Fishery, Growth and Reproductive Biology of *Metapenaeus affinis* (Decapoda, Penaeidae) in the Iraqi waters

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Abstract: The study evaluated the fishery, growth and reproductive biology of the Jinga shrimp (*Metapenaeus affinis*) in Iraqi waters from November 2022 to October 2023. The monthly shrimp landings from Iraqi marine waters ranged from 57 tons in December 2022 to 407 tons in September 2023, with an annual value of 3,515 tons. 8,021 individuals of *M. affinis,* ranging from 2.0 to 15.6 cm, were collected from the East Hammar marsh and Iraqi marine waters. The length-weight relationship indicated that males and females exhibited negative allometric growth patterns, with a significant difference between them. The mean values of the relative condition factor were 0.98±0.037 and 1.02±0.043 for males and females, respectively, referring to the healthy condition for both sexes. The growth model for the species was L_t= 16.3 (1- exp (-0.92 (t+0.084))). The overall sex ratio (male: female) was 1:1.41. The length at first maturity (L_{m50}) was 8.2 cm. The gonadosomatic index (GSI) values fluctuated from 2.14% in June to 4.34% in April for females of *M. affinis.* These results can assist in fisheries management and conservation of the shrimp species in Iraqi waters.

Key-Words: Metapenaeus affinis, fishery, growth and reproductive biology, Iraq.

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1 Introduction

Penaeid shrimps are commercially important and widely distributed worldwide in sub-tropical and tropical regions. They are the primary catch in shrimp fisheries, accounting for a total catch of 3.2 million tons in 2020 out of 5.6 million tons of crustaceans [1]. They often inhabit different habitats at different stages of their life cycle, requiring them to migrate between these habitats, such as when larvae and post-larvae migrate from spawning areas to nursery grounds, juveniles move out of the nursery area, and adults migrate to deeper offshore waters [2].

In Iraqi waters, *Metapenaeus affinis* (Milne Edwards, 1837), *Penaeus semisulcatus* De Haan 1844, and *Parapenaopsis stylifers* (Milne Edwards, 1837) were the main shrimp species caught, according to Ali [3]. These species have been crucial for sustaining artisanal marine fisheries in Iraq over the past years. Their catches have increased from 123.4 tons (1.85% of the total catch) in 2008-2009 to 7,288 tons (14.4% of the total catch) in 2020-2022 [4].

A typical Penaeus species spawns in the sea and enters inshore waters as a post larvae, usually around three weeks to one month old. It remains in these waters for nearly three months while growing. After this period, the shrimp migrates back to the sea when it is about four months old and measures 8.0-10.0 cm in total length [5]. Authors have noted that the larval stage of *M. affinis* migrates from the northern part of the Arabian Gulf toward the Shatt Al-Arab River, eventually reaching the nursery grounds in the East Hammar marsh. Various sizes of shrimp (ranging from 0.3 to 12.5 cm in total length) have been found in the marsh, indicating that this marsh serves as the primary nursery ground for this species in the northern Arabian Gulf. Later, the larger shrimp migrate back to the spawning grounds to mature sexually and spawn [6-8].

M. affinis is found in two regions within Iraqi waters: marine waters in the Arabian Gulf and brackish inland in the marshes. It is considered the most important species in Iraqi waters. According to Ali [3], the total annual catches of *M. affinis* in Iraqi marine waters during 1998/1999 ranged from

174.6 to 279.4 tons per year, and in inland waters (marshes) it was 1200 tons from April 2000 to January 2001.

Previous studies on the fishery and biology of *M. affinis* in Iraqi waters are limited. Salman *et al.* [8] described the abundance and seasonal migrations of *M. affinis* in Iraqi inland waters. Ali [3], Ali *et al*. [9] studied the fisheries of *M. affinis* in Iraqi marine waters. Abbas and Ghazi [10] focused on the landings of *M. affinis* in the main markets of Basrah Province, and Al-Maliky [11] studied the catch rate of *M. affinis* in the East Hammar marsh. Lastly, Hassan *et al*. [12] studied the stock assessment of *M. affinis* in Iraqi waters.

Consequently, the present study introduces the information about fishery, growth and reproductive biology of *M. affinis* in the East Hammar marsh and Iraqi marine water from November 2022 to October 2023.

