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A Catch of Two Species of Shrimp *Metapenaeus affinis* and *Penaeus semisculcatus* in Iraqi Marine Waters Northwest of the Arabian Gulf

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ABSTRACT

This study was conducted on two shrimp species, *Metapenaeus affinis* and *Penaeus semisulcatus*, in Iraqi marine waters during 2018, 2019, and 2020. The total catch of the two species was 4,541kg, with catches of 40.89kg, 37.59kg, and 21.52kg in 2018, 2019, and 2020, respectively. The highest catches occurred in June, July, August, September, and October, with amounts of 480kg, 580kg, 542kg, 487kg, and 590kg, respectively. The average catch per unit of effort per month for *M. affinis* was 11.88kg/ h, 9.88kg/ h, and 12.83kg/ h for the years 2018, 2019, and 2020, respectively. For *P. semisulcatus*, the average catch per unit of monthly effort was 5.17, 5.93, and 4.49 for 2018, 2019, and 2020, respectively. Four environmental factors were measured: water temperature, dissolved oxygen concentration, salinity, and pH. Canonical principal component analysis (PCA) of the two shrimp species in relation to environmental factors revealed a strong correlation between both species and salinity, followed by a weaker correlation with temperature and oxygen concentration. The abundance of both species was highest in October, followed by September and November. The aim of this study was to assess the catches of the two shrimp species in Iraqi marine waters, located in the northwest Arabian Gulf, and to examine the effects of certain environmental factors on their distribution.

INTRODUCTION

Shrimp is considered one of the most commercially important crustaceans globally, ranking among the top aquatic invertebrates in terms of investment. It is a valuable marine product in global markets, known for being a rich source of low-calorie protein and essential minerals such as phosphorus, iron, copper, magnesium, and zinc. Additionally, its nutritional and health value is enhanced by the presence of selenium, as well as vitamins B12, B6, A, D, and omega-3 fatty acids **(Dayal *et al.*, 2013)**.

Nearly 300 shrimp species are of economic interest worldwide, with approximately 100 species accounting for the majority of the annual global catch. Six species groups contribute to 83 percent of the global shrimp harvest. The most significant species by weight is the akiami paste shrimp, *Acetes japonicus* **(FAO, 2008)**.

There are three species of shrimp in Iraqi marine waters: *Penaeus semisulcatus, Metapenaeus affinis,* and *Parapenaopsis stylifers* **(Ali *et al*., 2007; Ali & Ahmed 2015)**. The first two species constitute the largest and most important part of commercial shrimp fishing in the Northwestern Arabian Gulf region. The first species prevails as we go south, and the second species prevails as we head north towards Iraqi internal waters. The species *M. affini* extends as it spreads to the inland waters of the Shatt al-Arab and the marshes **(Al-Maliky, 2013)**. Many studies have been conducted on various species of shrimp in Iraq. These include the study of **Ali *et al.* (2000)**, who examined the catch per unit effort for Iraqi marine fisheries, including shrimp catches. **Ali and Ahmed (2015)** conducted a socioeconomic study on the wealth of marine shrimp in Iraq's territorial sea. **Ali (2015)** focused on the investment in shrimp resources in Iraq's waters. Abbas and **Ghazi (2021)** investigated the commercial shrimp landings of two penaeid species in the main markets of Basrah Province, Iraq. **Al-Maliky (2022)** studied the shrimp fishing quantities offered in some Basrah markets and examined the economic feasibility of establishing a farm to raise commercial shrimp in southern Iraq. Lastly, **Mohamed and Abood (2023)** described the total landings and general trends of species caught in Iraqi artisanal marine fisheries during 2020 and 2021, including shrimp.

The present study aimed to know the catches of two species of shrimp *M. affinis* and *P. semisculcatus* in Iraqi marine waters Northwest of the Arabian Gulf and study the effect of some environmental factors (water temperature, salinity, and Hydrogen ion concentration and dissolved oxygen) on the catch of these two species.

MATERIALS AND METHODS

1. Shrimp collection

The fishing survey boat, Anwar 2, is 16 meters long, 4.5 meters broad, and has a 2-meter draft, with a 150-horsepower engine. It was used for fishing in Iraqi marine waters. Each boat was equipped with a trawl net with a mesh size of 5x5 cm and a bag mesh of 3x3 cm, along with a net pull line between 75 and 100 meters in length. From January 2018 to December 2020, two shrimp species were collected from Iraqi marine waters, with the net being hauled for three hours at a time. The specified coordinates for the fishing location are (29° 43'33.41"N; 48° 43'43.46"E) (Fig. 1). The specimens were stored at the Department of Marine Vertebrates at Iraq's Marine Science Centre. Total weights were calculated based on the year of collection, with the two species of shrimp classified separately by collecting each species during the months of the respective years (2018, 2019, and 2020). The collection was done during a seven-day sea voyage, with the net lowered into the sea for three hours, three times a day. The classification of the shrimp followed the method described by **Al-Maliky (2013)**.

