada* fry found from November to April and *Mugil cephalus* fry from August to January (Fig. 2).

Water temperature was measured directly by a usual thermometer model 33 S.C.I. graduated to 0.1°C. pH was measured *in situ* by using a pocket digital pH meter, model Orion (Research Model 201). Turbidity was assessed by using Turbidity meter. Dissolved oxygen was determined, by Winkler method [6]. Salinity was determined argent metrically as described by Strickland and Parsons [6]. Determination of all nutrients and Chlorophyll *a* followed the procedures described by Strickland and Parsons [6]. For phytoplankton, one liter of water was preserved in 4% neutralized formalin, the phytoplankton standing crop was estimated by counting method [7] and expressed as cell /liter.

Zooplankton samples were collected by filtering 5 liters of water through a plankton net 55 µm mesh size and

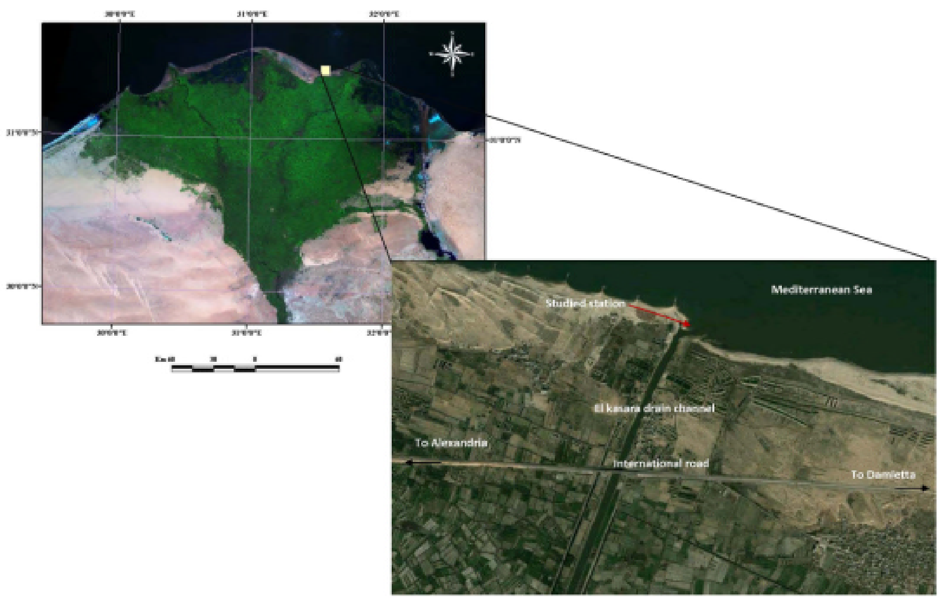

Fig. 1: Egyptian Mediterranean coast including El-Kasara station

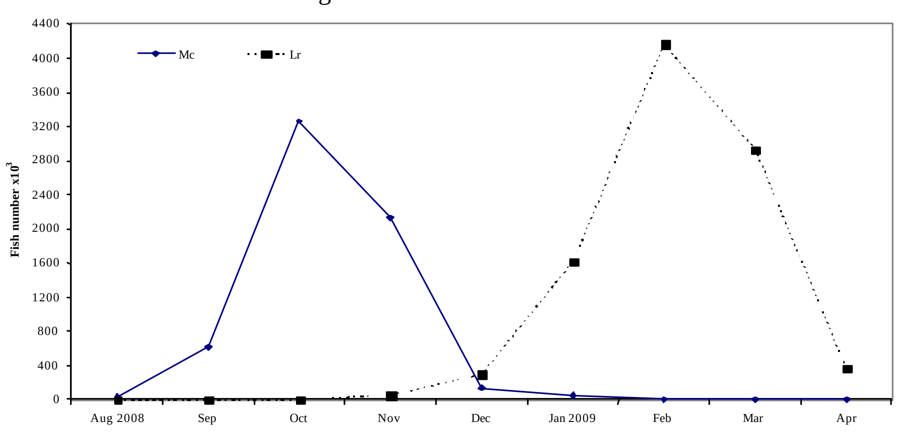

Fig. 2: Monthly abundance of *Mugil cephlus* and *Liza ramada* fry collected from El-Kasara Station (August 2008-April 2009).

the samples were preserved *in situ* in 4% formalin. The zooplankton standing crop was calculated from the average counts of three aliquots (5 ml each) and estimated as individual/m^3.