2 Materials and methods

In Iraq, shrimp of *M. affinis* are harvested at various life stages, including post-larval, sub-adult, and adult stages. Therefore, the study was conducted at two dissimilar locations in Iraqi waters from November 2022 to October 2023. The first location was the nursery grounds in the East Hammar marsh, north of Basrah where the *M. affinis* specimens were collected from the local fishermen who caught the shrimps from the areas of Al-Masshab and Al-Assafiya Creek, south of the East Hammar marsh using a traditional method known locally as 'Kasrah', the trawl net (Gufa) and seine net. The second location was the fishing grounds located northwest of the Arabian Gulf, within the Iraqi marine waters, where the shrimp samples were collected randomly from the main landing and auction site for marine resources at Al-Fao town (Fig. 1). Specimens were stored in the iceboxes and transported to the Department of Fisheries and Marine Resources laboratory for further examination.

The monthly raw data on the total fish and shrimp landings from the second location from November 2022 to October 2023 were obtained from the Basrah Agriculture Directorate. A trend line (technical analysis) was used to show the general direction and designate patterns of fish species' landings by the TREND function.

The specimens were identified according to Fischer and Bianchi [13] and sexed by macroscopic examination of the gonads. Each specimen was measured for total length (TL), from the tip of the rostrum to the end of the telson, and carapace length (CL), from the posterior margin of

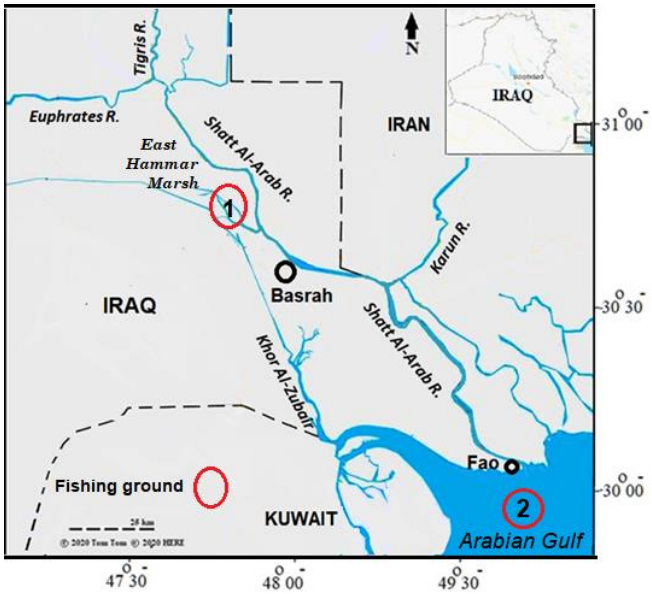

Fig. 1: Fishing grounds of *M. affinis* in the East Hammar marsh and the Iraqi marine waters.

the orbit to the posterior margin of the carapace using a biometric ruler to the nearest 0.1 cm. The weights of the shrimp and gonad were measured using a digital balance to the nearest 0.1 g. The lengths were grouped into 1.0 cm length groups for males and females.

The relationship between carapace length (CL) and total length (TL) for the species was estimated using the linear regression formula: CL= a + bTL, where a and b are constants. The length-weight relationship for males and females was determined using the power function $W= aL^b$ [14], where W is the weight of shrimp in grams, L is the total length in cm, a is a coefficient related to the body form, and b is an exponent indicating growth. To identify growth types (isometric or allometric), significant deviations from the b values were observed using a t-test [15]. A t-test was performed to check the similarity of the regression line between males and females.

The relative condition factor (K_n) of the shrimp was designed separately for males and females as $K_n= W/W'$, where W is the observed weight and

W' is the calculated weight of the shrimp, determined by inputting 'a' and 'b' values from the length-weight relationship [14].

Growth in length was described using the von Bertalanffy growth function (VBGF):

$$L_t = L\infty\ (1 - \exp\ (-K(t - t_0)))$$

Where $L\infty$ is the asymptotic length, K is the growth rate, L_t is the expected length at age t years, and t_0 is the theoretical age at length zero. The growth parameters ($L\infty$ and K) were estimated from the length-frequency data using the ELEFAN I incorporated in the FiSAT II software [16], with the initial seed value for $L\infty$ as the largest individual (L_{max}) seen in the samples, thus: $L\infty = L_{max}/0.95$ [17]. The theoretical age at length zero (t_0) was estimated independently, using the following equation [17]:

$$\log_{10}(-t_0) = -0.3922 - 0.275\ \log_{10}L\infty - 1.0381\ \log_{10}K$$

The ratio of the number of males to females was determined monthly for only those shrimp whose gonads were identifiable as male and female. The sex ratio was tested by the chi-square (χ^2) test. The size at which 50% of the shrimp were mature (L_{m50}) was determined in two ways, first from the relationship between the percentages of mature female shrimp of length group, and the second via the following equation [18]:

$$\text{Log}\ (L_{m50}) = -0.1189 + 0.9157 * \text{Log}\ (L_{max})$$

where L_{max} is the largest individual observed in the samples. The gonado-somatic index (GSI) of the shrimp was calculated monthly by the following equation [19]:

GSI= Weight of gonad/ Total body weight * 100.