2. Ecological factors

Physical properties were recorded as follows: water temperature was measured using a mercury thermometer with a scale range of 0–50°C. pH levels were determined using a tri-meter field apparatus from Kalbuneh Company. Salinity concentrations were measured using a salinity meter manufactured by Senso-Direct 150, a German Lovibone company, with results expressed in parts per thousand (ppt). Dissolved oxygen was measured using the Winkler method, as described by the American Public Health Association **(APHA, 1999)**, with results expressed in milligrams per liter (mg/l).

3. Canonical analysis

Practical canonical analysis was used to determine the association of environmental factors with two shrimp species during the year of collection.

4. Statistical analysis

The revised least significant difference (LSD) test was used at a significance level of 0.05 to assess the correlation coefficient between environmental factors.

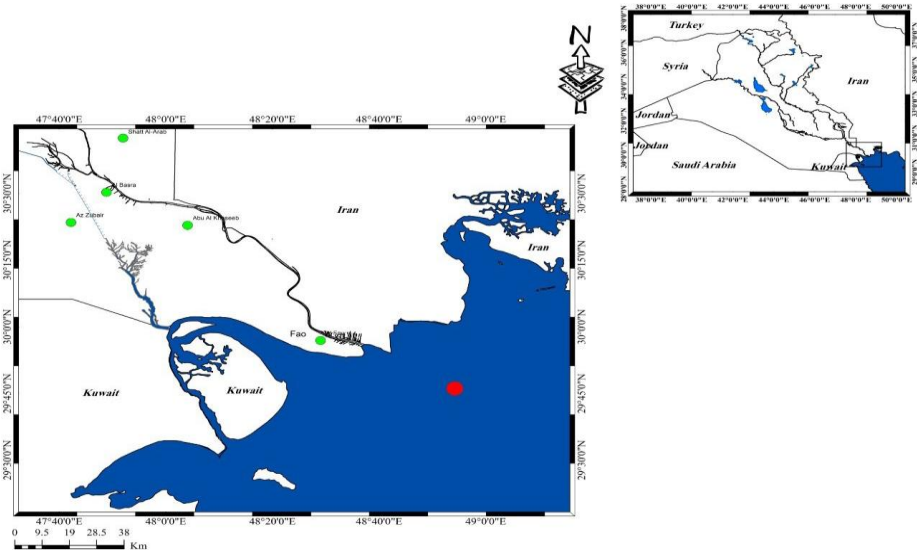

Fig. 1. Present study area in marine waters

RESULTS

1. Chemicals and physical parameters

1.1. Water temperature (W.T)

Water temperature exhibited monthly variations, reaching its highest values in June and August. During the study period, the minimum water temperatures recorded were 15, 16, and 17°C in January 2018, 2019, and 2020, respectively. The maximum temperatures

were 39°C in July 2018 and 2019, and 42°C in July 2020 (Fig. 2). No significant differences ($P > 0.05$) were detected in water temperature values across the years.

