Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 28(5): 1209 – 1222 (2024)
www.ejabf.journals.ekb.eg

The Length - Weight Relationship and Growth Parameters of the Halfbeak *Hemiramphus far* (family: Hemiramphidae) from Bardawil Lagoon, North Sinai, Egypt

Attia Ali Omar El- Aiatt[1*], Kariman Shalloof[1], Shymaa Attia Ali[2], Mohamed Attia[2]
[1]National Institute of Oceanography and Fisheries (NIOF), Egypt
[2]Lakes and Fish Resources Protection and Development Agency (LFRPDA)
[*]**Corresponding Author : attiamr@yahoo.com**

ARTICLE INFO
Article History:
Received: Aug. 17, 2024
Accepted: Sept. 25, 2024
Online: Sep. 29, 2024

Keywords:
Age and growth,
Exploitation rate,
Probability of capture,
Hemiramphus far,
Bardawil Lagoon

ABSTRACT

This study presents a comprehensive assessment of the black-barred halfbeak (*Hemiramphus far*) in Bardawil Lagoon, North Sinai, Egypt, focusing on key parameters such as length at first capture, growth metrics, mortality rates, and relative yield per recruit. Data were collected monthly from May to December 2022, comprising a total of 1,593 fish samples from commercial catches in the lagoon. The fish that were sampled ranged in length and weight from 17 to 36.7cm and 22 to 247.3g, respectively, with an average of 23.84cm and 85.67g. The formula for the length-weight relationship of the studied species was W = 0.0029 TL $^{3.2286}$. This study showed four age groups. The estimated von Bertalanffy growth parameters were L_∞ = 37.8cm and k = 0.48 year^{-1}. It was found that the growth performance index (Φ') was 2.84. An estimate of the length at first capture was 20.89cm. The length at first capture was determined to be 20.89cm. The mortality rates were calculated as follows: total mortality (Z) at 2.15, natural mortality (M) at 0.95, and fishing mortality (F) at 1.2 year^{-1}. The exploitation rate (E) was found to be 0.56, indicating overfishing and high fishing pressure on the population. The relative yield per recruit analysis (Y'/R) showed that the current exploitation level significantly exceeds the sustainable threshold ($E_{0.5}$=0.383). To sustainably manage this resource, the current exploitation rate needs to be reduced by 32%, decreasing from 0.56 to 0.383. The findings from this investigation are critical for the assessment and management of the *H. far* fishery in Bardawil Lagoon, ensuring the sustainability of this important fish species.

INTRODUCTION

The family Hemiramphidae has 61 identified species distributed in 16 genera; they are often referred to as "halfbeaks" **(Eschmeyer *et al.*, 2021)**. For the majority of these fish species, their most important morphological characteristic is a lower jaw that is significantly longer than the upper one (**Tiralongo *et al.*, 2022)**. These omnivorous fish consume fish, algae, and zooplankton **(Talwar, 1962)**. Larger species of Hemiramphidae are used as sources of food in many regions of the world, and their flesh is considered an excellent food source **(Salas *et al.*, 2011)**. It is an epipelagic, schooling fish that usually swims close to the sea surface in coastal waters. It feeds on zooplankton and floating matter, i.e. sea grasses, but also green algae and sometimes diatoms **(Golani *et al*., 2006)**. The Indo-West Pacific region, which includes East Africa, the Red Sea, New Caledonia, and northern Australia, is endemic to *H. far*. It moved via the Suez Canal to the eastern Mediterranean Sea **(Boughedir *et al*., 2015)**. Based on the IUCN Red List, it is classified as "Not Evaluated" **(CMS, 2015)**, meaning that it is not protected or subject to fisheries regulation. One of the earliest Lessepsian fish that appeared in the Mediterranean Sea was *H. far*. It was firstly recorded as *H. marginatus* and was originally discovered in Palestine **(Steinitz, 1927)** and after that, it dispersed throughout Egypt, Turkey, Syria, Greece, Croatia, and Libyan coasts **(Golani *et al*., 2013)**. It began to expand widely in the 1980s off the coasts of Albania **(Collette & Parin, 1986)**, Libya **(Shakman & Kinzelbach, 2006)**, Algeria's eastern coast **(Kara *et al*., 2012)**, and Lebanon **(Rafrafi-Nouira *et al*., 2012)**. If appropriate fisheries management isn't carried out, an intensive halfbeak catch operation may cause the fish population to decrease. Information on several aspects of fishery biology must be provided for the management of fisheries resources to be effective. Quantitative information on fish species, such as the relationship between fish sizes and weights and condition factors, is essential for fish population management **(Narzary & Khangembam, 2022)**.

Research conducted on *Hemiramphus far* is very limited in Egypt in general and rare in Lake Bardawil Lagoon in particular. However, its production accounted for about 40 metric tons of the total catch of Bardawil Lagoon during 2021 fishing season **(Bardawil Lagoon administration, 2022)**. Therefore, the goal of the current study was to provide information on growth parameters for this species in Bardawil Lagoon that include length at first capture, mortality, and exploitation rate. The data obtained during these investigations supports the proper management of this species in the area under investigation.

MATERIALS AND METHODS

1. Study area and data collection

Bardawil Lagoon is a shallow, salty lagoon bordered by the Mediterranean Sea that is located on the North Sinai Peninsula. From May to December 2022, 1593 samples of the black-barred *Hemiramphus far* were monthly collected by El- Bouss (Veranda) method from the Bardawil Lagoon's commercial catch.

