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EFFECT OF THE ENVIRONMENTAL FACTORS ON THE DISTRIBUTION OF MUGILIDAE IN BARDAWIL LAGOON, NORTH SINAI, EGYPT

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ABSTRACT

Total of 482 individuals of Mullet species were collected from Bardawil lagoon, North Sinai, Egypt fishery (3 stations: El Nasr, Egswan, Tulul) during April 2019 to January 2020 season. *Liza. ramada* is the highest with respect to the relative abundance in Bardawil lagoon. In El-Nasr station results showed that *Liza. ramada* is abundance species, *Mugil. cephalus* is less abundance. *Liza. aurata* and *Liza. saliens* and *Liza. carinata* are rare species, while *Chelon labrosus* non-existent. In Egzwan station it found that *Liza. ramada* is abundance species, *Mugil. cephalus* is less abundance. *Liza. aurata, Liza. saliens, Liza. carinata* and *Chelon labrosus* are rare species. In Tulul station results showed that *Liza. ramada*, *M. cephalus* and *Liza. aurata* are less abundance. *Liza. saliens, Liza. carinata* and *Chelon labrosus* are rare species. The diversity of species was (1.10, 1.34 and 1.50) in stations EL-Nasr, Egzwan and Tulul respectively. The values of Richness index were 0.78, 1 and 0.98 in El-Nasr, Egzwan and Tulul, respectively. The values of Evenness index were 0.68, 0.75 and 0.84 in El-Nasr, Egzwan and Tulul, respectively. But EL- Nasr has the highest value in dominants species.

INTRODUCTION

Mugilidae in Bardawil lagoon with an important financial return and exist in a vast range in the lagoon. the distribution of these species is no longer equal and unspecified Each kind is associated to particular surroundings appropriate for dwelling so it used to be essential to find out about their distribution and relative abundance and its relationship to the environment in Bardawil lagoon. Assessment of marine fish assets and assessment of species diversity offers an assessment of the importance of enhancing management and most appropriate sustainable use of this essential water aid (**Punnakulam, 2018**) Diversity indications furnish facts about the value of a species in a community (**Galib *et al.*, 2013**). Noticeably, increasing moderation in environmental prerequisites leads to extended abundances, greater complex trophic structure, and increase the effect on of species interactions on shape (**Menge, 2000; Menge and Branch, 2001**). Widely, evaluating spatial distributions of species range in one-of-a-kind geographical locations, is one of the techniques to the overalls in community formation or habitat use (**MacArthur, 1972; Gaston, 2000; Thrush *et al.*, 2005 and Warwick *et al.*, 2016**), where environmental conditions are intently related to biological facets (biotic), following ecological action (abiotic) (**Olff *et al.*, 2009**). Moreover, macrobenthic purposeful approaches employed in biodiversity and their community's buildings alongside distinct environmental gradients to know the vogue of their nonstudents can range in diversity are

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composed and their relative choice pressures (**McGill *et al*., 2006**). They also argued that the time-honored precept of neighborhood ecology can also not be executed if research continues to focal point on binary species interactions independently of the environment.

The family Mugilidae has spread in a wide range around the world due to its multiplicity of races and species due to its adaptation to live in different environments with a wide tolerance for environmental factors, as well as the taste of its flesh, which is desirable for many people around the world, making it the focus of attention for biologists and aquaculture together, as it is one of the preferred economic fish for all classes of society. The mullet is registered in Fishbase, there are 17 genera comprising between seventy-two and eighty species (**Harrison, 2003; Nelson, 2006**). Four genera and eight species have been listed in the Mediterranean: Chelon (one species), *Liza* (five species, which include two unusual ones: The *L. carinata* is one arising from Asia, the *L. haematocheilus*, which escaped from farms), *Mugil* (one species) and *Oedalechilus* (one species). The latter looks to be very rare (**Cambrony, 1983**) and the solely one not to enter lagoons and estuaries (**Kottelat and Freyhof, 2007**).

MATERIALS AND METHODS

Study Area

Bardawil lagoon is a shallow hyper saline lagoon. Its region is about 685 km^2extends for a distance of about ninety five km, from a point 45 km east of Port Said and extending to a point 18 km west of El-Arish. The survey was conducted in Bardawill Lagoon at 3 stations (El Nasr, Egswan, Tulul) from April 2019 to January 2020.