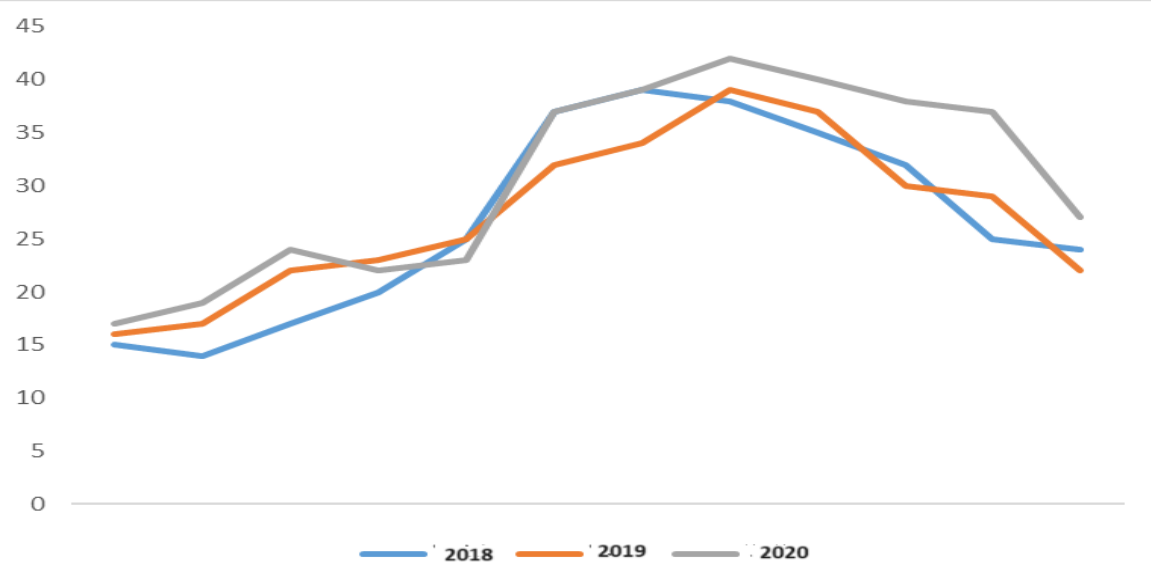

Fig. 2. Monthly variations of water temp. (°C) at the study station of Iraqi marine water

2. Salinity (‰)

Monthly variations in water salinity were analyzed. The results of the present study showed that water salinity values ranged from 38‰ in December to 43‰ in March, July, and August 2018; from 38‰ in January to 45‰ in July 2019; and from 41‰ in August to 48‰ in September 2020 (Fig. 3). No significant differences ($P \leq 0.05$) were found in salinity values between the three years.

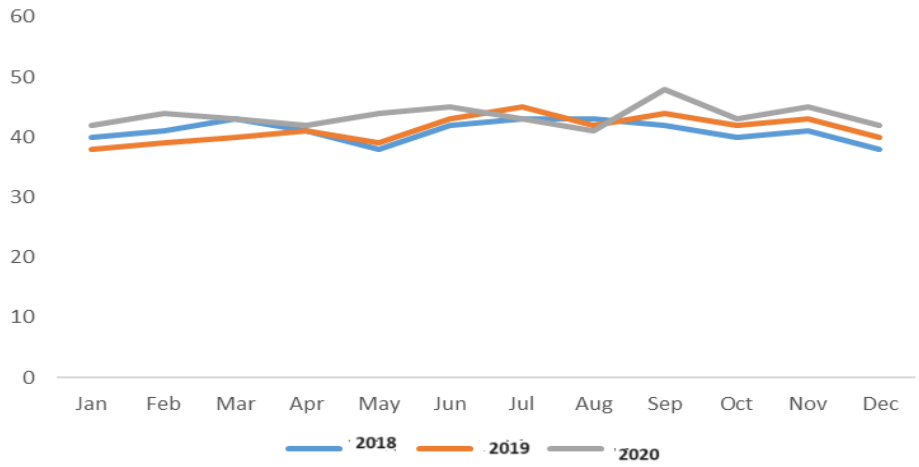

Fig. 3. Monthly salinity values change for 2018, 2019, and 2020

3. Hydrogen ion concentration (pH)

The monthly fluctuations in pH values are shown in Figs. (3, 5). The minimum value of 7.2 was recorded in January 2018 and 2020, while the maximum value of 8.9 was recorded in October 2020. No significant differences ($P > 0.05$) were found among years.

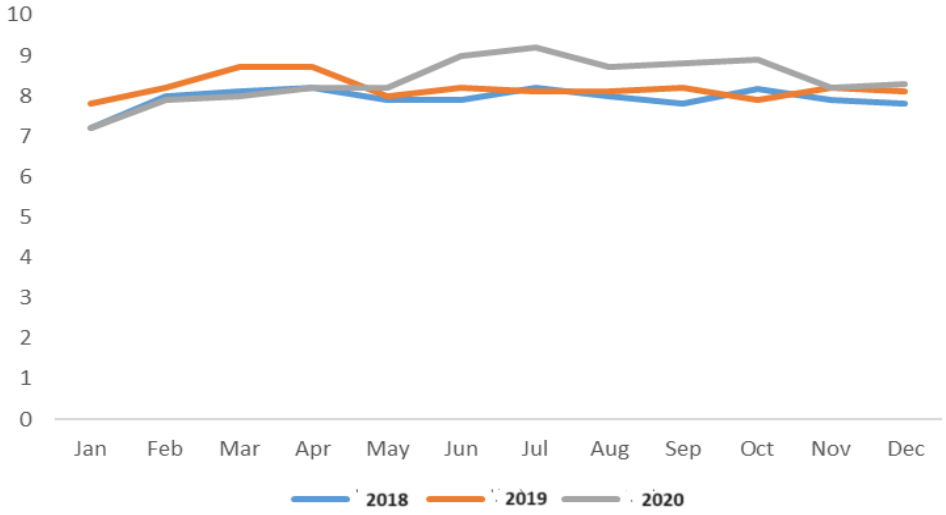

Fig. 4. Monthly changes in hydrogen ion concentration (pH) values for 2018, 2019, and 2020

4. Dissolved oxygen (mg/l)

The maximum DO value of 13.8mg/ l was recorded in April 2018, while the minimum value of 5.0mg/ l was detected in December 2018 and January 2019 (Fig. 5). The results showed significant differences ($P > 0.05$) in DO values among study years.