The obtained data were analyzed using Microsoft Office Excel, ver., 2010.

3 Results

3.1 Shrimp landing

Figure 2 depicts Iraqi marine fisheries' monthly shrimp and total fish landings from November 2022 to October 2023. The monthly shrimp landings ranged from 57 tons in December 2022 to 407 tons in September 2023, with an overall value of 3,515 ± 56.4 tons. Total fish landings varied from 1,487 tons in December 2022 to 2,948 tons in September 2023, with an overall value of 26,522 ± 259.6 tons. Both shrimp and total fish catches showed a positive trend during this period (b= 22.41 and 94.83, respectively). The overall contribution of shrimp to the total landing was about 13.25%.

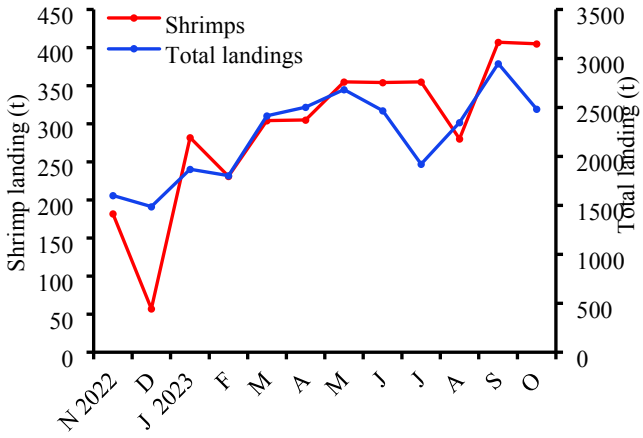

Fig. 2: Monthly shrimp and total landings by Iraqi marine fisheries during 2022-2023.

3.2 Growth

3.2.1 Length-frequency distributions

Figure 3 illustrates the seasonal length-frequency distributions of 8021 specimens of *M. affinis* ranging in size from 2.0 to 15.6 cm. The number of individuals collected in winter was 1393 individuals, ranging in length from 2.0 to 15.0 cm, and the highest frequency of catch belonged to the length group 5.0 cm, constituting 15.3%, while the length groups from 4.0 to 8.0 cm formed the main catch (63.0%). 2107 specimens of *M. affinis* were collected in spring, ranging from 4.0 to 15.0 cm, and the dominant length group was 7.0 cm formed 24.8%, while the length groups 5.0 to 8.0 cm constituted 75.0%. Lengths of 2140 individuals of the species involved in summer extended from 4.0 to 15.0 cm, and the most dominant length group recorded was 7.0 cm, representing 22.8%, though the length groups 6.0 to 10.0 cm constituted 86.0%. The sample, composed of 2381 specimens, was caught during autumn, ranging from 4.0 to 13.0 cm, and the most frequent length group was 7.0 cm, accounting for 17.9%, and the length groups 6.0 to 10.0 cm formed 79.6%.

3.2.2 The length-weight relationships

The length-weight relationships of 4048 specimens of *M. affinis*, with 1555 males and 2493 females, are presented in Figure 4. The male specimens had a total length and weight range of 4.0-12.6 cm and 0.40-13.70 g, while the female specimens had a

range of 3.0-15.6 cm and 0.22-30.71 g. The length-weight equations for males and females were estimated to be:

$W= 0.0092*TL^{2.852}$, $r^2= 0.971$ for males

$W= 0.0074TL^{2.974}$, $r^2= 0.966$ for females

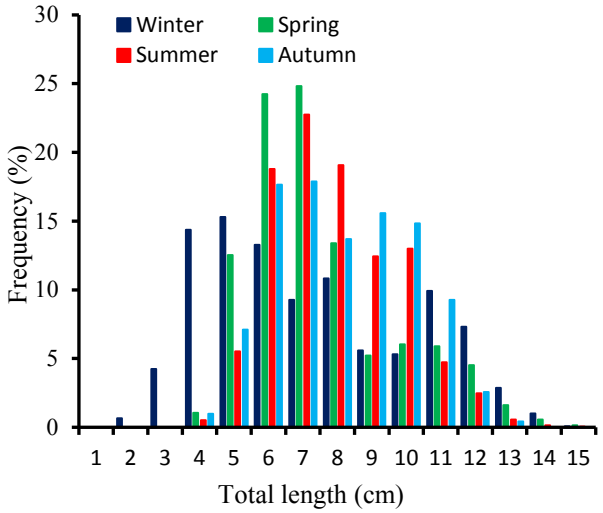

Fig. 3: The seasonal length-frequency distributions of *M. affinis* in Iraqi waters.

The slopes of the weight-length relationship for both sexes were subjected to a t-test, which revealed that this species exhibited negative allometric growth since their 'b' values significantly differed from the theoretical value of 3 (t= 11.839 and 2.353, $p<0.05$ for males and females, respectively). There was a significant difference in the lengths and weights of males and females (t= 7.294, $p<0.05$).

The relationship between the total length (TL) and carapace length (CL) for 714 individuals of *M. affinis* was CL= 0.3965*TL-0.1994, $r^2= 0.976$.

3.2.3 Relative condition factor (K_n)

Figure 5 shows the monthly variations in the mean relative condition factor (K_n) in male and female *M. affinis*. The lowest K_n values were recorded in April (0.92) for males and in October (0.95) for females, while the highest values were 1.05 and 1.09 in March for both sexes, respectively. There was a significant difference in K_n values between the sexes (t= 2.20, $p>0.05$). Overall, the K_n values were 0.98±0.037 for males and 1.02±0.043 for females.

Monthly total length-frequency data for the combined sexes of *M. affinis* were analyzed using

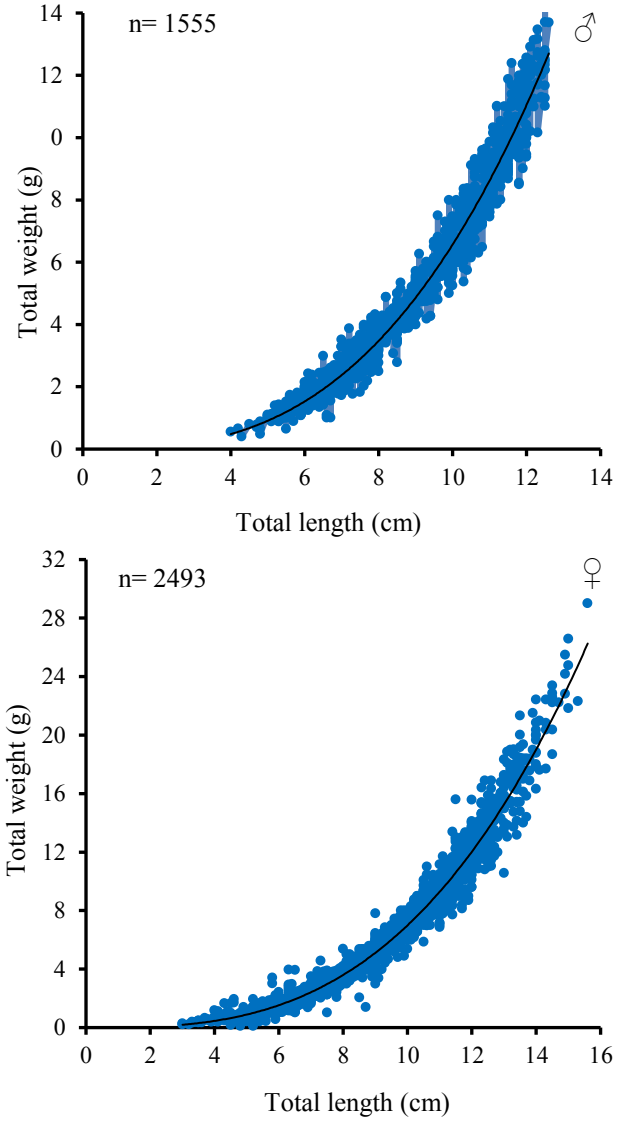

Fig. 4: The length-weight relationship of males and females of *M. affinis* in Iraqi waters.

