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# Seasonal Variations in Gonadosomatic Index, Hepatosomatic Index, and Condition Factor of *Metapenaeus affinis*

**Intisar M. A. Jabbar*, Aqeel A.A. Al-Waeli, Ibtisam M. Abdul-Sahib, Tariq H.Y. Al-Maliky**
Dept. of Marine Biology, Marine Science Centre, University. of Basrah, Basrah, Iraq
***Corresponding author: intesar.jabbar@uobasrah.edu.iq**

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**ABSTRACT**

Samples of *Metapenaeus affinis* were collected from the marine waters off the Iraqi coast between January 1 and December 1, 2022, to investigate the development of sexual maturity. Seasonal variations in gonadal function were observed in males, with peak rates (0.052) recorded in the summer and the lowest rates (0.024) in the winter. In females, the highest rates (0.979) occurred in spring, while the lowest (0.549) ones were observed in the winter. Liver function development was correlated with the stages of sexual maturity. In males, liver function was at its highest (0.234) in winter and lowest (0.108) in spring. In females, the highest liver function (0.404) was observed in fall, and the lowest (0.265) was in summer. The physical condition index also aligned with the stages of sexual maturity. In males, the highest values (13.789) were recorded in summer and the lowest (8.697) in spring. In females, the index peaked (9.499) in fall and was at its lowest (8.925) in winter. This study revealed that the shrimp exhibits a broad reproductive cycle. Statistical analyses showed that for females, the condition factor and liver function did not vary significantly across seasons. However, gonadal function exhibited significant differences between spring and the other seasons, with no significant differences between the remaining seasons. In males, the condition factor showed significant differences between summer and the other seasons, with no significant differences among the remaining seasons. Liver function showed significant variation between winter and the other seasons, with no differences among the rest. Regarding reproductive function, significant differences were observed between spring, summer, and fall, with no differences among those three seasons.

## INTRODUCTION

*Metapenaeus affinis* is a member of a group of shrimp species that are found in the world, including the Arabian Gulf, the Indian Ocean, and the internal waters of Iraq. It is considered one of the commercially important species in the Iraqi marine catch, with two reproductive peaks **(Al-Maliky *et al.*, 2009; Al-Maliky, 2013)**. The life cycle of shrimp plays a crucial role in the environment. Studying the environmental and biological characteristics of shrimp provides valuable insights into the life cycle of each species.

Nutritional requirements in shrimp are generally higher in sexually mature adults compared to non-reproductive adults and juveniles, although knowledge in this area remains limited **(Arshadi *et al.*, 2020)**.

The seasonality of gonad development in tissues is associated with the storage of organic and mineral reserves, which are transferred to the reproductive glands during gamete formation. It is expected that, during gonad development, energy reserves in the liver are utilized, so the values of the gonadal and hepatic indices are expected to vary inversely with some of these reserves **(Abdel-Mohsena, 2017)**. The condition coefficient is an index calculated from weight and length and indicates the interaction between living and abiotic factors in the biological state of aquatic organisms **(Solanki *et al.*, 2020; Prajapati & Ujjania, 2021)**. **Yamane *et al.* (2022)** studied the reproductive cycle of shrimp *Metapenaeus ensis* in the Gulf of Japan by studying seasonal changes in the development of their ovaries. The results showed that reproduction continued from July until September and that there were more than two reproductive cycles.

Marine species of shrimp are the most commercial, and in Iraq, there are several economically important species in stock, but they are not exploited by farming. Previous studies on the life cycle of *M. affinis* and other shrimp species in Iraq include those by **Al-Maliky (2017)**, **Al-Maliky *et al.* (2019)**, **Al-Maliky *et al.* (2021)**, **Al-Maliky (2022a)** and **Al-Maliky (2022b)**.

The importance of the current study lies in providing data on the life cycle of shrimp, addressing the lack of scientific information in this field.

## MATERIALS AND METHODS

Samples of shrimp were collected from the Al-Faw area - covering the period from January the 1st to December the 1st, 2022. Once the samples arrived at the laboratory, tests were conducted, and females were separated from males, following the methodology of **Al-Maliky (2013)**. Weight was measured using a sensitive scale, while height was measured using a vernier. After dissection, the liver and gonads were weighed according to the procedures outlined by **Htun-Han (1978)** and **Ohtomi and Yamamoto (1997)**:

Hepatic function (HSI) = liver weight (g) / body weight (g) * 100

Sexual function (GSI) = gonad weight (g) / body weight (g) * 100

Condition factor (CF) = (body weight - gonad weight) g / cubic length of shrimp ($cm^3$) * 100

### Statistical analysis

One-way ANOVA was applied to analyze and compare the results of the study by using the SPSS program.