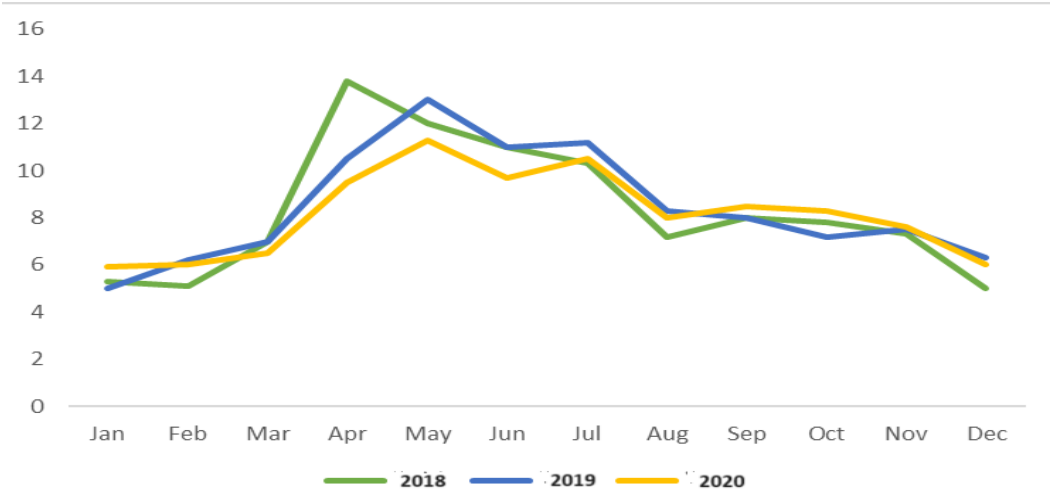

Fig. 5. Monthly changes in dissolved oxygen (mg/l) values for 2018, 2019, and 2020

5. Shrimp catch

The total shrimp catch for the two species, *M. affinis* and *P. semisculcatus*, amounted to 4541kg, including 1857kg, 1707kg, and 977kg in 2018, 2019, and 2020, respectively. These catches represented 40.89%, 37.59%, and 21.52% of the total catch (Fig. 6). The highest shrimp catches were recorded in June, July, August, September, and October, with catches of 480kg, 580kg, 542kg, 487kg, and 590kg, respectively. These values accounted for 10.57%, 12.77%, 11.94%, 10.72%, and 12.99% of the total catch. In contrast, the lowest catches were observed in January and February, with 272kg and 235kg, representing 5.99% and 5.18%, respectively. Additionally, November and December had catches of 271kg and 232kg, representing 5.97% and 5.11%, respectively (Fig. 7).

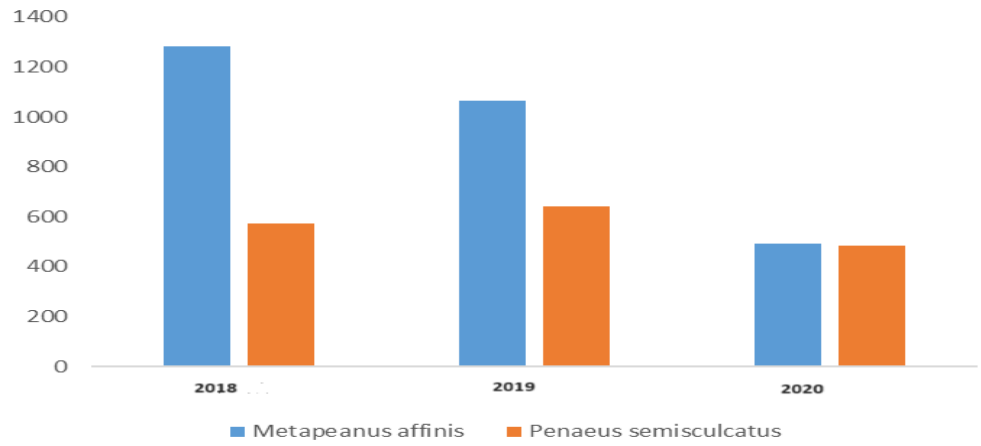

Fig. 6. Total catch of shrimp of the two species *M. affinis* and *P. semisculcatus* for 2018, 2019 and 2020