Samples

A total of 482 individuals of mullet species were randomly collected from the catch of trammel net (Dabba and Dahbana) and Bouss between April 2019 to January 2020 from Bardawil lagoon. To investigate the biodiversity of the species present in the lagoon and their relative abundance.

Environmental Parameters

Water samples were taken monthly from April 2019 to January 2020, Water temperature and dissolved oxygen Were determined by dissolved oxygen meter.MD 21820 USA, 802 Washington Ave. The value was expressed in mg/l. Hydrogen ion concentration (pH) was measure by pH meter. Po Box329. Chesterton. Lot 04812, Maryland. Cod 5-0035-Oh. 802 Washington Ave. Water salinity was measure by using TDS system and the values were expressed in ppt. Po Box329.Chesterton. 21620, LaMotte. The value was expressed in ppt.

Biological Indexes

Relative abundance

The relative abundance is a measure of the complete populace of individuals and the extent of the relative contribution of each crew within the people in the sample. Calculated primarily based on the following equation (**Odum, 1970**):

$$R_a = (N / N_s) \times 100$$

Where, N: The number of individuals of each type in the sample.

Ns: The total number of the sample.

The relative abundance indexes

The relative abundance index expresses the variety of returning people and one taxonomic unit compared to the complete populace of folks **(Barbour *et al.*, 1995)** where: R= Rare species less than 10%. La= Less abundance (10:40) %. A= Abundance species (40:70) %. D= Dominant more than 70%.

The diversity indexes

The diversity index was calculated by using the **Shannon-Weaver (1949)** equation: diversity index (H), $H=-\sum p_i * ln p_i$

Where, $Pi = n_i / N$.

n_i = number of individuals of one species.

N= total number of all individuals in the sample.

Richness index

The degree of richness of the equation is calculated by **Margatef (1968).** D=S-1/lnN D= Richness Index. S = total number of species.

N = total number of all individuals in the sample.

Evenness Index, (Pielou, 1977) (E)

This expresses how evenly the individuals are distributed among the different species. Pielou's evenness index is commonly used.

J=H/lnS J= evenness index. H= diversity index.

S = total number of species.

Evenness index is constrained between 0 and 1. The less variation in communities between the species, the higher Evenness index level.

Dominance index (D)

Dominance index of the equation is calculated by **Berger and Parker (1970)**:

$$D = N_{max} / N$$

D= dominance index.

N_{max} = number of individuals for dominance species.

N = total number of all individuals in the sample.