2. Data analysis

The length-weight relationship of *H. far* was predicted using the power equation of the logarithmic modification equation, $W= a\ L^b$ (**Ricker, 1975)**, where W is the total weight (g), and L is the total length (cm), a and b are constants. The age determination of *Hemiramphus far* in Bardawil Lagoon was conducted using length frequency data analyzed through ELEFAN I, a method established by **Pauly and David (1981)**. This approach employs the standard statistical technique of **Bhattacharya (1967)** to classify length frequency data into distinct age groups. The analysis was facilitated using FiSAT II software, a comprehensive toolkit developed by **Gayanilo *et al.* (1997)** for fish stock assessment. FiSAT II enables the conversion of length frequency data into meaningful biological insights, allowing for a detailed understanding of the age structure of fish populations. **Gayanilo *et al.* (2003)** provided guidelines for utilizing this software, ensuring accurate data interpretation for effective fisheries management and research. This methodology plays a critical role in evaluating the growth and mortality parameters essential for sustainable management of the fishery in Bardawil Lagoon.

The growth parameters of *Hemiramphus far* were evaluated using the von Bertalanffy growth equation, formulated as: $L_t = L_\infty [1–e^{- K (t- t_0)}]$ where L_t is the length at time t, t_0 is the hypothetical time at which length equals zero, K is the growth coefficient, and L_∞ is the asymptotic length, which were calculated by ELEFAN I **(Pauly & David, 1981)**. To compare the growth parameters of the studied species across different regions, the growth performance index (Φ), as introduced by **Pauly and Munro (1984)**, was employed. This index is defined by the equation: This index (Φ) = Log K + 2*Log L_∞, where K is the growth coefficient, and L_∞ is the asymptotic length. The probability at first capture Lc_{50} is estimated from the ascending left side of the length converted catch curve included in the FiSAT II tool **(Pauly, 1984)**. The length-converted catch curve was used for estimating total mortality **(Pauly, 1984)**. **Pauly**'s **(1984)** empirical equation was used to estimate natural mortality (M) using the growth parameters (L_∞ and K) and the water temperature (T) [T= 23.5 according to **Bardawil Lagoon administration (2022)**]: Ln M = - 0.0152 - 0.279 Ln L_∞ + 0.6543 Ln K + 0.463 Ln T. The formula for calculating fishing mortality (F) was F= Z–M. **Cushing (1968)** provided the formula for calculating the rate of exploitation (E): E= F/Z. The knife-edge selection model **(Beverton & Holt, 1966)** served as the basis for the estimation of the relative yield and relative biomass-per-recruit.

RESULTS AND DISCUSSION

1. The Length frequency distribution

1593 samples of the black-barred *Hemiramphus far* (Fig. 1) from Bardawil Lagoon, with lengths ranging from 17 to 36.7cm and weights ranging from 22.2 to 247.3g were collected for the purpose of this study. The dominant length was from 21.0 to 25.0cm (Fig. 2). These length groups account for about 67.5% of the total catch from the black-barred *H. far* in Bardawil Lagoon. The data obtained by **Rafrafi-Nouira *et al*. (2012)** in Tunisia for the same species under study showed that these results were nearly identical, having lengths ranging from 17.5 to 36.5cm and weights between 16 and 143.2g.

However our results are higher than those found on Egypt's Mediterranean coast, where the weights ranged from 24 to 160g and the lengths from 15 to 31cm **(Mehanna & Farouk, 2021)**. The lengths of *H. far* were 16 to 30cm, and the weight was between 25 and 153g in Bardawil Lagoon **(Mahmoud, 2019)**. In addition, *Hyporhamphus picarti* (Family: Hemiramphidae) in Lake Manzala, Egypt, has a length range of 12–15cm only **(Shalloof *et al.*, 2023)**. Male and female total lengths of *H. far* in Karachi, Pakistan, ranged from 17.6–21.4cm and 17.6–21.6cm, respectively **(Yousuf & Khurshid, 2008)**. In Libyan coastal waters, *H. far* measured 17.9–24.5cm in length and 33.5-70.7g in weight **(Shakman & Kinzelbach, 2006)**. These variations could result from the method utilized for collecting the samples and other factors.

Fig. 1. Image of the black-barred *H. far* from Bardawil Lagoon

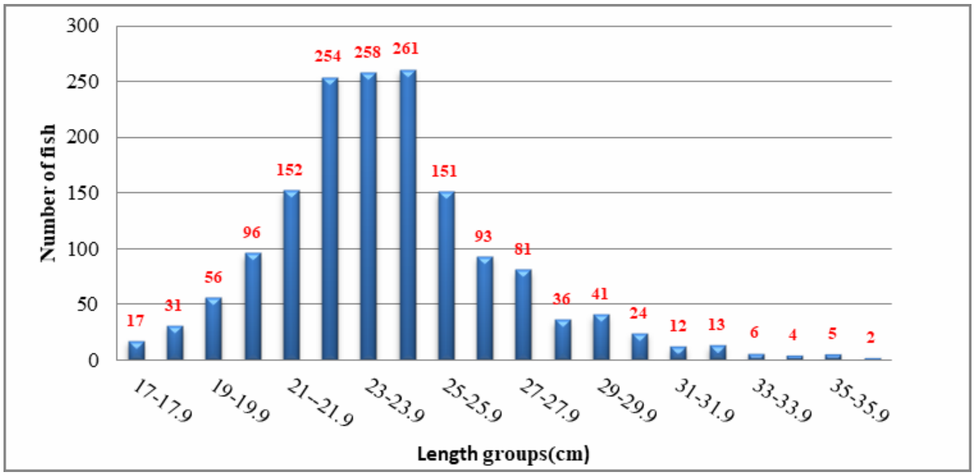

Fig. 2. Length frequency distribution of *H. far* in Bardawil Lagoon during the period of study

2. The length weight relationship

The length-weight relationship of the black-barred *H. far* in Bardawil Lagoon during fishing season 2022 was found to be W = 0.0029 L $^{3.2286}$, where "L" indicates the total length in cm and "W" stands for the weight in g (Fig. 3). The value of “b” showed a tendency toward a positive allometric growth.