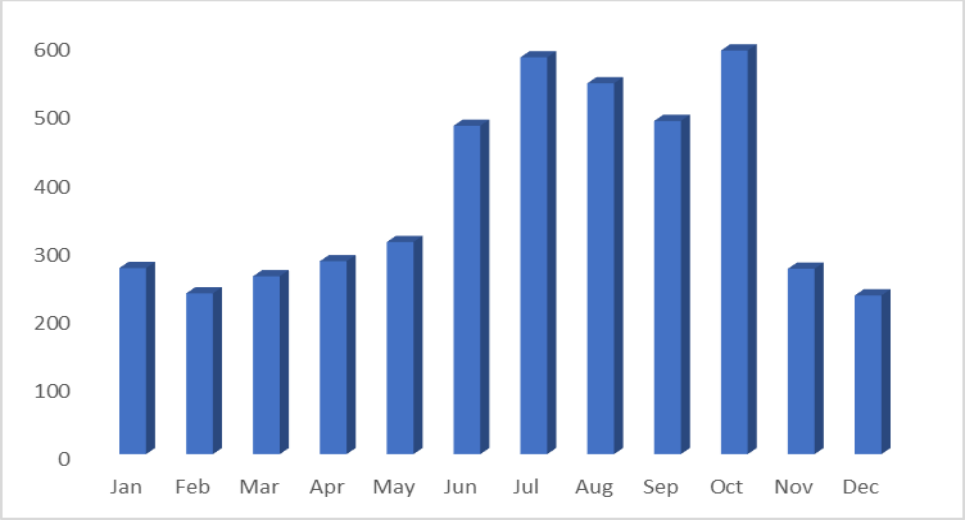

Fig. 7. Monthly changes in the total catch of shrimp of the two species *M.affinis* and *P.semisculcatus* in the Iraqi marine water

6. *M. affinis*

This species' total catch of shrimp amounted to 2,842kg, including 1,283kg in 2018, 1,067kg in 2019, and 492kg in 2020, representing 45.15, 37.54, and 17.31% of the total catch, respectively.

Fig. (8) shows the monthly changes in total catch quantities, which reached the highest levels of 210 and 191 in July 2018 and 2019, respectively, and 76kg in October 2020, while the lowest total catch was 46kg in December 2018, 48kg in March, and 23 kg

in August for the years 2019 and 2020 respectively, with a monthly catch rate of 106.92kg, 88.92kg and 41kg for the three years.

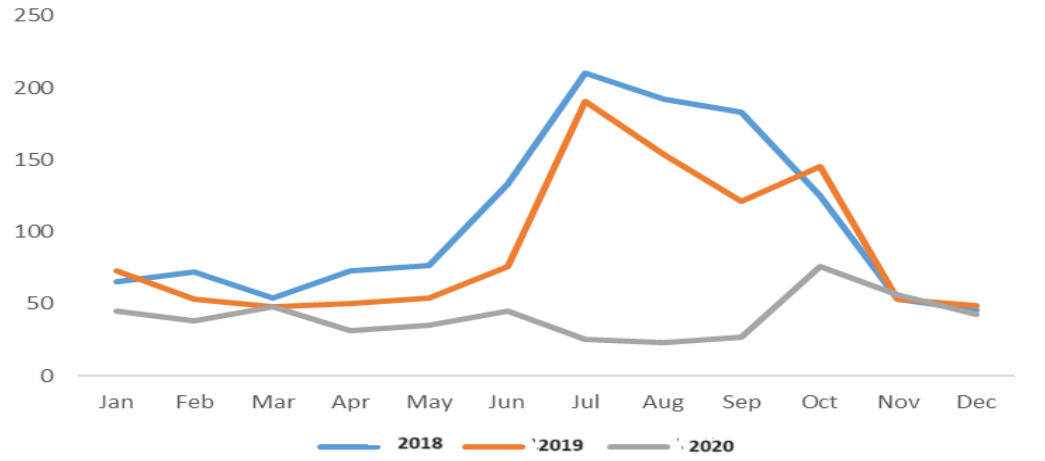

Fig. 8. Monthly changes in the catch of shrimp *M. affinis* for 2018, 2019 and 2020

Fig. (9) shows the monthly changes in the catch per unit of effort (kg/h) for the species *M. affinis*. The average catch per unit of effort per month was 11.88kg/ h, 9.88kg/ h, and 12.83kg/ h for 2018, 2019, and 2020, respectively. The catch rates ranged from a low of 5.11kg/ h in December to a high of 23.33kg/ h in July 2018. In 2019, the lowest catch rate was 5kg/ h in January, while the highest was 21.22kg/ h in July. In 2020, the lowest catch rate was 5.33kg/ h in March, and the highest was 25.33kg/ h in October.