The data of monthly amounts of fish fry of *Liza ramada* and *Mugil cephalus* collected from the studied location were taken from the General Authority of Fish Resources Development at Damietta region (Fig. 2). The relations between the different parameters were analyzed using product moment (Pearson's) correlation coefficient.

RESULTS

The study area demonstrated marked temporal variability in hydrographic conditions, nutrient concentrations and plankton abundance. The water temperature showed the classical seasonal variations known in the Egyptian coastal water, whereas it varied between 29.5C° in August and 12.5 C° in January (Fig. 3). The surface salinity appeared to be widely variable during different months reflecting changes in the value of the discharged waste water. The measured values fluctuated between 3.26 ppt during August to 9.26 ppt during January (Fig 3).

The transparency was low during August and September, whereas the turbidity reached 40 and 44.5 NTU, respectively (Fig. 4). On the other hand, transparency increased gradually to reach its maximum during the period from January to April. The monthly pattern of dissolved oxygen (Fig. 4) demonstrated high values during most months (4.97-8.02 mg/L), except during August and September whereas it showed minimum values (0.86 and 1.46 mg/L, respectively).

The pH values of the surface water pointed out alkaline tendency, varying between a minimum of 7 during February and a maximum of 7.9 during April Fig. 5).

Chlorophyll *a* showed wide temporal variations and three distinguished peaks during August, October and April (Fig. 5). The highest values was recorded during August (159.45µgm/L) and the lowest concentration was recorded during December (45.01 µgm/L).

The monthly concentrations of nitrite showed high values (Fig 6). December and January seem to be the richest months (268.76 and 309.54 µgm/L respectively).Ammonia showed three levels of concentrations. The highest one during November (172.7µgm/L), a moderately high level during August, October and December-March, (82.3-104.28 µgm/L) and low one during September and April(11.66 and 17.35 µgm/L), (Fig. 6).

Total phosphorus concentrations ranged from 215 to 1195 µgm/L, except the highest values (1195 and 945 µgm/L) during August and April, respectively (Fig. 7). Silicate concentrations reflected wide temporal variations(15.17-43.36 µgm/L). The highest concentration was found during March (43.36 µgm/L), also other 2 small peaks were noticed during September and January (32.9 and 26.51 µgm/L respectively). During the other months its concentration ranged between 16.92 and 20.77 µgm/L (Fig. 7).

The density of phytoplankton was usually high indicated high primary production during all months, fluctuated between 39 x 10^3 and 58 x 10^3 cells/L. As shown in figure 8, the peaks of abundance appeared during September, October and April (52.5, 58 and 51 x 10^3 unit/L respectively) and the lowest count was recorded during November (39 x 10^3 unit/L), while during the rest of months the counts ranged between 40 x 10^3 and 49 x 10^3 unit/L. Clear indication of high secondary production was revealed from the high abundance of zooplankton during the studied period (19.5 x10^3-63.5 x 10^3 organisms/m^3), whereas the peak was recorded during