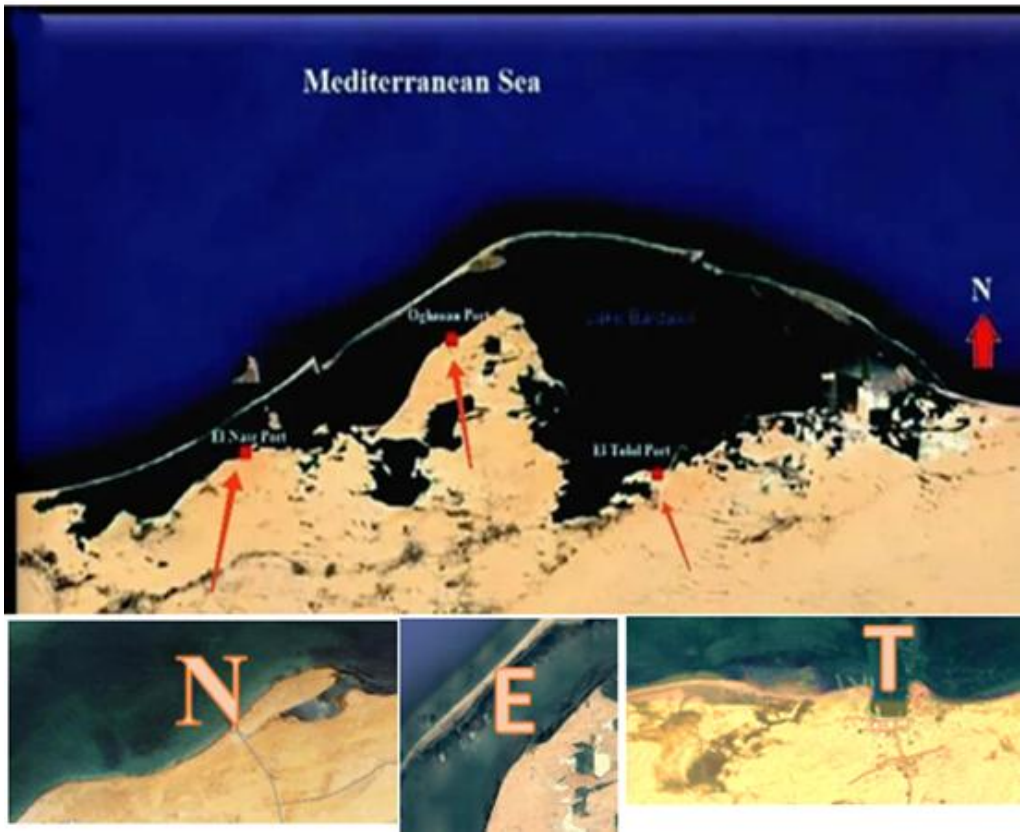

Fig. 1. Bardawil lagoon

Fig. 2. ***Mugil cephalus***

Fig. 3. ***Liza ramada.***

Fig. 4. ***Liza aurata***

Fig. 5. ***Liza saliens***

Fig. 6. ***Liza carinata***

Fig. 7. ***Chelon labrosus***

RESULTS AND DISCUSSION

Ecological Studies

Water temperature

It is nicely known the water temperature of the most vital factors affecting the whole aquatic surroundings in-water surveys of fish, phytoplankton, zooplankton, aquatic plants, and benthic faunas in addition to its impacts on all physic-chemical properties. In Bardawil lagoon the water is attribute *via* a slender version among the low temperature in El-Nasr, Egzwan and Tulul are 24.4, 24.1 and 23.7^{o}C, respectively. **El-Kassas *et al.* (2016)** found that the average of water temperature fluctuated between 15.9 and 27.4^{o}C. In general, in Bardawil lagoon.

Dissolved oxygen (DO)

The average dissolved oxygen of El-Nasr, Egzwan and Tulul were 6.1, 6.8 and 6.3, respectively. **Zalat *et al.* (2019)** found that dissolved oxygen values in Bardawill Lagoon ranged from 4.5 mg/l (September, 2014) to 6.7 mg/l (March 2014).

pH value

The pH value differed in the stations of Bardawill lagoon. The average pH value of El Nasr, Egzwan and Tulul were 8.2, 8.2 and 8.1, respectively.

Depth of bottom

The average depth of bottom of El Nasr, Egzwan and Tulul were 1.5 m, 2.5 m and 1.26 m, respectively. The maximum value of depth was (185 cm) recorded at El Nasr in Bardawill Lagoon (**Zalat *et al.*, 2019**).

Water salinity

Bardawil water characteristic with high salinity of seawater due to elevated evaporation process with few waves action and the increase the distances and low depths of shallowness and subjected to regular evaporation waters main to a great increase to about 57.3, 42.7 and 49.8 of El-Nasr, Egzwan and Tulul, respectively. The same values were recorded by **El-Kassas *et al.* (2016).**

Biological Indexes

Relative abundance

Fig. 13 as well as Tables 4 and 5 showed that *L. ramada* is the highest with respect to the relative abundance in Bardawil lagoon. In El-Nasr it found that *L. ramada* is abundance species, *M. cephalus* is less abundance. *L. aurata* and *L. saliens* and *L. carinata* are rare species, while *Chelon labrosus* non-existent. These results agree with those of **Souelem *et al.* (2022)** who found that the western region of Bardawil lagoon is characterized by its salinity, and this is reflected in a society with less diversity in living organisms. Five species of the mullet family have been recorded in the south of the lagoon, they are *M. cephalus*, *L. ramada, L. aurata, L. saliens* and *L. carinata* **(Souelem *et al.*, 2022).** In Egzwan *L. ramada* was the abundance species, *M. cephalus* is less abundance. *L. aurata, L. saliens, L. carinata* and *Chelon labrosus* are rare species. In Tulul it was found that *L. ramada*, *M. cephalus* and *L. aurata* are less abundance. *L. saliens, L. carinata* and *Chelon labrosus* are rare species (Tables 1 and 2). **Mehanna *et al.* (2020)** pointed that the grey mullets are the most abundant fish species inhabiting Bardawil lagoon. They form about 26% of the total lagoon production, Mullet's catch is composed mainly from *Mugil cephalus, Liza ramada* and *L. aurata*, while both *Chelon labrosus* and *L. saliens* are found in tiny amounts and recorded under the "others" group.