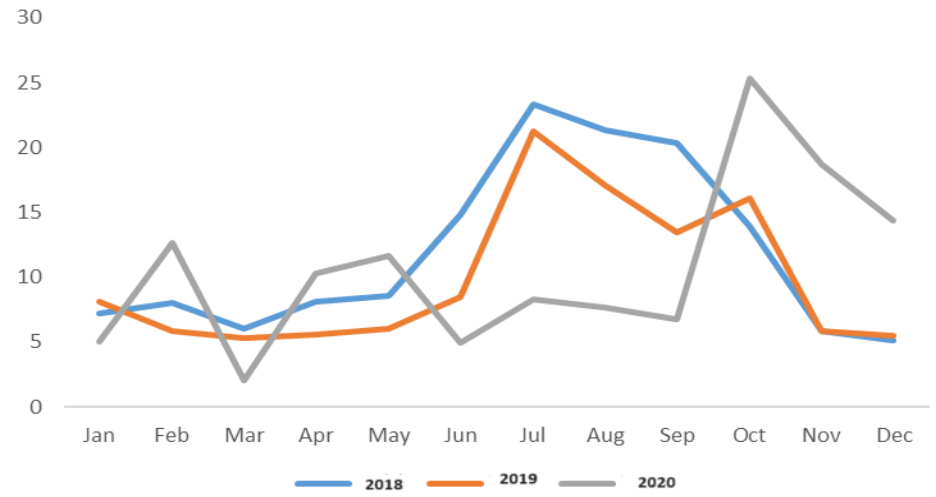

Fig. 9. Monthly changes in the catch per unit effort (kg/h) of the species *M. affinis*

7. P. semisculcatus

The total catch of *P. semisculcatus* shrimp during the study period amounted to 1,699kg, including 574kg in 2018, which is 33.78% of the total catch, and 640kg in 2019, which is equivalent to 37.67%, and 485kg in 2020, which is 28.55% of the total catch.

The results of monthly changes in the total catch of this species showed that the largest catch of 90kg was obtained in July 2018 at a rate of 15.68%, and 94kg in June 2019, equivalent to 14.69%, and 87kg in October 2020, at a rate of 17.94% of the total catch of that species. The lowest year was 13kg in February 2018, 21kg in December 2019, and 17kg in March 2020, at a rate of 2.26, 3.28, and 3.51%, respectively, with a monthly catch rate of 47.83, 53.33, and 40.42kg for the years 2018, 2019, and 2020, respectively (Fig. 10).

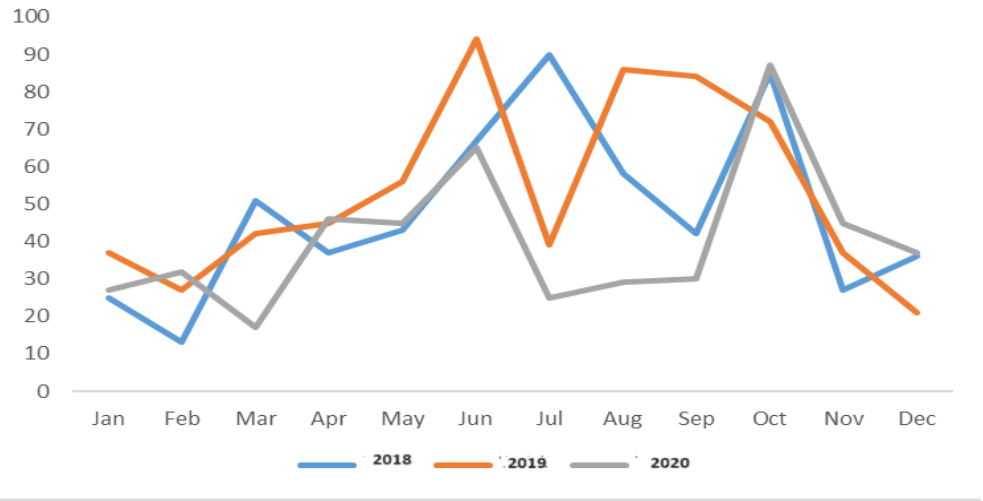

Fig. 10. Monthly changes in *P. semisculcatus* shrimp catch for 2018, 2019, and 2020

The results of the present study showed that the average catch per unit of monthly effort for the species *P. semisculcatus* reached 5.17, 5.93, and 4.49kg/ h for the years 2018, 2019, and 2020, respectively. They ranged from their lowest rate of 1.44kg/ h in February to their highest rate of 9.44kg/ h in October 2018. The lowest catch per unit of effort was 3.0kg/ h in February, while the highest was 10.44kg/ h in June 2019. In 2020, the lowest catch rate was 1.89kg/ h in March, and the highest was 9.67kg/ h in October (Fig. 11).