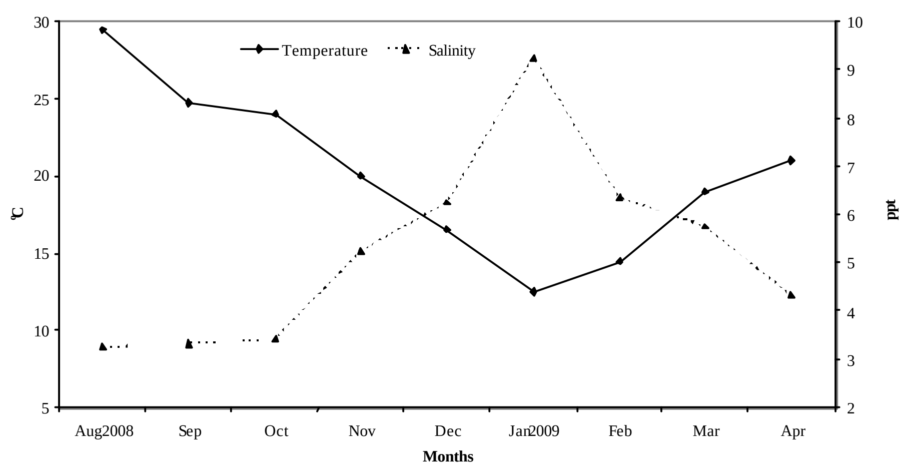

Fig. 3: Monthly variation of water temperature and salinity in El-Kasara station (August 2008-April-2009)

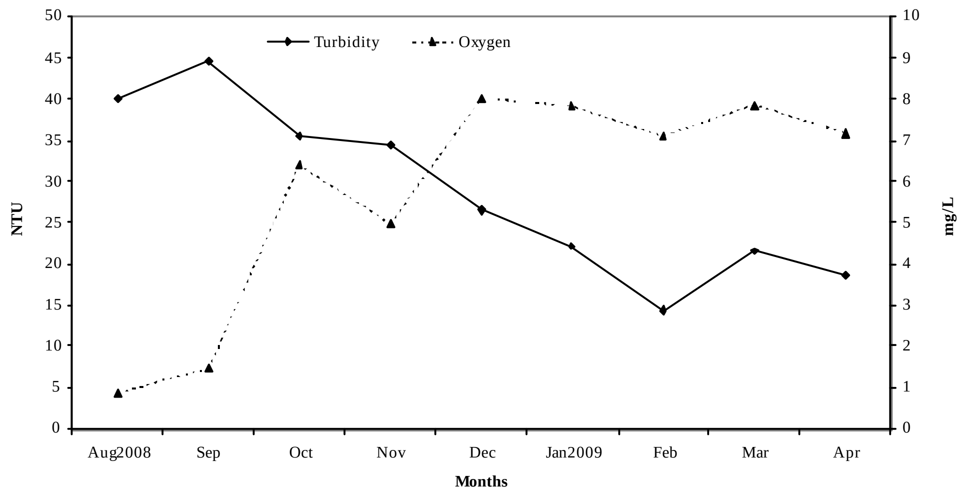

Fig. 4: Monthly variation of turbidity and disssolved oxygen in El-Kasara station (August 2008-April-2009)

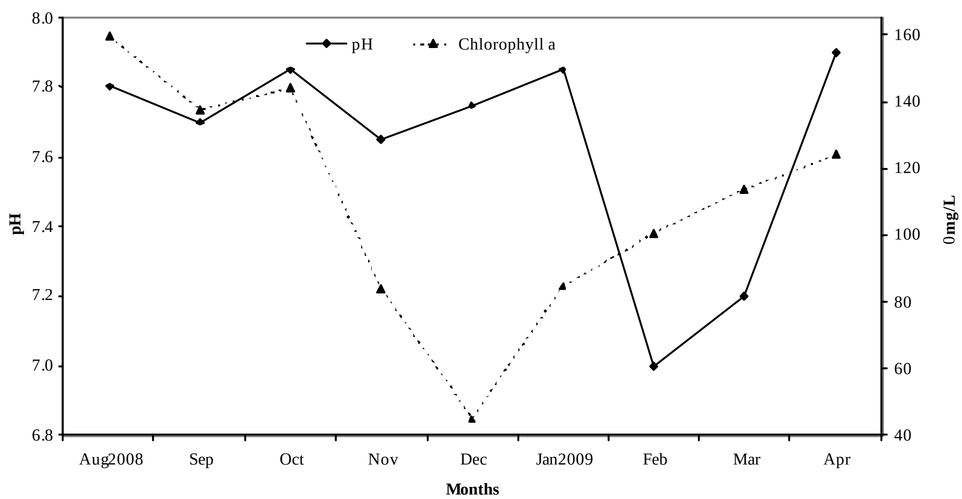

Fig. 5: Monthly variation of pH and chlorophyll a in El-Kasara station (August 2008-April-2009)