## RESULTS AND DISCUSSION

The seasonal variations in the reproductive and hepatic functions of male shrimp are illustrated in Fig. (1). Reproductive function peaked during summer and exhibited its lowest in winter, while hepatic function reached its highest values in winter and its lowest in spring. For reproductive function in males, no significant differences were observed between spring and winter or between summer and fall (Table 1). However, for females, significant differences were observed between spring and the other seasons showing no significant differences among themselves (Fig. 2 & Table 1).

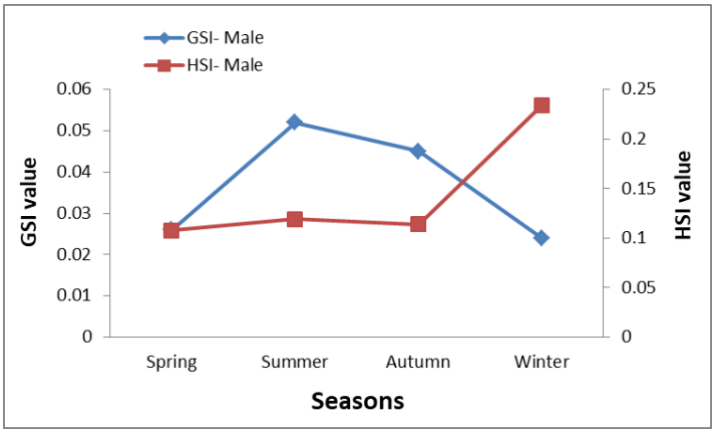


**Fig. 1.** Seasonal changes in GSI and HSI of males of *M. affinis*

**Table 1.** Seasonal changes in gonadosomatic index, hepatosomatic index, and condition factor for shrimp *M. affinis* (mean± standard error)

| Seasons | Gonadosomatic Index | | Hepatosomatic index | | Condition factor | |
|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Male | Female |
| Spring | 0.026±0.020 a | 0.979±0.350 a | 0.108±0.032 a | 0.265±0.223 b | 8.697±1.899 a | 9.004±1.214 b |
| Summer | 0.052±0.024 b | 0.972±0.491 b | 0.119±0.084 a | 0.337±0.213 b | 13.789±9.618 b | 9.234±2.923 b |
| Autumn | 0.045±0.024 b | 0.610±0.298 b | 0.114±0.084 a | 0.404±0.273 b | 9.808±5.674 b | 9.499±2.078 b |
| Winter | 0.024±0.019 a | 0.549±0.320 b | 0.234±0.158 b | 0.295±0.285 b | 9.172±2.120 b | 8.925±3.352 b |

Different letters mean there are significant differences, and similar letters mean there are no significant differences.

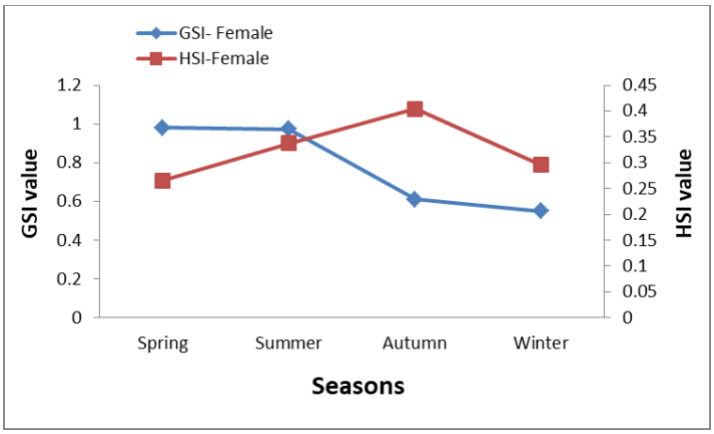


**Fig. 2.** Seasonal changes in GSI and HSI of females of *M. affinis*

In males, hepatic function showed a significant difference between winter and the other seasons, which did not differ significantly among themselves. In females, no significant differences in hepatic function were observed across the seasons (Fig. 3).

Fig. (4) depicts the reproductive and hepatic functions of females. Reproductive function was at its highest in summer and lowest in winter, while hepatic function reached its highest in fall and lowest in spring.

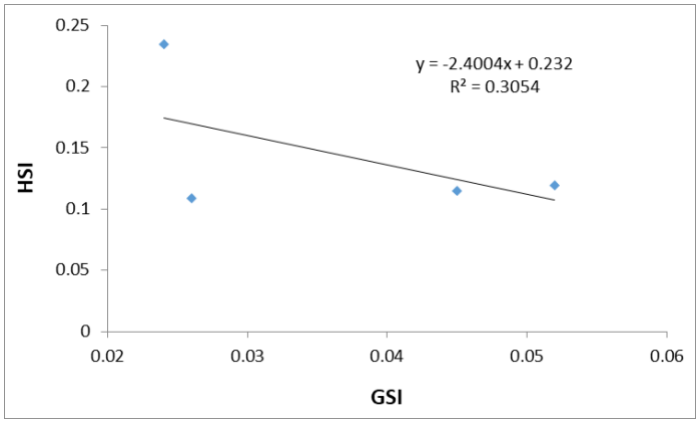


**Fig. 3.** Regression analysis between GSI and HSI of males of *M. affinis* collected in seasons (spring, summer, autumn and winter) 2022