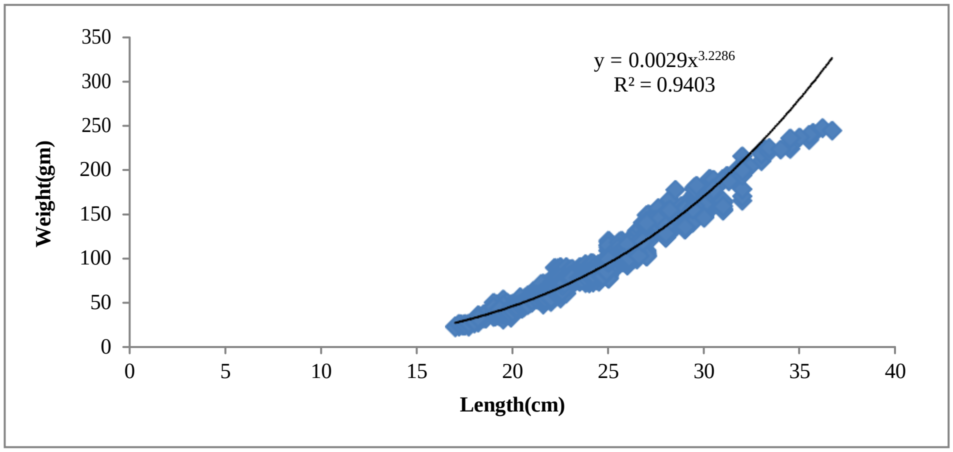

Fig. 3. Length-weight relationship *H. far* during fishing season 2022 in Bardawil Lagoon

An organism grows when its length, weight, or both vary as it gets older **(Yousuf & Khurshid, 2008)**. Among the most important tools in fisheries science and management are the length-weight relationship and condition factor **(Furuichi *et al*., 2021)**. Fish condition is an aspect of this relationship, which is impacted by life history, sex, nutritional status, season, and locality **(Jennings *et al*., 2001; Froese, 2006)**. Fish may change in shape throughout growing with size (positive or negative allometric growth, $b > 3$ or $b < 3$ respectively) or isometric growth, $b = 3$, even after they have reached adult body shape during their ontogenetic development. In the present study, *b*-values showed positive allometric growth ($b = 3.2286$). The parameters of the length-weight relationship can be applied in fisheries management or conservation research to determine fish conditions, evaluate temporal or regional variability in fish growth, and convert lengths to weights **(Froese *et al*., 2011)**. The length-weight relationship of the black-barred *Hemiramphus far* in different countries is given in Table (1).

Table 1. The length-weight relationship of *Hemiramphus far* in different areas of the world

Area	Sex	a	b	Author/s
Bardawil Lagoon	Combined	0.0029	3.2286	**Present study**
Bardawil Lagoon	Combined	0.0007	3.42	**Fetouh and El-Far , 2023**
Bardawil Lagoon	Combined	0.0042	3.105	**El-Aiatt *et al*., 2019**
Youtefa Bay, Indonesia	Combined	0.0062	2.6919	**Baigo Hamuna *et al*., 2023**
Mediterranean sea, Egypt	Combined	0.0044	3.08	**Mehanna *et al* ., 2021**
Bardawil Lagoon	Males	0.003	3.2138	**Mehanna *et al*., 2019**
Bardawil Lagoon	Females	0.007	2.9432	**Mehanna *et al*. , 2019**
Bardawil Lagoon	Combined	0.0046	3.0799	**Mehanna *et al*., 2019**
Palawan, Philippines	Combined	0.018	2.69	**Palla *et al*., 2018**
South coast, Kenya	Males	0.00004	3.0	**Ontomwa *et al*., 2018**
South coast, Kenya	Females	0.00009	2.7	**Ontomwa *et al*. , 2018**
Karachi coast	Males	0.257	3.06	**Yousuf and Khurshid , 2008**
Karachi coast	Females	0.2264	3.207	**Yousuf and Khurshid , 2008**
Caledonian Lagoon	Combined	0.3298	1.831	**Kulbicki *et al* ., 2005**
South African	Combined	0.000133	3.576	**Harrison, 2001**
Philippines	Combined	0.017	3.00	**Pauly *et al*., 1998**

Pauly and Gayanilo (1997) stated that b values can be anywhere between 2.50 and 3.50. Variations in fish exponent "b" values in different locations can be attributed to a variety of environmental factors and locations **(Andreu-Soler *et al.*, 2006)**. Some of the factors that impact the parameters are the season, habitat, gonad maturity, sex, food, fullness of the stomach, health, and preservation technologies **(Hossain *et al.*, 2006)**.