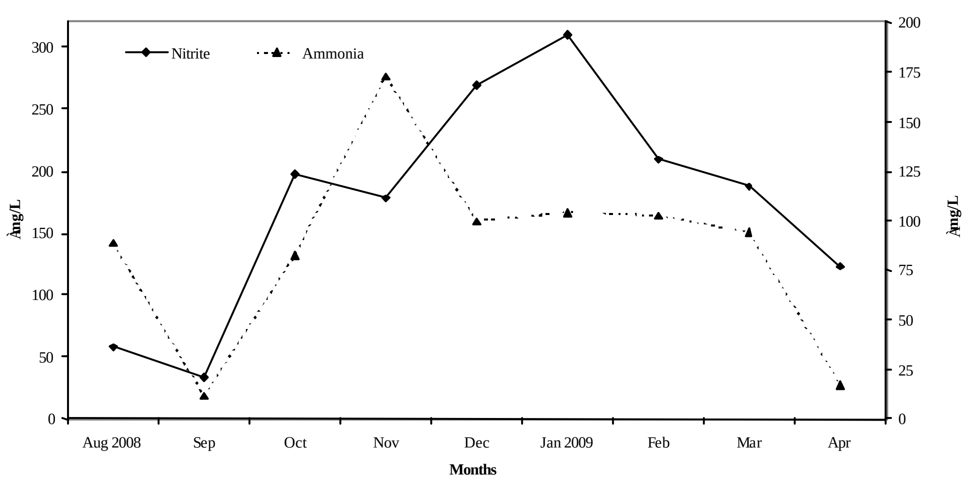

Fig. 6: Monthly variation of nitrite and ammonia in El-Kasara station (August 2008-April-2009)

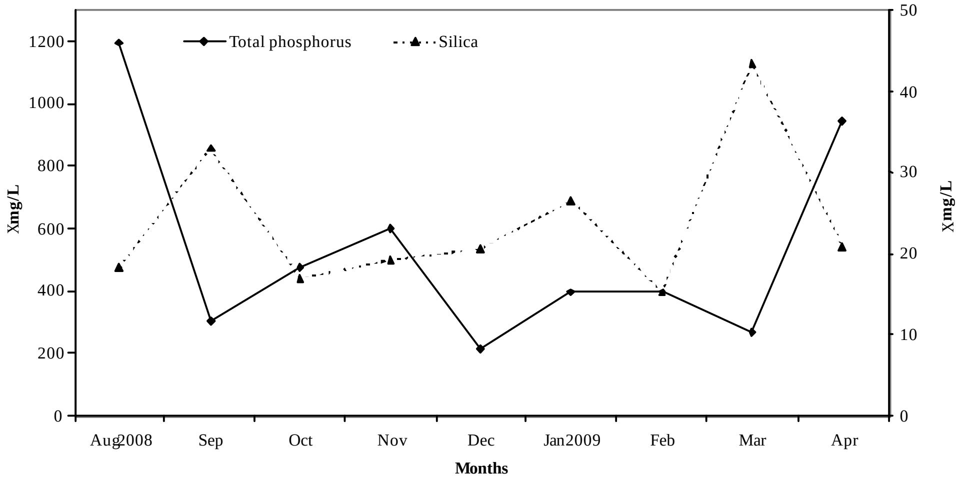

Fig. 7: Monthly variation of total phosphorus and silicate in El-Kasara station (August 2008-April-2009)