3.2.4 Growth model

the ELEFAN-I incorporated in the FiSAT II software. The initial seed value for $L\infty$ used in the ELEFAN-I was 15.6 cm. The restructured length frequency of *M. affinis* superimposed growth curves is shown in Figure 6. The asymptotic length ($L\infty$) was 16.3 cm, with a growth rate (K) of 0.92 per year. Theoretical
age at length zero (t_o) was estimated as -0.084 per year. The growth model for *M. affinis* was:

$$L_t= 16.3\ (1- \exp\ (-\ 0.92\ (t + 0.084)))$$

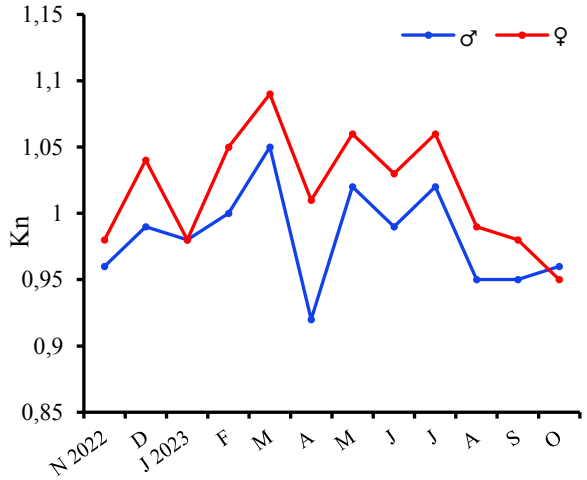

Fig. 5: Monthly variations in relative condition factor (K_n) of male and female *M. affinis*

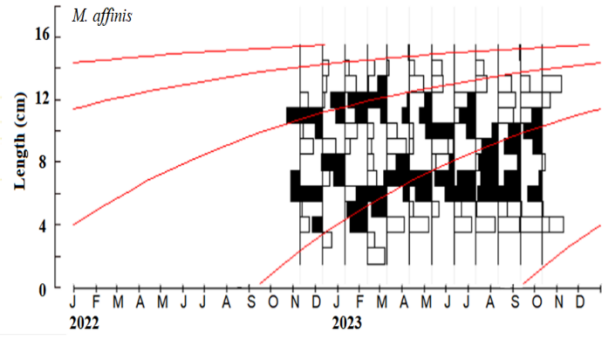

Fig. 6: Restructured length-frequency distribution with growth curves for *M. affinis* in Iraqi waters.

4 Reproduction

4.1 Sex ratio

Table 1 represents the monthly sex ratio of *M. affinis* in Iraqi waters during the study. A total of 4872 specimens of *M. affinis* were sexed, out of which 2023 (41.5%) were males and 2849 (58.5%) were females. The sex ratio showed a preponderance of females over males around the year, except for January. The overall sex ratio (male: female) was 1:1.41, which significantly differed from the expected 1:1 ratio, indicating a preponderance of females over males (χ^2= 140.0; $P < 0.05$).

4.2 Maturity

This study examined 201 mature females of *M. affinins* to determine their lengths at first sexual maturity (L_{m50}). The maturity curve was created by plotting the percentage of mature females against their length groups (Fig. 7). The length at first maturity (L_{m50}) was 9.1 cm. This finding was verified using the equation of Binohlan and Froese (2009), yielding 9.4 cm for *M. affinins* based on the largest length (15.6 cm) in the samples.

Table 1: Monthly sex ratio of *M. affinis* in Iraqi waters.

	Total number	No. of specimens		Sex ratio (M: F)	X^2
		Male	Female		
N 2022	424	143	281	1:1.97	44.9
D	300	128	172	1:1.34	6.5
J 2023	387	222	165	1:0.74	8.4
F	534	242	292	1:1.21	4.7
M	325	134	191	1:1.43	10.0
A	390	170	220	1:1.29	6.4
M	424	140	284	1:2.03	48.9
J	525	231	294	1:1.27	7.6
J	314	103	211	1:2.05	37.1
A	342	119	223	1:1.87	31.6
S	493	196	297	1:1.52	20.7
O	414	195	219	1:1.12	1.4
All	4872	2023	2849	1:1.41	140.0