3. Growth parameters

In the current study, the application of the **Bhattacharya (1967)** method revealed the presence of four distinct age groups for *Hemiramphus far*, as illustrated in Table (2) and Fig. (4). The mean lengths at the end of each year of life were 22.86, 28.34, 32.21, and 34.79cm, constituting 85.6, 10.5, 2.5, and 1.4% for age groups I^+, II^+, III^+ and IV^+, respectively. The previous age groups had an average weight of 70.8, 141.8, 214.3, and 274.9g, respectively (Figs. 5, 6).

Table 2. Decomposition of composite distributions using Bhattacharya's method

Age group	Computed mean	S.D.	Population	S.I.
I^+	22.86	1.990	1364	n.a.
II^+	28.34	1.510	168	3.130
III^+	32.21	0.670	39	3.550
IV^+	34.79	0.880	22	3.330

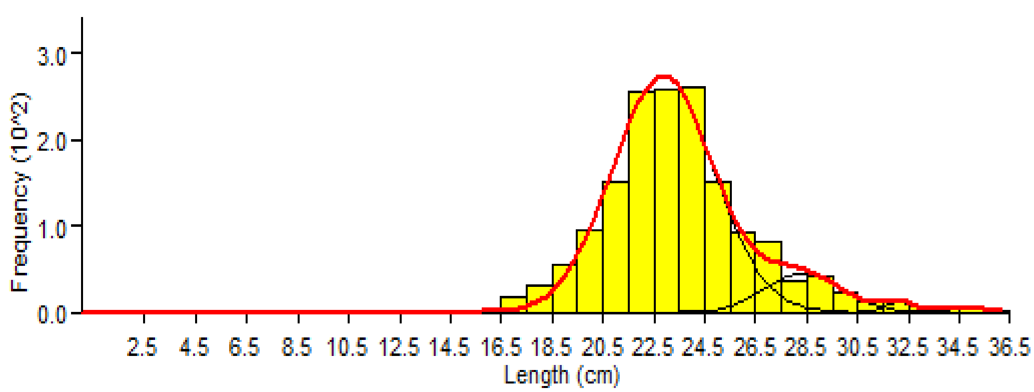

Fig. 4. Length frequencies of *H. far* by using Bhattacharya's method

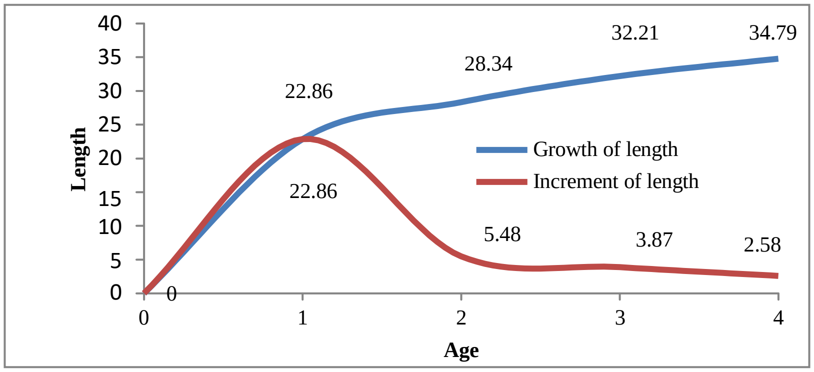

Fig. 5. The length at the end of the year of life and the increment of length of the black-barred *H. far* during fishing season 2022

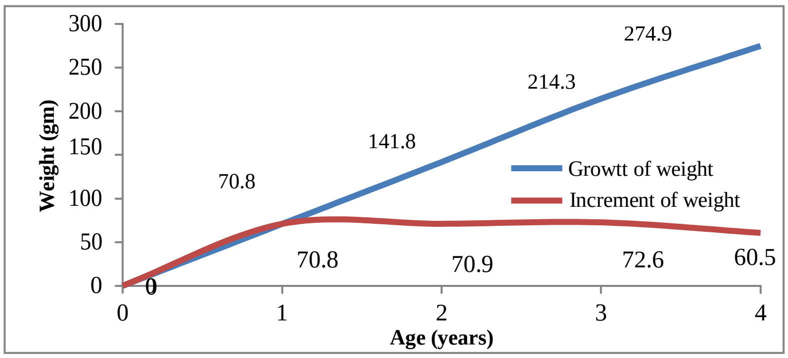

Fig. 6. The weight at the end of the year of life and the increment of weight of the black-barred *H. far* during fishing season 2022

The lengths at the end of each year of life in the current study were 22.86, 28.34, 32.21, and 34.79cm from the first to the fourth year, respectively. These lengths are longer than those obtained by **Mehanna *et al.* (2019)** for the same species, where the average lengths at the end of each year of life were 19.08, 23.65, 26.89, and 29.19cm from the first to the fourth year, respectively. This increase in size may be due to environmental changes that have recently occurred in the area of the study due to developments that have occurred in Bardawil Lagoon, such as the work of radial canals that have led to a reduction in the level of salinity in the lake. Reduction in the level of salinity may lead to an abundance of certain types of algae and zooplankton, which are the main components of nutrition for these types of fish, which leads to an increase in their growth rates.

Based on the present study, the black-barred *H. far* had its largest annual growth in its first year of life, followed by an obvious decrease in its second year and a minimum value in its fourth year of life, with an increment of 22.86, 5.43, 3.87, and 2.58cm for age groups I^+, II^+, III^+ and IV^+, respectively (Fig. 5).These results agree with those of **Mehanna *et al.* (2019)** regarding the same species of fish.