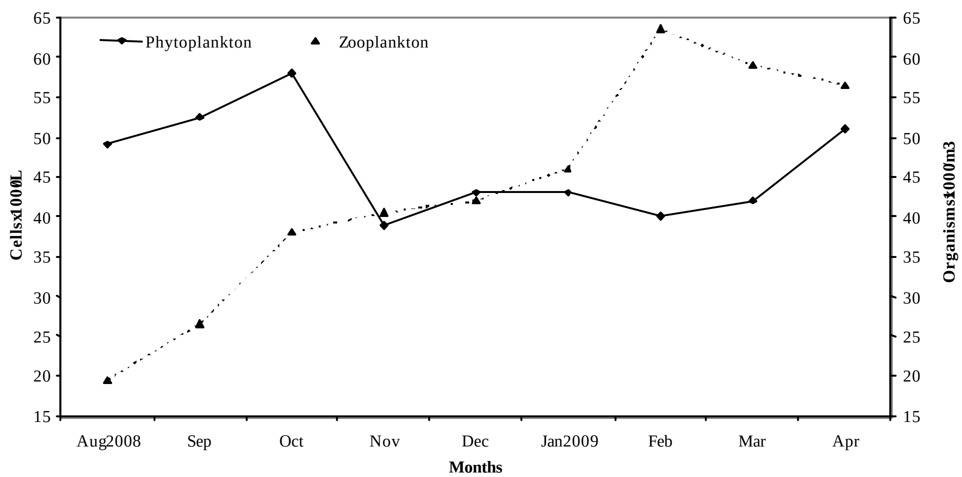

Fig. 8: Monthly abundance of phytoplankton and zooplankton in El-Kasara station (August 2008-April-2009)

Table 1: Correlations of different hydrobiological parameters and fry of *Mugil cephalus* (M.c.), *Liza ramada* (L.r.)

Mugil cephalus	*Liza ramada*	Phytop-lankton	Zoopl-ankton	Chl.a	D.O	Salinity	Temp.	pH	Turbidity	Silicate	NO_2	Total PO_4	NH_3	
M.c.	1	-0.430	0.329	-0.282	0.181	-0.071	-0.37	0.279	0.271	0.450	-0.308	0.021	-0.068	0.284
L.r.		1	-0.679	0.806**	-0.201	0.482	0.523	-0.614	-0.881**	-0.738*	0.215	0.375	-0.369	0.179
Phytopl.			1	-0.637	0.735*	-0.517	-0.736*	0.780*	0.658	0.604	-0.115	-0.586	0.437	-0.649
Zoopl.				1	-0.393	0.793*	0.524	-0.743*	-0.642	-0.926**	0.123	0.500	-0.362	0.091
Chl.*a*					1	-0.639	-0.722*	0.796*	0.134	0.455	0.044	-0.756*	0.558	-0.49
D.O						1	0.663	-0.81**	-0.236	-0.830**	0.054	0.843**	-0.476	0.232
Salinity							1	-0.915**	-0.210	-0.639	0.119	0.843**	-0.445	0.422
Temp.								1	0.363	0.769*	-0.055	-0.849**	0.601	-0.337
pH									1	0.466	-0.238	-0.11	0.391	-0.251
Turbidity										1	0.015	-0.602	0.183	-0.102
Silica											1	-0.098	-0.425	-0.238
NO_2												1	-0.516	0.529
Total PO_4													1	-0.114
NH_3														1

**Correlation is significant at p<0.01, * Correlation is significant at p<0.05

April (63.5 x 10^3 organisms/m^3) and the low counts (19 x10^3-42 x10^3 organisms/m^3) were recorded during the period from August-December (Fig. 8).