The highest diversity of species was found in Tulul while it was lower in El-Nasr. Egzwan record the highest value in richness Index. The value of evenness index was (0.68, 0.75 and 0.84) in El-Nasr, Egzwan and Tulul, respectively. But El-Nasr had the highest value in dominants species (Tables 6 and 7).

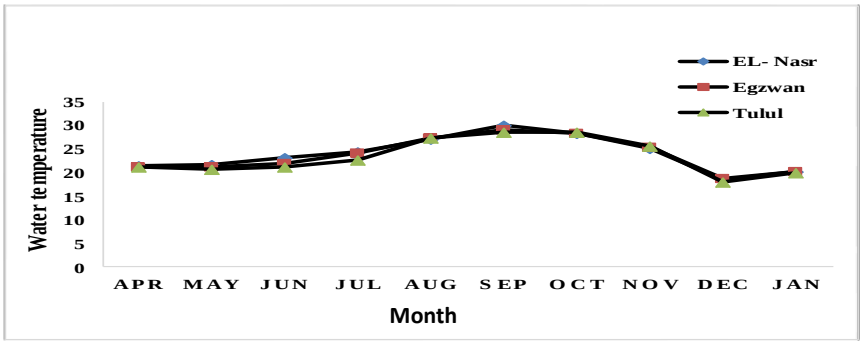

Fig. 8. Average water temperatures in El-Nasr, Egzwan and Tulul of Bardawil lagoon during a single fishing season, 2019

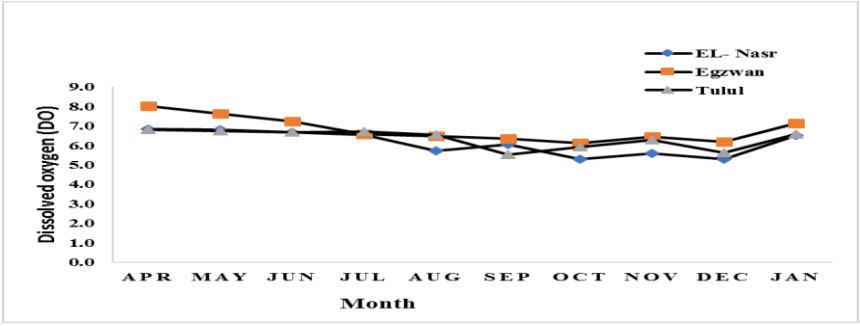

Fig. 9. Average dissolved oxygen in El-Nasr, Egzwan and Tulul of Bardawil lagoon during a single fishing season, 2019

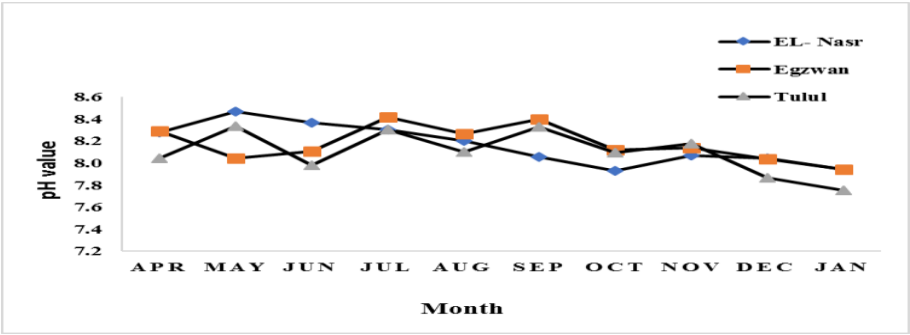

Fig. 10. Average pH value in El-Nasr, Egzwan and Tulul of Bardawil lagoon during a single fishing season, 2019