This study's growth parameters were: K = 0.48 year^{-1}, L_∞ = 37.8 cm, W_∞ = 156.82 g and age at zero size (t_o) = -1.2916 years. 2.8362 is the value of the growth performance index. Table (3) summarizes the growth parameters of *H. far* in Bardawil Lagoon. Estimations of the growth parameter (K) by using the ELEFAN I program are shown in Fig. (7).

Table 3. Growth parameters of *H. far* in Bardawil Lagoon during 2022

Av. L	Av. W	L_C	L_∞	K	φ	Z	M	F	E
23.8	85.7	20.89	37.8	0.48	2.84	2.15	0.95	1.2	0.56

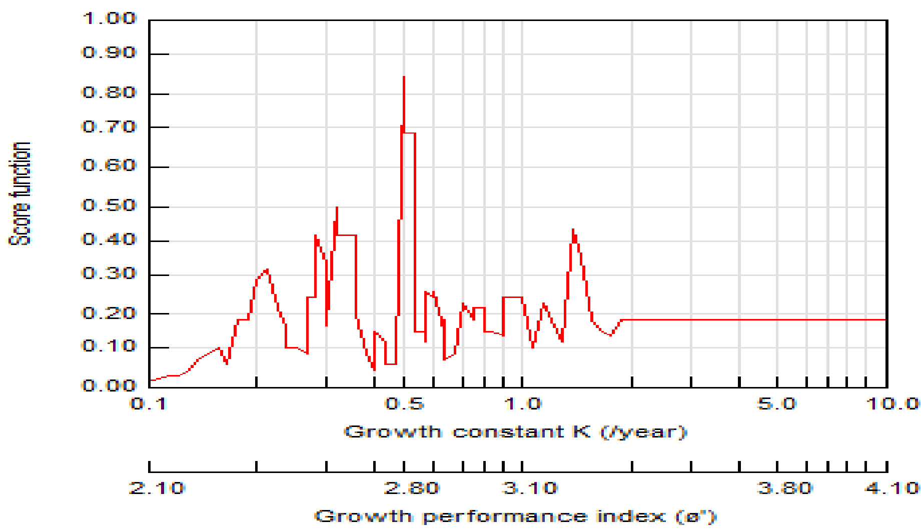

Fig. 7. Estimating of the growth parameter (K) by using ELEFAN I program of *H. far* during 2022

These results are greater than those recorded by **Mehanna *et al*. (2019)** (L_∞ = 34.8cm and K = 0.34). This may be due to the somewhat lower salinity in Bardawil Lagoon after the construction of radial channels in the lake and the increase in the rate of water flow to distant places inside the lake. Before the construction of the radial channels, the salinity in Bardawil Lagoon ranged from 38 to 65‰, and after the construction of the radial channels, the salinity ranged from 38 to 53‰ **(Bardawil Lagoon administration, 2022)**. The growth performance indexes (ɸ) of the black-barred *Hemiramphus far* in Bardawil Lagoon during 2022 was 2.84. This result is greater than that recorded by **Mehanna *et al*. (2019**), where it was 2.53. This increase may be due to the reasons mentioned above, since large sizes of these fish were observed. They differ from what was during the implementation of the **Mehanna′s (2019)** research (the data of which was collected in 2016), as traces of radial channels did not appear in Bardawil Lagoon at that time. In addition, low salinity may lead to an abundance of certain types of algae and zooplankton, which are the main components of nutrition for the studied species, which may lead to an increase in their growth rates.

Length at first capture

Based on the catch cumulated curve, *H. far's* length at first capture (L_c) was 20.89cm. Using the FiSAT II program, the probability of capture of *H. far* in Bardawil Lagoon at levels of 25, 50, and 75% were 20.06, 20.89, and 21.81cm, respectively (Fig. 8).

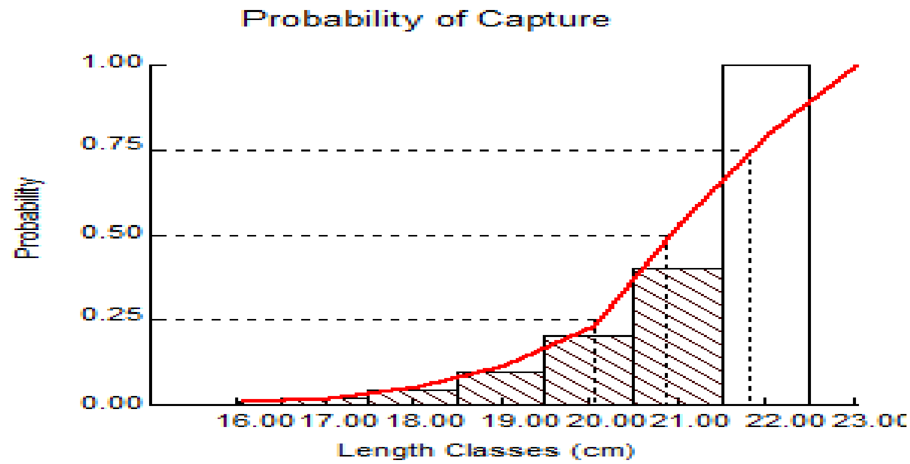

Fig. 8. Probability of capture of *H. far* during fishing season 2022

According to **El-Aiatt *et al*. (2019)** and **Mahmoud (2019)**, the combined sexes of *H. far* had L_c values of 22.6 and 20.8cm in Bardawil Lagoon, respectively.