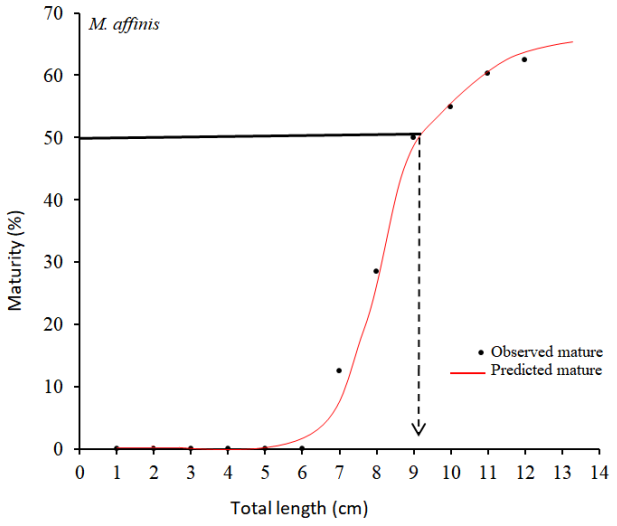

Fig. 7: The length at first sexual maturity (L_{m50}) of *M. affinins* in Iraqi waters.

4.3 Gonado-somatic index

The monthly variation of the gonadosomatic index (GSI) of female *M. affinins* is shown in Figure 8. The GSI of *M. affinins* fluctuated during the

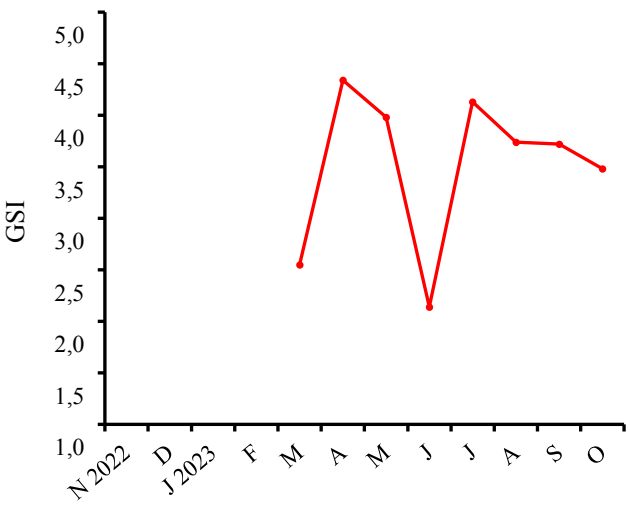

Fig. 8. Monthly fluctuations in the gonadosomatic index (GSI) of females of *M. affinins* in Iraqi waters.

sampling months with a minimum level of 2.14% in June and a maximum level of 4.34% in April.

5. Discussion

The present findings indicated that Iraqi artisanal marine fisheries had annual shrimp and total fish landings of 3,515 and 26,522 tons, respectively. Mohammed *et al.* [5] stated that the total shrimp caught in the 1995/1996 seasons was 1,657 tons in Kuwaiti waters. Ali [7] reported that the total catch of *M. affinis* in marine waters during the 1998-1999 season was between 174.6 and 279.36 tons, while it was 1,200 tons in the inland waters of Iraq during the 2000-2001 season. The landings of penaeid shrimps exhibited significant fluctuations over the last decade, as the landings in 2008 were 43,695 tons and gradually decreased to 37,642 tons in 2019, so their contribution to the total marine landings of Maharashtra, India, declined from 13.1% to 10.8% [20]. According to Mohamed and Abood [21], the total fish landing was 19,877 tons in 2020 and 1,364 tons in 2021, while shrimp landings were 3,107 and 2,221 tons, respectively. Moreover, the total fish landings were 16,971 tons in 2022, with shrimp landings at 1,961 tons [3]. Both total fish and shrimp landings experienced significant increases in the current study. This improvement in the landings of the species from Iraqi marine waters may be attributed to the development of infrastructure, the upgrading of navigation technology and the increasing mechanized power of fishing boats [21].

According to the study, the length range of *M. affinis* individuals (2.0-15.6 cm TL, 0.6-6.0 cm CL) was found to be similar to that of male *M. affinis* in Mumbai waters, India, 6.5-15.0 cm TL [22] and in the Mediterranean Sea, Egypt, 5.4-16.0 cm TL [23]. However, the [illegible]n range was higher than that Ibrahim [24] stated in the Terengganu Waters, Malaysia (1.3-4.2 cm CL). Conversely, the length range of *M. affinis* in this study was lower than those indicated by Leena and Deshmukh [22] for female *M. affinis* in Mumbai waters, India (6.6-19.0 cm TL), Metin and Aydin [25] in the Izmir Bay, Turkey (7.3-17.5 cm TL), Dash *et al*. [26] in the Gujarat Waters, India (2.0-19.8 cm TL) and Dongre *et al.* [20] in the Ratnagiri coast of Maharashtra, India (8.5-17.4 cm TL). The environmental factors, food supply, population density, fishing pressure, and possibly using different fishing gears may be responsible for the differences in the sizes of the species in different geographic localities [27, 28]. These differences in size ranges may be due to various factors, such as water temperature, food availability, population density, fishing pressure, and possibly the use of different fishing gears [27, 29-30].