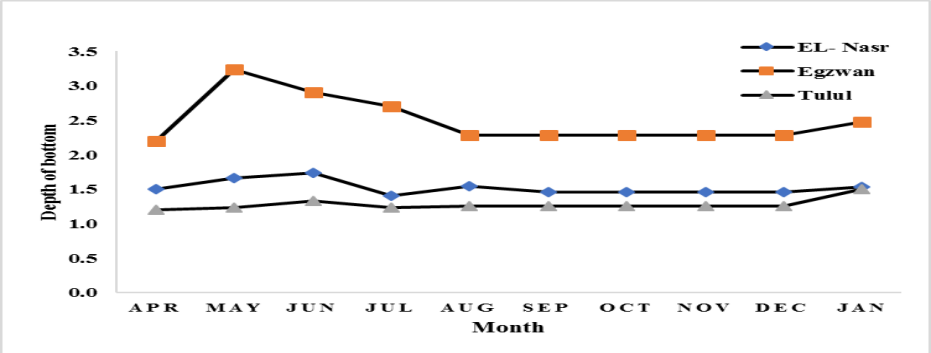

Fig. 11. Average depth of bottom in El-Nasr, Egzwan and Tulul of Bardawil lagoon during a single fishing season, 2019

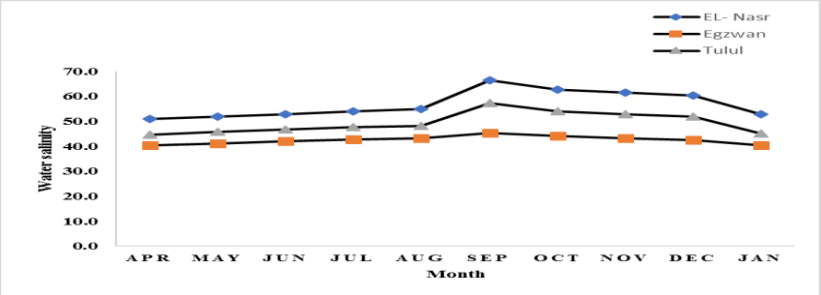

Fig. 12. Average water salinity in El-Nasr, Egzwan and Tulul of Bardawil lagoon during a single fishing season, 2019

Table 1. The mean water temperature (^{0}C), dissolved oxygen (D.O), pH, depth (m), salinity (pp_t) per each month in El-Nasr of Bardawil lagoon during a single fishing season, 2019

Station	Month	Water temp(^{0}C)	D.O(mg/l)	PH	Depth(m)	Salinity (pp_t)
El- Nasr	**Apr**	21.5	6.8	8.3	1.5	50.9
	May	21.6	6.8	8.5	1.7	51.9
	Jun	23.1	6.7	8.4	1.7	52.9
	Jul	24.4	6.5	8.3	1.4	53.9
	Aug	27.1	5.7	8.2	1.5	54.9
	Sep	29.9	6.0	8.1	1.5	66.5
	Oct	28.2	5.3	7.9	1.5	62.7
	Nov	25.2	5.6	8.1	1.5	61.4
	Dec	18.6	5.3	8.0	1.5	60.4
	Jan_{2020}	20.10	6.50	7.94	1.53	52.78
Average		**24.0**	**6.1**	**8.2**	**1.5**	**56.8**

Table 2. The mean water temperature (^{0}C), dissolved oxygen (D.O), pH, depth(m), salinity (pp_t) per each month in Egzwan of Bardawil lagoon during a single fishing season, 2019

Station	Month	Water temp(^{0}C)	D.O(mg/l)	PH	Depth(m)	Salinity (pp_t)
Egzwan	**Apr**	21.2	8.0	8.3	2.2	40.4
	May	21.2	7.6	8.0	3.2	41.0
	Jun	22.0	7.2	8.1	2.9	42.0
	Jul	24.2	6.6	8.4	2.7	42.7
	Aug	27.3	6.5	8.3	2.3	43.2
	Sep	29.0	6.3	8.4	2.3	45.4
	Oct	28.2	6.1	8.1	2.3	44.1
	Nov	25.2	6.4	8.1	2.3	43.1
	Dec	18.8	6.2	8.0	2.3	42.4
	Jan_{2020}	20.13	7.15	7.94	2.48	40.48
Average		**23.7**	**6.8**	**8.2**	**2.5**	**42.5**