Mortality and exploitation rate

The length-converted catch curve (Fig. 9) was used to determine the total mortality (Z) based on age at 2.15 year^{-1}. The natural mortality (M) was estimated to be 0.95 using the growth parameters (L_∞ and K) and the average water temperature (T = 23.5°C). The results showed that the exploitation ratio (E) was 0.56 and the fishing mortality (F) was 1.20 year $^{-1}$. Total mortality is the total amount of individuals lost from a population during a given period of time due to death (both natural and fishing-related). The current study showed yearly rates of 2.15, 0.95, and 1.2 year^{-1} for total, natural, and fishing mortality, respectively. These findings surpass those of **Mehanna *et al.* (2019)** for the same species and area, where the findings for total, natural, and fishing mortality were 1.89, 0.64, and 1.25, respectively. The variation might result from the sample size, sampling period, and calculating method.

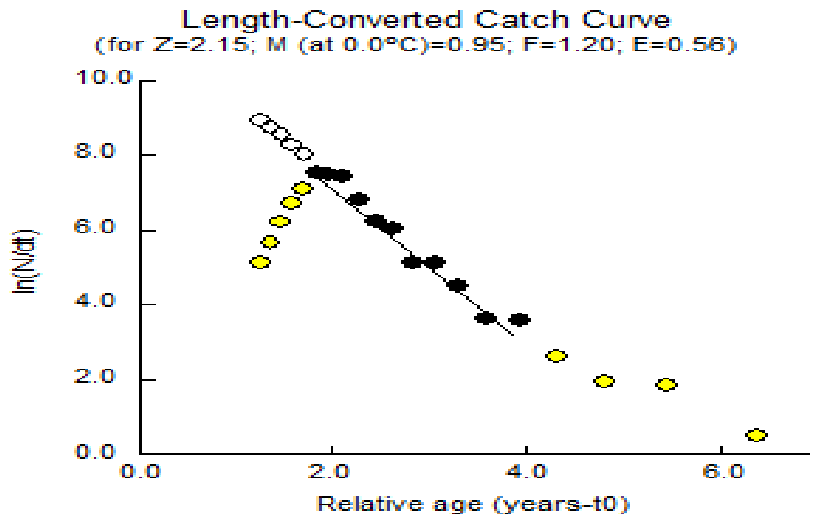

Fig. 9. The length-converted catch curve of *H. far* during fishing season 2022

4. Relative yield per recruit

In Fig. (10), the maximum yield per recruit (E_{max}) (the maximum level of exploitation that generates the maximum sustainable yield) was 0.889. The level of exploitation at which 50% of the fish's biomass would be maintained ($E_{0.5}$) was 0.383, and the amount of exploitation at an economical yield ($E_{0.1}$) was 0.769.

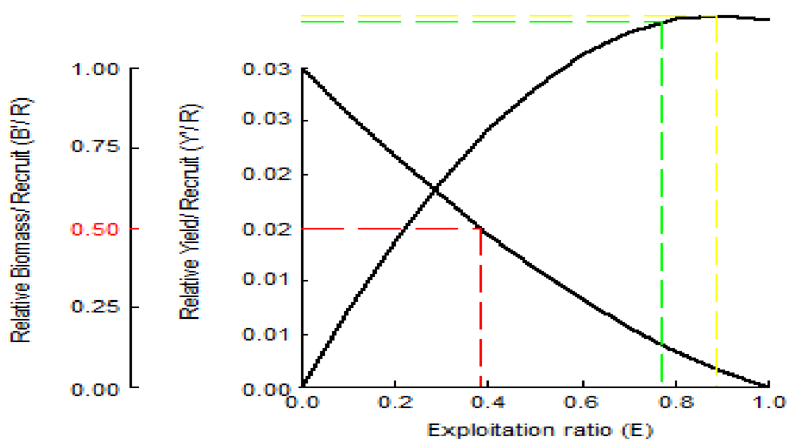

Fig. 10. The relative yield and biomass per recruit of *H. far* during the period of study

According to **Gulland (1971)**, a fish resource is often optimally exploited at a fishing mortality level that produces E = 0.5, meaning that optimal fishing mortality is equal to natural mortality (F = M). During the fishing season of 2022, the exploitation rate (E) for *H. far* was greater than 0.5 (E = 0.56). In the present study, the level of exploitation at which 50% of the fish's biomass would be maintained ($E_{0.5}$) was 0.383. Therefore, to safeguard the black-barred *H. far* fish stock in Bardawil Lagoon, we must reduce the exploitation rate from 0.56 to 0.383, which is equivalent to 32% of the current rate.

CONCLUSION

The length-weight relationship of *H. far* in Bardawil Lagoon indicates an allometric growth as the value of b = 3.2286. Four age groups were recorded in the current study. The length at first capture (L_c) was estimated to be 20.89cm. Total (Z), natural (M), and fishing mortality (F) were 2.15, 0.95, and 1.2 year^{-1}, respectively. The exploitation rate (E) was 0.56 indicating that the stock of *H. far* in Bardawil lagoon suffered from overfishing. In order to manage this resource sustainably, the current rate of exploitation needs to be lowered by 32% of its present value.

REFERENCES

Andreu-Soler, A.; Oliva-Paterna, F. J. and Torralva, M. (2006). A review of length – weight relationships of fish from the Segura River basin (SE Iberian Peninsula). J. Appl. Ichthyol., 22: 295–296.