The growth coefficients (b) of the length-weight relationship for male and female *M. affinis* indicated a negative allometric growth pattern ($b < 3$), meaning that the shrimps get moderately thinner as they increase in length [31, 17, 28]. A similar growth coefficient pattern for the species was reported by Ibrahim [24] in the Terengganu Waters, Malaysia and Dash *et al*. [26] for males of the species in Gujarat Waters, India. In contrast, Abdel Razek *et al*. [23] showed an isometric growth pattern for males *M. affinis* and a positive allometric growth pattern for females in the Mediterranean Sea, Egypt. The growth coefficient (b) is affected by several factors, including habitat, season, gonad maturity, sex, stomach fullness and health [31, 14, 32, 30].

The relative condition factor is considered an index of general well-being and suitability of shrimp to grow in a particular water body, and the value expresses the degree of well-being, relative robustness, plumpness and fatness in numerical terms [27, 33]. It was observed in this study that females of *M. affinis* had better condition factors than males, as indicated by the overall values.

However, both sexes of *M. affinis* had overall K_n values above 1.0, indicating healthy populations. Le Cren [13] stated that K_n values greater than 1.0 indicate good well-being, while values less than 1.0 imply the opposite. The condition factors of many species fluctuate due to their reproductive cycle, feeding rhythms, and other environmental and physiological factors [34-36].

The $L\infty$ of *M. affinis* in the present study was (16.3 cm TL, 6.26 cm CL), which was similar to the values obtained by Leena and Deshmukh [22] for male species in Mumbai waters, India (16.2 cm), Saputra *et al*. [37] for male in the North Coast of Central Java, Indonesia (16.8 cm), and Jahrah *et al.* [38] for female in the Samboja Kuala Waters, Indonesia (16.1 cm), while it was lower than those stated by Leena and Deshmukh [22] for female *M. affinis* in Mumbai waters, India (20.4 cm); Dinh *et al*. [39] in the Mekong Delta, Viet Nam (19.0 cm), Dash *et al.* [26] in the Gujarat Waters, India (18.6 cm for males and 20.5 cm for females), Abdel Razek *et al*. [23] in the Mediterranean Sea, Egypt (19.9 cm) and Dongre *et al*. [20] in the Ratnagiri coast of Maharashtra, India (18.0 cm). On the other hand, the $L\infty$ value in this study was higher than those reported in other studies such as Mohammed *et al.* [5], Ibrahim [24], Gerami *et al*. [40], Safaie [41], Kapiris *et al.* [42], Ansari *et al.* [43] and Tirtadanu *et al*. [44].

The present value growth coefficient (K) for *M. affinis* is comparatively higher than those stated for the species in some studies, such as Ibrahim [24] in the Terengganu Waters, Malaysia; Kapiris *et al*. [42] in the Bay of Izmir, Turkey; Abdel Razek *et al*. [23] in the Mediterranean Sea, Egypt and Jahrah *et al*. [38] in the Samboja Kuala Waters, Indonesia, while was lower than the values informed by Mohammed *et al.* [5], Safaie [41], Ansari *et al*. [43], Tirtadanu *et al.* [44], Dash *et al*. [26], Saputra *et al.* [37] and Dongre *et al*. [20]. However, Abdel Razek *et al.* [23] recorded the lowest value (0.24) for the species in the Mediterranean Sea, Egypt, while the highest value was 2.1 for female *M. affinis* on the coast of Khoozestan Province, Arabian Gulf [43]. According to Pauly and Munro [45], the K value for penaeid shrimps ranges from 0.39 to 1.6. The differential in the growth parameters of the same species in various regions could be influenced by many factors, like environmental conditions, nutrient abundance, metabolic and reproductive activities, genetic makeup of the individual, fishing pressure, and sampling method (Nikolsky, 1963; Spare and Venema, 1998; Wootton, 2011; Panda *et al.* 2018; Çiloğlu and Ateş, 2022).