The statistical treatment of data revealed the occurrence of several significant correlations between the different parameters (Table 1). Zooplankton showed positive significant correlation($P< 0.05$) with dissolved oxygen and another negative with temperature and turbidity; while phytoplankton showed positive significant correlation($P< 0.05$) with chlorophyll *a* and temperature and another negative with salinity. Chlorophyll *a* showed significant correlation ($P< 0.05$) with salinity, temperature and nitrite. Dissolved oxygen showed high significant ($P< 0.01$) positive and negative correlation with temperature, turbidity and nitrite. Also salinity showed high significant correlation ($P< 0.01$) with temperature and nitrite. As for the fish fry of *Liza ramada* showed high positive correlation ($P< 0.01$) with zooplankton and another negative with pH. But *Mugil cephalus* showed no correlation with any of the measured parameters.

DISCUSSION

El-Kasara station is located at the outlet of El-Kasara freshwater drain towards the Mediterranean Sea. It receives variable pollutants through the discharged agricultural and domestic wastes. The variability in the quantity and quality of these wastes and their dispersion, the influence of tides and the continuous mixing of marine and fresh waters, are of great importance on the dynamics of hydrographic conditions, nutrient concentrations, plankton density and fish fry abundance in El-Kasara station.

According to the present study El-Kasara station is characterized by low water transparency (turbidity:14.35-44.5 NTU) during the studied period, due to the mixing processes between fresh and seawater, in addition to the high chlorophyll content. Similar observations were reported [8-10]. The low transparency is also attributed to the high counts of zooplankton (average: 470 x 10^3 individual/m^3). This is in agreement with Edmondson [11] who reported that, light could be absorbed by other substances rather than chlorophyll *a*.

Dissolved oxygen and chlorophyll *a* were generally high. The dissolved oxygen is important in the metabolic activities of aquatic organisms and serves as an indicator of water quality [12]. In the present study a strong negative correlation was reported between dissolved oxygen and temperature, while a positive correlation was found between dissolved oxygen and the parameters salinity, transparency and nitrite. This explains the effect of salinity on the dissolved oxygen variations. It is to be noted that the values of dissolved oxygen in El-Kasara station (usually between 5-8 mg / L) indicate the well aeration conditions which pronouncedly exceed the critical levels (3-5 mg/L) for aquatic biota [13].

The concentration of chlorophyll *a* ranged between 0.5 and 1.0 µgm/L is considered a criteria of acute eutrophication in the aquatic habitat [14, 15]; relative to the markedly high concentrations of chlorophyll *a* in El-Kasara station (45.01-159.45 µgm/L) and it is classified as an acute eutrophic area. Positive significant correlation was existed between chlorophyll *a* and temperature, total phosphorus and low significant negative correlation with dissolved oxygen, salinity and nitrite. Abdel-Mawla [9] attributed the high concentration of chlorophyll a in Nosha Hydrodrome due to high concentration of nutrient salts persisting during warm months, also the decrease in salinity as indicator of nutrient enrichment.

Salinity varied monthly (3.26-9.26 ppt) due to the dispersion of fresh water and the wind action. The significant correlation of salinity with nitrite, temperature, phytoplankton and chlorophyll *a* indicated salinity variations as one of the major factors influencing several biotic and abiotic components of the ecosystem in the study area. Moreover, the significant correlation between salinity and these parameters is mainly attributed to the quantity and quality of the discharged wastes, which are usually loaded with large amounts of nutrients and different pollutants.

Significant variability was observed in the monthly distribution of all measured nutrients with a peak of each one differed in timing from the others. Such differences may be attributed to the variability of nutrient levels in the discharged waters, which are exposed to seasonal quantitative and qualitative changes. The increased nutrient supply led to abnormal flourishing of phytoplankton and consequently high abundance of zooplankton which were several times higher than the values recorded at other Egyptian coastal waters [16-19]. The significant correlation between temperature and both chlorophyll *a* and phytoplankton suggests that the elevated phytoplankton biomass during August-October can in part be stimulated by the higher water temperature in the presence of large amount of nutrient salts, which are mainly brought by the fresh water discharge from El-Kasara drain.