Baigo H.; Ervina, I. and Lalu Panji , I. A. (2023). Length-weight relationship and condition factors of eight fish species caught by traditional papuan fishers in Youtefa Bay, Indonesia. European Journal of Ecology, 9.2, 2023, pp. 9-16.

Bardawil Lagoon administration (2022). Lakes and Fish Resources Protection and Development Agency (LFRPDA). Fisheries Statistics Yearbook.

Beverton, R. J. H. and Holt, S. J. (1966). Manual of methods for fish stock assessment. Part II. Tables of yield function. FAO Fish. Biol. Tech. Pap., (38) 10 + 67 pp. (ver. 1).

Bhattacharya, C. G. (1967): A simple method of resolution of a distribution into Gaussian components. Biometrics, 23: 115-135.

Boughedir, W.; Rifi, M. and Shakman, E. (2015). Tracking the invasion of *Hemiramphus far* and *Saurida lessepsianus* along the southern Mediterranean coasts: A Local Ecological Knowledge study. Mediterranean Marine Science, 16(3): 628-635.

Convention on the Conservation of Migratory Species of Wild Animals (CMS) (2015). Appendices I and II of the Convention on the Conservation of MigratorySpecies of Wild Animals (CMS). Fromhttp://www.cms.int/en/species [Accessed 12/10/2017].

Collette, B. B. and Parin, N.V. (1986). Hemiramphidae. In: "Fishes of the North-eastern Atlantic and the Mediterranean" (P.J.P. Whitehead, M.L. Bauchot, J.C. Hureau, J. Nielsen & E. Tortonese eds), Vol. II, pp. 620-622, Paris, France, UNESCO. 1473 pp.

Cushing, D.H. (1968). Fisheries biology. A Study in Population Dynamics. The Univ. Wisconsin Press. Madison, 200 p.

El-Aiatt, A. A. O.; Shalloof, K. A. Sh. and Saber, M.M. (2019): Bio-economic studies on the catch of Bardawil lagoon, North Sinai, Egypt. Egyp. J. Aquat. Res.45 (1): 59- 65.

Eschmeyer, W.N.; Fricke, R. and Van Der Laan, R. (eds) (2021). Catalog of fishes: genera,species,references.http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp (accessed 25 May 2021)

Fetouh, M. and El-Far, A. (2023). Length-Weight Relationships and Condition Factors of Bony Fishes Inhabiting the Southern East Mediterranean Sea, Bardawil Lagoon, Egypt. Egyptian Journal of Aquatic Biology & Fisheries. Vol. 27(5): 837 – 855 (2023).

Froese, R. (2006). Cube law, condition factor and weight-length relationships: history, meta- analysis and recommendations. Journal of Applied Ichthyology, 22(4): 241-253. https://doi.org/10.1111/j.1439-0426.2006.00805.x.

Froese, R.; Tsikliiiras, A.C. and Stergiou, K. I. (2011). Editorial note on weight–length relations of fishes. Acta Ichthyol. Piscat. 41 (4): 261263.

Gayanilo, F.C. Jr.; Sparre, P. and Pauly, D. (2003). FAO-ICLARM Stock Assessment Tools (FiSAT) user's Guide. FAO Computerised Information Series (Fisheries). No. 8. Rome, FAO, 266p.

Gayanilo, F. C.; Sparre, P. and Pauly, D. (1997). The FAO-ICLARM Stock Assessment Tools (FiSAT) User's Guide. FAO Computerized Information Series (Fisheries).

Golani, D.; Öztürk, B. and Başusta, N. (2006). The Fishes of the Eastern Mediterranean. Turkish Marine Research Foundation, İstanbul, 259 pp.

Golani, D.; Massutí, E.; Orsi-relini, L.; Quignard, J.P.; Dulcic, J. and Azzurro, E. (2013). CIESM Atlas of Exotic Fish Species. Available at: http:// www.ciesm.org/atlas/appendix1.html. Last accessed December 5, 2014.

Gulland, J. A. (1971). The fish resources of the Oceans. Fishing News Books Ltd., England. 255p

Hossain, M. Y.; Ahmed, Z. F.; Leunda, P. M.; Roksanul, A. K.; Jasmine, S.; Oscoz, J.; Miranda, R. and Ohtomi, J. (2006). Length-weight and length-length relationships of some small indigenous fish species from the Mathabhanga River, southwestern Bangladesh. J. Appl. Ichth., 22: 301-303.

Harrison, T.D. (2001). Length- weight relationships of fishes from South African estuaries. J. Appl. Ichthyol. 17(1): 46-48.

IUCN. (2021). The IUCN Red List of Threatened Species. -Version 2021-3.

Jennings, S.; Kaiser, M.J. and Reynolds, J.D. (2001). Marine Fisheries Ecology. Blackwell Science, Oxford. 432pp.

Kara, M. H.; Rouag, F. and Laouira, L. (2012). Westward range expansion of the lessepsian spotted halfbeak *Hemiramphus far* (Hemiramphidae) in the Mediterranean Sea. Marine Biodiversity Records 5(45): 1-4.

Kulbicki, M.; Guillemot , N. and Amand, M. (2005). A general approach to length-weight relationships for New Caledonian Lagoon fishes. Cybium 29(3):235-252.

Kumar, A.; Jakhar, J.K. and Vardia, H. K. (2017). Length-weight relationship and relative condition factor of *Clarius batrachus* (Linnaeus, 1758) from Gaurmati Fish Farm, Kawardha, Chhattisgarh, India. Intl J Curr Microbial Appl Sci 6 (12): 1425-1431. DOI: 10.20546/ijcmas.2017.612.160.