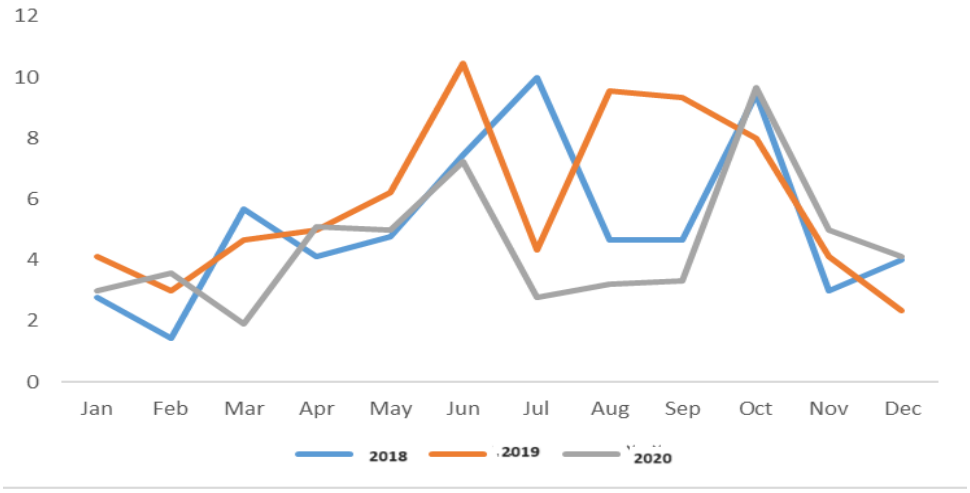

Fig. 11. Monthly changes in the amount of catch per unit effort (kg/h) of the species *P. semisculcatus*

Fig. (12) shows the results of the practical canonical analysis (PCA) between the two shrimp species, *P. semisulcatus* and *M. affinis*, and several environmental factors. The analysis reveals a strong correlation between both species and salinity concentration, followed by a weaker correlation with temperature and oxygen concentration. The species were most abundant and had a strong positive correlation in October, followed by September and November. In contrast, the correlation between the two species and acidity was negative during the remaining months of the year.

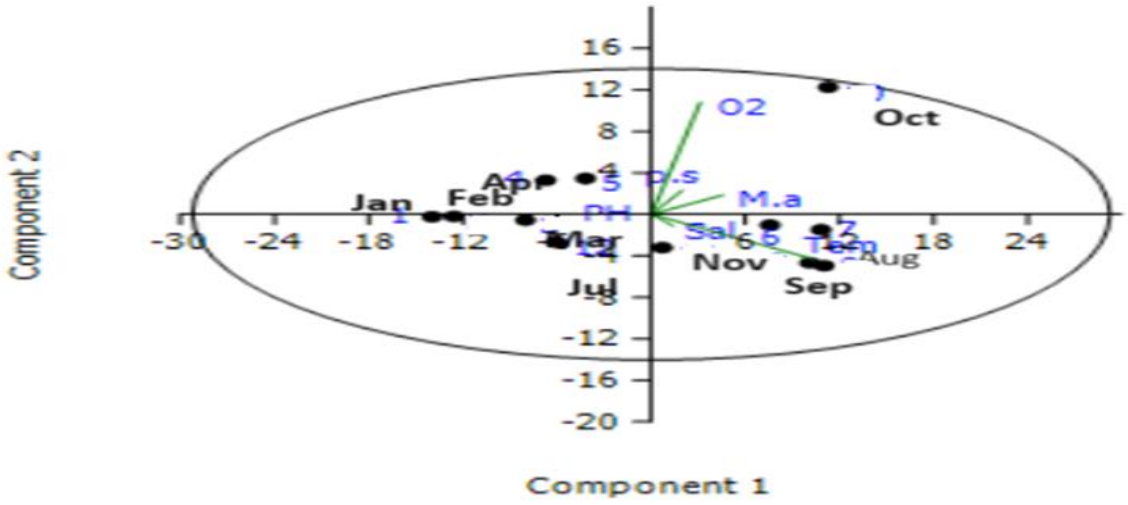

Fig. 12. PCA analysis between two species of shrimp with environmental factors during average fishing years

When comparing the catch levels of the two shrimp species over the years of the current study, as well as comparing the quantities and weights of shrimp caught in previous and current years, it was found that catch levels fluctuated, increasing and decreasing over the years. This trend is shown in Table (1).