Table 3. The mean water temperature (^{0}C), dissolved oxygen (D.O), pH, depth (m), salinity (pp_t) per each month in Tulul of Bardawil lagoon during a single fishing season, 2019

Station	Month	Water temp(^{0}C)	D.O(mg/l)	PH	Depth(m)	Salinity (pp_t)
Tulul	**Apr**	21.2	6.8	8.0	1.2	44.5
	May	20.8	6.7	8.3	1.2	45.7
	Jun	21.2	6.7	8.0	1.3	46.7
	Jul	22.7	6.7	8.3	1.2	47.7
	Aug	27.3	6.5	8.1	1.3	48.2
	Sep	28.5	5.5	8.3	1.3	57.2
	Oct	28.5	5.9	8.1	1.3	54.0
	Nov	25.5	6.3	8.2	1.3	52.7
	Dec	18.1	5.6	7.9	1.3	51.9
	Jan_{2020}	20.00	6.59	7.75	1.50	44.97
Average		**23.4**	**6.3**	**8.1**	**1.3**	**49.3**

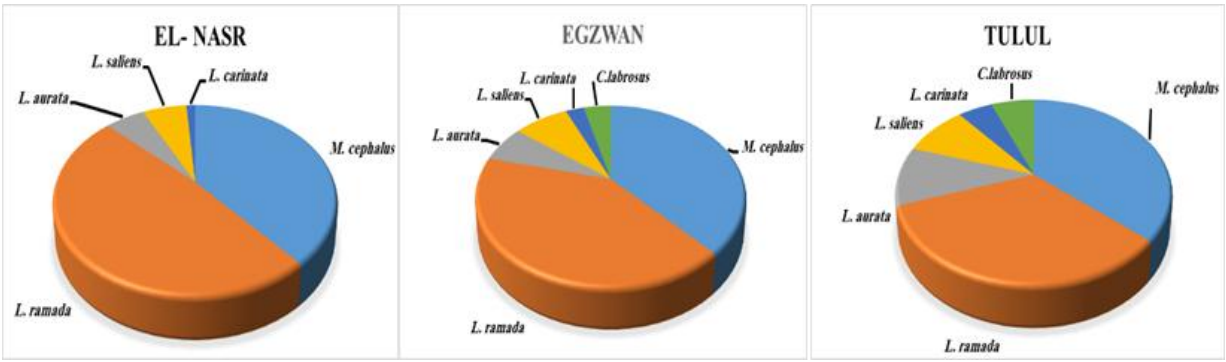

Fig. 13. Relative abundance in El- Nasr, Egzwan and Tulul

Table 4. Show the relative abundance of Mullet Species in Bardawil lagoon

Species	Sample			Frequently
	El- Nasr	Egzwan	Tulul	
M. cephalus	×	×	×	182
L. ramada	×	×	×	197
L. aurata	×	×	×	36
L. saliens	×	×	×	37
L. carinata	×	×	×	14
C. labrosus	-	×	×	16
Total				482

Table 5. The relative abundance index of Mullet Species in Bardawil lagoon

Species	El- Nasr	Egzwan	Tulul
M. cephalus	La	La	La
L. ramada	A	A	La
L. aurata	R	R	La
L. saliens	R	R	R
L. carinata	R	R	R
C.labrosus	-	R	R

R= Rare species less than 10%, La= Less abundance (10:40) %, A= Abundance species (40:70).