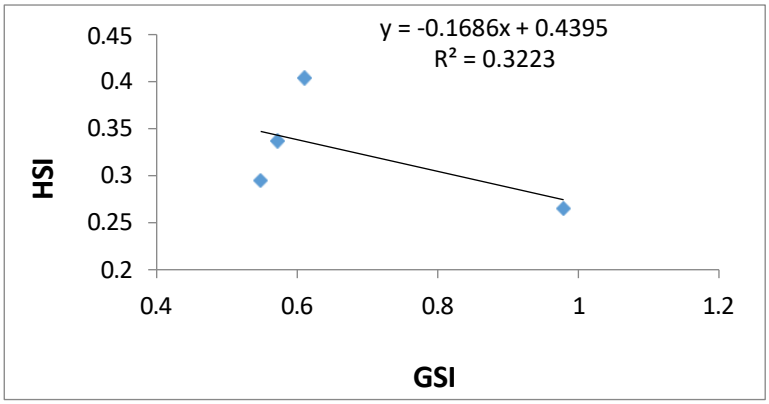


**Fig. 4.** Regression analysis between GSI and HSI of females of *M. affinis* collected in seasons (spring, summer, autumn and winter) 2022

A comparison of the condition of male and female shrimp across the seasons of the year shows that the highest values were recorded for males in summer, while the lowest values were recorded in spring for both males and females (Fig. 5).

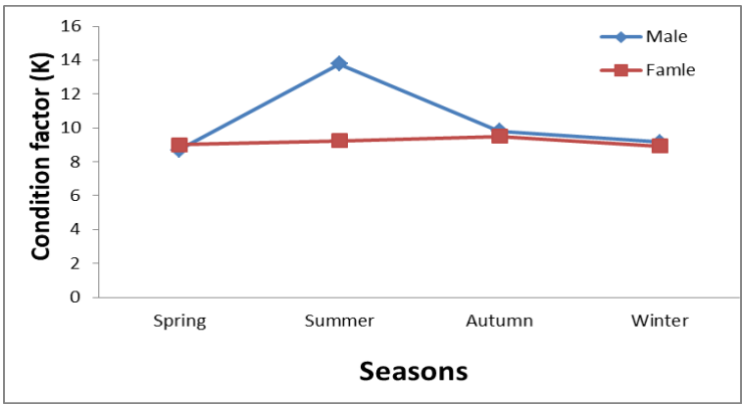


**Fig. 5.** Seasonal changes in condition factor for male and female *M. affinis*

**Al-Maliky *et al.* (2015)** studied *Macrobrachium nipponense* and found a male-to-female ratio of 3.8:1, along with correlations between maternal weight, egg weight, and the number of hatched larvae. In the current study, the condition coefficient for males showed significant differences between spring and the other seasons, while for females, no significant differences were observed across seasons.

**Fatihah *et al.* (2022)** reported five stages of gonadal maturity in *Macrobrachium rosenbergii*, noting that the gonadosomatic index (GSI) was significant in females but not in males. The species reproduced multiple times throughout the year, with reproduction occurring year-round. Similarly, **Abdel Mohsen *et al.* (2017)** found that male *Portunus pelagicus* crabs reached peak sexual maturity in winter, while females peaked in spring. Their study also indicated an inverse relationship between gonadal and hepatic indices across seasons, with this pattern being more pronounced in males than in females.

**Mansasirli (2015)** described the reproductive characteristics of *Metapenaeus monoceros*, noting a male-to-female ratio of 1.4:1, a mature female size of 74mm, and two peak egg-laying periods: from June to July and from August to October. **Suryanti *et al.* (2018)** explored the relationship between length, weight, and the condition coefficient in *Penaeus merguiensis*. Their results showed a strong correlation (over 90%) between shield length and body weight for both sexes, with condition coefficient values ranging from 0.570 to 1.773.

The current study aligns with these findings, showing distinct reproductive cycles for male and female shrimp, with females exhibiting higher gonadal function values than males. This suggests continuous spawning in females, especially during spring and summer.

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## CONCLUSION

The study found that reproductive function in male *M. affinis* is most significant during the spring and summer seasons, with the highest values observed in the summer and the lowest in the winter. In females, reproductive function is significant only in spring, with the highest values in both spring and summer, and the lowest in winter. Hepatic function in males is most significant in winter, with the highest values in winter and the lowest in spring. In females, hepatic function is at its highest in fall and lowest in spring. The condition coefficient for males is significant in spring, with the highest value recorded in summer and the lowest in the spring. In the remaining seasons, the condition coefficient remains consistent, as it does for females.

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## CONFLICTS OF INTERSTS

The authors declare that they have no competing interests.

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