Table 1. The quantities of shrimp caught in the present study and the previous and present years

Wight kg and ratio shrimp	year	zone	Reference
51.6	1990-1991	Iraqi marine water	Ali *et al*.(1998)
146.2	1992		
268.3	1993		
1317.1	1994		
30%	1995-1999	Shatt Al-Arab estuary	Mohamed *et al*.(2002)
20%		Khor al-Amea	
32%		Khor Abdallah	
87%	2009-2010	Northwest Persian Gulf (Khuzestan provinces)	Nezhad *et al*.(2012)
40	2011	Northwest Arabian Gulf	Mohamed and Abood,(2023)
215	2013		
280	2014		
232	2015		
760	2016		
1600	2017		
1800	2018		
1600	2019		
3200	2020		
2600	2021		
75%	2018	Al-Basrah	Al-Maliky,(2022)
15%		Al-Ashar	
5%		5. mile	
80%	2019	Al-Basrah	
15%		AlAshar	
7%		5.mile	
1857	2018	Iraqi marine water	Present study
1707	2019		
977	2020		

DISCUSSION

The present study demonstrates that *M. affinis* clearly dominates over *P. semisulcatus* in terms of catches during the years 2018, 2019, and 2020. The study also notes that the abundance of both species peaks in June, July, August, September, and December, with catch percentages of 12.99, 10.72, 11.94, 12.77, and 10.57%, respectively. These findings reinforce the idea that *M. affinis* constitutes a significant portion of the commercial catch in Iraqi marine waters **(Ali, 1997)**. This species is particularly important in the catches in the waters of the Shatt al-Arab and marshes, where it migrates from the sea **(Salman *et al.*, 1990)**. Moreover, **Al-Maliky (2022)** highlighted the importance of smaller shrimp species, including *M. affinis*, in marine aquaculture in Iraqi waters, emphasizing the role of *Macrobranchium nipponense* in commercial shrimp farming.

Globally, shrimp is one of the most widely consumed crustaceans. From the early 1990s, global farmed shrimp production increased from over half a million tons to 3–5 million metric tons **(Eayrs, 2005)**. Shrimp is valued for its high nutritional content, including low-energy protein, essential minerals such as phosphorus, iron, copper, magnesium, and zinc, as well as vitamins B12, B6, A, D, and omega-3 fatty acids **(Dayal *et al.*, 2013)**.

In the present study, the total shrimp catch over the years was 1857kg in 2018, 1707kg in 2019, and 977kg in 2020, indicating a decline over the period. This decrease is likely due to increased fishing pressure and overfishing. Shrimp and commercial fish are key components of food security, as noted by **Al-Shamary and Younis (2022)**, who recorded 1881kg of commercial fish caught in Iraqi marine waters during their study. The increase in the number of boats, both Iraqi and non-Iraqi, operating in the area also contributes to the declining shrimp population. This trend is consistent with **Ali *et al.* (1998)**, who found that the catch in 1994 was 1317kg, reflecting similar fluctuations in catches during the years 1990 to 1993.

Shrimp make up a significant portion of the commercial catch in bottom trawl net fisheries, where both commercial and non-commercial species are captured. **Allsopp (1982)** observed that in temperate regions, the ratio of shrimp to fish in the catch is about 1:5, which can increase to 1:10 in tropical regions. **Mohamed *et al*. (2002)** found that in Iraqi marine waters, the shrimp-to-fish ratio is approximately 1:4, which is higher than in temperate regions. In the current study, it was observed that shrimp catches were lowest in January and February, which aligns with findings by **Mohamed *et al.* (2002)** and **Al-Shamary (2021)**, who also noted lower shrimp catches during these months.

The presence of shrimp in marine waters is influenced by factors such as water temperature, salinity, fishing practices, breeding seasons, climate change, and the movement of shrimp to deeper waters. As observed in the present study, *M. affinis* catches are higher than those of *P. semisulcatus*, with the total catch for *M. affinis* being 492kg in 2018, 1067kg in 2019, and 1283kg in 2020. The *P. semisulcatus* species, which is found only in marine waters, has fewer individuals, confirming findings by **Salman *et al.* (1990)**.

Shrimp catches generally peak in the summer months, which is consistent with observations by **Abbas and Ghazi (2021)**. However, a decline in shrimp catches has been noted in recent years due to overfishing. Fishermen working day and night, using modern bottom trawl nets with varying mesh sizes, have contributed to the deterioration of the seaweed layer, particularly during shrimp breeding seasons. This, in turn, leads to the depletion of shrimp stocks in marine waters, as confirmed by the **FAO (2009)** and **Mohamed and Abood (2023)**.

Additionally, **Al-Maliky (2022)** highlighted significant fluctuations in shrimp prices in Basra markets, which can be attributed to variations in the catch of both species.

CONCLUSION

We conclude that the catch quantities were higher in previous studies than in the present study due to the presence of ideal environmental conditions. However, now the effects of climate change, overfishing, and changes in environmental conditions, including temperature and salinity, have led to a decrease in catch quantities

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