Table 6. Show Biological indexes of Mullet Species in Bardawil lagoon

Ecological indexes	$R^{2.\ Sal}$	$R^{2.\ DO}$
diversity index	0.36	0.15
Richness Index	0.83	0.61
Evenness Index	0.18	0.03
Dominance index	0.42	0.19

Table 7. Shows coefficient values between Ecological indexes and Environmental parameters (salinity and dissolved oxygen) for Mullet Species in Bardawil lagoon

Biological indexes	Stations		
	El- Nasr	Egzwan	Tulul
S	5	6	6
N	165	152	165
diversity index	1.10	1.34	1.50
Richness Index	0.78	1.00	0.98
Evenness Index	0.68	0.75	0.84
Dominance index	0.48	0.41	0.36

Where: ^{Sal} (mean of salinity) ^{DO} (mean of dissolved oxygen)

The coefficient values between Ecological indexes and Environmental parameters (salinity and dissolved oxygen) for mullet species showed that the diversity indexes may not be significantly related to the differences in environmental factors among the three stations while richness Index is related to and influenced by environmental factors and salinity is the main factor affecting the richness and abundance of species in the study areas (El-Nasr, Egzwan and Tulul). **Cardona (2000)** pointed out the salinity is a key factor for understanding the distribution of *Mugil cephalus*. There are other environmental factors that do not affect it as much as salinity.

There may be diversity in species, but it is not necessarily the presence of these species in different regions. Because some individuals of the same species may be able to withstand harsh environmental conditions and live in them, while most of them cannot.

Mullets in universal tolerate a huge range of salinity **(Thomsnon, 1966; Bardach *et al.*, 1972).** Although euryhaline, members of the family Mugilidae differ in their affinity to positive salinity ranges, which in turn have an impact on the habitat selection and, consequently, their distribution patterns. Influence of abiotic factors on the distribution of young mugilids has been described by several authors **(Perlmutter *et al.*, 1957; Lasserre and Gallis, 1975; Brusle, 1981; Cardona, 2000, 2006).** They pointed out that salinity is the key aspect that determines the distribution pattern of young mugilids *M. cephalus* and *L. ramada* prefer oligohaline and freshwater conditions, *C. labrosus* and *L. saliens* exhibit a choice for intermediate mixohaline conditions, while *L. aurata*, the least tolerant species, has an affinity for greater maritime conditions, both qualitative and quantitative, it is evident that their distribution follows the described pattern. **Cardona (2006)** supports that the hypothesis that juvenile bottlenecks with salinity are relevant to grey mullet population formation.

Conclusion

This study recommends reducing salinity in the western part of Bardawil lagoon in order to allow all species of the mullet family to spread throughout the lagoon. And completing an inventory study of the types and genera of fish and their abundance in Bardawil lagoon.

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الملخص العربي

تأثير العوامل البيئية على توزيع العائلة البورية بمنخفض البردويل شمال سيناء- جمهورية مصر العربية

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تم تجميع عدد 482 عينة من أنواع العائلة البورية من مصيد منخفض البردويل، شمال سيناء، مصر، من ثلاث محطات (النصر، اغزيوان، التلول) من ابريل 2019 الي يناير 2020. وكانت الطوبارة هي الأعلى من حيث الوفرة النسبية في بحيرة البردويل. ووجد في محطة النصر ان الطوبارة كانت من الانواع الوفيرة، والبوري الحر من الأنواع الأقل وفرة والدهبانة والجرانه والسهيلي من الأنواع النادرة، في حين ان الكالون لم يوجد هناك. وفي محطة اغزيوان كانت الطوبارة من الانواع الوفيرة، والبوري الحر من الأنواع الأقل وفرة والدهبانة والجرانه والسهيلي والكالون من الأنواع النادرة. وفي محطة التلول وجد ان الطوبارة والبوري الحر والدهبانة كانوا من الأنواع الأقل وفرة بينما الجرانة والسهيلي والكالون كانوا من الأنواع النادرة. وكان دليل التنوع للأنواع (1.10، 1.34، 1.50) في محطات النصر واغزيوان والتلول على التوالي، وبلغت قيمة دليل الغني (0.98،1،0.78) في محطات النصر واغزيوان والتلول على التوالي، وبلغت قيمة دليل التكافؤ (0.84،0.75،0.68) في محطات النصر واغزيوان والتلول على التوالي، وكانت محطة النصر هي الأعلى في قيمة السيادة.

الكلمات الاسترشادية: التوزيع، الوفرة النسبية، العائلة البورية، بحيرة البردويل، مصر.

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