Each of phytoplankton density and chlorophyll *a* showed two peaks of abundance during October and

April; and zooplankton showed one peak during April, while the lowest zooplankton counts recorded during October. Therefore, two types of relations between chlorophyll a, phytoplankton and zooplankton could be expected, a direct one appeared during April and another reverse relation dominated during October, November, February and March. Such relations may be explained by the significant effect of grazing or by the theory of animal exclusion [20]. Meanwhile, the high chlorophyll *a* concentration at El-Kasara station may be caused mainly by freshwater phytoplankton. In eutrophic waters, phytoplankton production exceeds zooplankton consumption, because of the growth of large algae that are relatively unutilized by filter feeding zooplankton, while in other situations high zooplankton production is unrelated to phytoplankton production because of large influx of detrital allochthonous matter [21].

Phytoplankton had a positive significant correlation with chlorophyll *a*, temperature, pH and turbidity, while it had a reverse correlation with zooplankton, dissolved oxygen, salinity, nitrite and ammonia. Variations in phytoplankton biomass in estuaries and coastal areas have been linked to a number of factors including light and macronutrient availability [22-24], temperature [25] and biological factors such as zooplankton grazing and competition [9, 26, 27].

Positive significant correlations was existed between zooplankton with dissolved oxygen, salinity and nitrite and a negative significant correlation was evident with turbidity and low negative significant correlation with temperature and pH. Hydrology and nutrient enrichment may exert a strong influence on the species composition and size distribution of the zooplankton, as shown in other shallow Mediterranean waters [28-30].

In the Mediterranean sea, there has been a decline in fry availability of some mullet species in recent years due to pollution and over fishing of parent stocks: *Mugil cephalus*, for instance, has shown a decrease in number, whereas *Liza ramada*, which is more tolerant to coastal organic pollution and eutrophication, is still abundant despite massive fishing [3]. The spatial distribution of larvae of the different fish species is conditioned by environmental heterogeneity, the processes enhancing productivity and their behavior throughout the seasonal cycle [31]. El-Kasara location is dedicated by fry of Mullet species (*Mugil cephalus* and *Liza ramada*). Not all estuaries and coastal waters are equal and the quantity or quality of their available habitats for juveniles of marine fish species is not necessarily the same [32-34].

Distribution of *Liza ramada* fry is affected by salinity during the study period (5-9 ppt). Different studies have reported high concentrations of fish eggs and larvae associated with low salinity waters [35, 36]. Their ability to adapt to fresh water at a gradual decrease [37, 38]or an abrupt decrease of salinity [39] is manifested at an early larval age. Salinity are also involved in ichthyoplankton distributions [40-45].

A negative correlation existed between *Liza ramada* and phytoplankton, pH, temperature and turbidity and another highly positive with zooplankton. Environmental factors influencing growth rate include temperature [46-48] and food availability [46, 49]. Mugilidae larvae and post-larvae feed mostly on zooplankton [50]. Therefore, zooplankton is now generally acknowledged to be an excellent indicator for the detection of changes in marine ecosystems [51]. Studied biotic and abiotic factors had no significant correlations with the distribution of *Mugil cephalus* Juveniles in estuarine nursery areas tolerate and overcome some of the occurring environmental constraints, benefiting from favorable conditions for growth, such as high food availability, water temperature and refuge from predators [51-53].

At El-Kasara a fluctuation in different ecological factors is a major factor attract fish fry. Hydrodynamics is a key factor for the recruitment success of marine fishes [54]; given the natural variability in current speeds and direction, the potential for drift into nursery environments of varying quality might be expected to result in high recruitment variability.

In conclusion, the continuous discharge of agricultural and domestic waste water into El-Kasara station has caused drastic changes in the hydrographic conditions with abnormal increase of nutrients, high plankton production and acute degree of eutrophication. The inhibitory effect of these wastes on oxygen is still not clear. The main environmental factor attracting *Liza ramada* was the food (zooplankton abundance), but for *Mugil cephalus* no relations were found.

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