The sex ratio of *M. affinis* in this study showed a preponderance of females over males around the year, except for January, the overall sex ratio was 1:1.41, which is significantly different from the theoretical 1:1 sex ratio. The dominancy of female *M. affinis* was also recorded by several studies, such as Salman *et al*. (1990) from the nursery grounds in Hammar Marsh, Iraq (1:1.14), Kamrani *et al*. (2005) and Gerami *et al*. (2013) from the Hormozgan province, Arabian Gulf, 1.15 and 1.52, respectively, Metin and Aydin (2017) from the Izmir Bay, Turkey (1:1.22), Dash *et al*. (2018) from the Indian Waters (1:1.30) and Abdel Razek *et al*. (2022) from the Mediterranean Sea, Egypt (1:1.71). According to Tirtadanu *et al.* (2017), the sex ratio of this shrimp in the waters of Kotabaru, Indonesia, was 1:2.56 (M: F). Similarly, Jahrah *et al.* (2023) reported that the overall sex ratio of *M. affinis* in the Samboja Kuala Waters, Indonesia, was 1:2.43 (M: F). They highlighted that male shrimps typically have a shorter lifespan during the spawning season, leading to a higher ratio of females in the stock as time progresses. The sex ratio shows significant variation for the same species in different water bodies, and the predominance of sex may differ due to sexual segregation during the spawning period, the life stage, behavioural characteristics between the sexes, mortality, migration, vulnerability to fishing gear and fishing site (Nikolsky, 1963; Mouine *et al.*, 2011; Gerami *et al*., 2013).

The results show that the length at first maturity (L_{m50}) of *M. affinis* was 9.4 cm (3.5 cm CL). Kamrani *et al*. (2005) and Gerami *et al*. (2013) reported that the L_{m50} of *M. affinis* in Hormozgan coastal waters, Arabian Gulf was 2.7 cm CL (7.5 cm TL). Metin and Aydin (2017) stated that the males and females of *M. affinis* reached their first sexual maturity at 10.2 and 10.6 cm TL, respectively, in Izmir Bay, Turkey. Tirtadanu *et al*. (2017) and Saputra *et al*. (2018) found that the L_{m50} for females *M. affinis* in the Kotabaru waters and North Coast of Central Java, Indonesia were 8.0 and 11.6 cm TL, respectively. The size of the first maturation varies between regions, influenced by factors such as habitat conditions, food availability,

and trophic parameters specific to each province [46-49].

Gonad maturity result showed that the highest value of the gonadosomatic index (GSI) for females of *M. affinins* in this study was observed in April. Salman *et al.* (1990) stated that *M. affinis* migrates from the Arabian Gulf to nursery grounds in the Hammar marsh of Iraq between May/June and January/ February. During this migration, the size of the shrimp ranges from 0.3 to 12.5 cm TL as they are found in the marsh. Additionally, spawning at sea appears to occur immediately after their migration. *M. affinis* showed two spawning peaks, the first in winter-spring (February-May) and the second in July, September and or October in Pakistan inshore waters [50]. Gerami *et al*. [40] noted that the peak spawning season for *M. affinis* occurs in late winter and early spring (March-April) and has continuous spawning throughout the year in Bushehr waters, Arabian Gulf. Meanwhile, Metin and Aydin [25] stated that gonad maturity of *M. affinis* begins in May, with the most mature gonads observed in August and they prefer to reproduce within 5-15 m of coastal areas in Izmir Bay, Turkey. The details of the penaeid shrimp biology study are still lacking, and there is insufficient information and data about their reproduction, spawning seasons, and maturation [51].

6 Conclusions

In conclusion, the contribution of shrimps to Iraqi marine landings was significant, accounting for 13.25% of the total fishery landings. The size range of *M. affinis* was comparable to that reported by several authors in various geographic locations. *M. affinis* exhibited negative allometric growth patterns for both sexes, and the average value of the relative condition factor indicated a healthy condition for the species. The asymptotic length (L_∞) of *M. affinis* is aligned with findings from other studies on this species. The sex ratio of the species showed a predominance of females over males, which was notably different from the theoretical ratio. Additionally, the length at first maturity (L_{m50}) for *M. affinis* was consistent with findings from other research. The highest value of the gonadosomatic index (GSI) for female *M. affinis* was recorded in April. These results can aid in managing and conserving the species in Iraqi waters.

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Conflict of interest

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