Le Cren , E. D. (1951). The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). J. Anim. Ecol., 20 (2): 201 – 219.

Mahmoud, H. S. (2019). Biological and Dynamical studies on the black - barred halfbeak *Hemiramphus far* (family: Hemiramphidae) in Bardawil Lagoon. (MSc Thesis) Fac. Env. Agric. Sci. Arish Univ. EL-Arish. North Sinai.

Mehanna, S. F. and Farouk , A. E. (2021). Length - weight relationship of 60 fish species from the Eastern Mediterranean Sea, Egypt (GFCM-GSA 26). Front. Mar. Sci. 2021.

Mehanna, S. F.; Salem, M. and Mahmoud, H. S. (2019). Some biological aspects and reproductive dynamic of the black-barred halfbeak *Hemiramphus far* (family: Hemiramphidae) in Bardawil Lagoon, Egypt. Egyptian Journal of Aquatic Biology and Fisheries 23(3):127-137.

Narzary, B. and Khangembam, B. K. (2022). A study on the length-weight relationship and condition factor of five small indigenous fish species of Sarreswar Beel in lower Assam, Northeast India. Iran. J Ichthyol 9(4):204-212. doi: 10.22034/iji.v9i4.929.

Ontomwa, M. B.; Okemwa, G. M.; Kimani, E. N. and Obota, C. (2018). Seasonal variation in the length-weight relationship and condition factor of thirty fish species from the Shimoni artisanal fishery, Kenya. Western Indian Ocean Journal of Marine Science, 17(1):103-110.

Palla, H.P.; Pagliawan , H.B.; Rodriguez, E.F. ; Cacho , B.S.M.G.T.; Gonzales, B.J. ;Bonnell, C. and Fowler ,T. (2018). Length-weight relationship of marine fishes from Palawan, Philippines. The Palawan Scientist 10:17-28.

Pauly, D. (1980). A selection of simple method for the assessment of tropical fish stocks. FAO, Fish. Circ., (729): 54.

Pauly, D. (1984). Fish population dynamics in tropical waters: a manual for use with programmable calculators. ICLARM Stud. Rev., (8):325p.

Pauly, D.; Froese, R. and Albert, J. S. (1998). The BRAINS table. p. 195-198. In R. Froese and D. Pauly (eds.) FishBase 98: concepts, design and data sources. ICLARM, Manila, Philippines. 298 p.

Pauly, D. and Munro, J.L. (1984). Once more on growth comparison in fish and invertebrates. ICLARM Fishbyte 2: 1-21.

Pauly, D. and Gayanilo, Jr. F. (1997). A Bee: An alternative approach to estimating the parameters of a length-weight relationship from length frequency samples and their bulk weights. NAGA ICLARM, Manila, Philippines.

Rafrafi-Nouira, S. ; Boumaïza, M. ; Reynaud, C. and Capapé, C. (2012). Additional records of Lessepsian teleost species off the Tunisian coast (central Mediterranean). Annales Series Historia Naturalis, 22(1): 55-62.

Ricker, W. E. (1975). Computation and interpretation of biological statistics for fish populations. Bull. Fish. Res. Board Can., 191: 382.

Salas, S.; Chuenpadgee, R.; Charles, A. and Seijo, J.C. (2011). Coastal fisheries of Latin America and the Caribbean. FAO Fisheries and Aquaculture Technical Paper 554, FAO, Rome, 430 pp

Shakman, E.A. and Kinzelbach, R. (2006). Halfbeak fish *Hemiramphus far* (Forsskål, 1775) in coastal waters of Libya. Zoology in the Middle East 39: 111–112.

Shalloof, K. ; El- Ganiny, A.; El-Far, A.; Fetouh, M. ; Aly, W. and Amin, A. (2023). Catch composition and species diversity during dredging operations of Mediterranean coastal lagoon, Lake Manzala, Egypt. The Egyptian Journal of Aquatic Research, 49 (2023) 347–352.

Sparre, P. and Venema, S. C. (1998). Introduction to tropical fish stock assessment. Part I, FAO Fish. Tech. pap. 306/1 Rev. 1.

Sparre, P. ; Ursin, E. and Venema, S. C. (1989). Introduction to tropical fish stock assessment. Part 1. Manuel. FAO Fisheries Technical Paper. No. 306.1. FAO, Rome. 337 pp.

Steinitz, W. (1927). Beiträge zur Kenntnis der Küstenfauna Palästinas. Pubbl. Staz. Zool. Napoli 8: 311-353.

Talwar, P. K. (1962). Studies on the food and feeding relationships of the halfbeak fishes (Hemirhamphidae) from the Gulf of Mannar and Palk Bay. *Indian Journal of Fisheries* 9A: 1–9

Tiralongo, F. ; Tibullo, D.; Monaco, C.; Peri, I.; Vella, A.; Vella, N.; Messina, G. and Lombardo, B.M. (2022). From the Strait of Sicily to the Sicilian Ionian Sea: the expansion of *Hemiramphus far* (Forsskål, 1775) in Italian waters. *BioInvasions Records* 11(2): 524–529, https://doi.org/10. 3391/bir.2022.11.2.24

Yousuf, F. and Khurshid, S. (2008). Length-weight relationship and relative conditions factor for the halfbeak *Hemiramphus far* Forsskål, 1775, from the Karachi coast. *University Journal of Zoology*, Rajshahi University, 27, 103-104.