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**Research Article**

# Feeding and reproductive biology of *Babylonia spirata* (Linnaeus, 1758) in the northern Oman Sea

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**Abstract**

In this research, spiral babylon (*Babylonia spirata* L.) specimens were collected by special circular traps from different depths up to 60 m based on the snail distribution from September 2021 to May 2022. The snails were sampled monthly and transferred to the laboratory after counting and washing. The examination of stomach contents showed that this snail species had a scavenger diet and mostly fed on animal corpses including oysters, clams, squids, and shrimps, as well as fish such as Leiognathidae. The length at sexual maturity for females and males were 31.1 and 32.5 mm, respectively. *B. spirata* had a reproductive potential in all seasons and therefore, this is a gonochronic species with internal fertilization. The females had two spawning peaks with the weakest in autumn and the strongest in winter. Also, the main spawning season for this species was estimated from November to March 2022. At the breeding season, the majority of the stomachs were empty with poor feeding.

**Keywords:** Spiral babylon, Feeding behavior, Spawning periodicity, Length composition, Oman Sea

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## Introduction

The spiral babylon (*Babylonia spirata*, Linnaeus, 1758) belongs to the class *Gastropoda* and the family *Babyloniidae*, which is found in the Oman Sea. This species inhabits pelagic and benthic zones up to the depths of 60 m. It is also distributed in the mud and sand beds of tropical and semitropical parts of tidal areas in the Indian Ocean and a little distribution in the western Pacific Ocean (Mohan, 2007). This gonochronic species spawns in a large number per year at a preferred temperature range of 25-29°C. It has a scavenger diet and, feeding on the aquatic animal dead bodies (Sealifebase, 2021). *B. spirata* has a commercial and export values (around 1-2 USD per kg depending on the size), and therefore, its catch from natural habitats has been increased in recent years.

This study aimed to investigate the feeding, spawning season, and fertility stages of *B. spirata* in the Oman Sea.

## Materials and methods

*Sampling areas*

This survey was conducted in four sampling sites in the northern Oman Sea (Fig. 1).

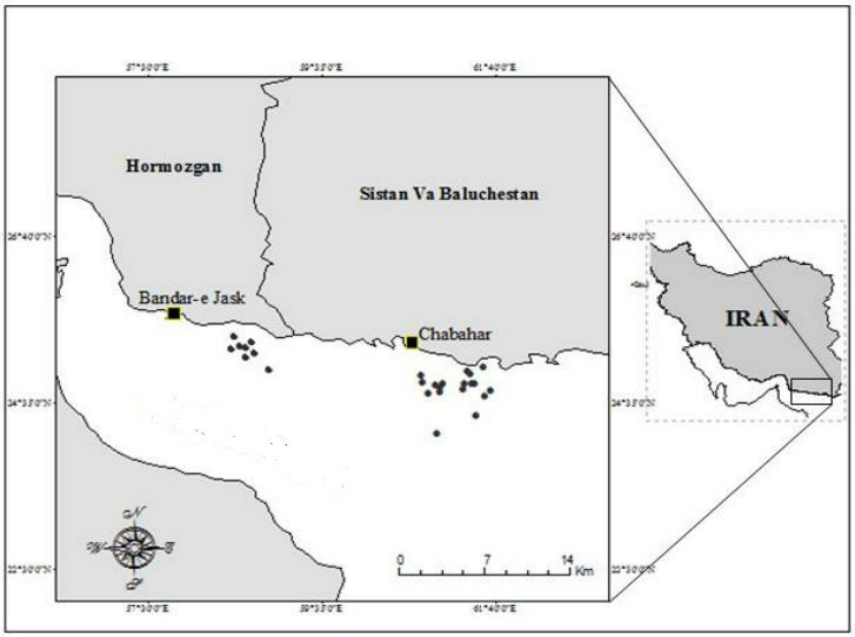


**Figure 1: Sampling sites of *Babylonia spirata* in the northern Oman Sea.**

*Sampling*

*B. spirata* samples were collected by special circular traps (Fig. 2) from different depths up to 60 meters (based on the dispersal of snails) for one year from September 2021 to May 2022. Generally, Trapes was located at a depth of 40 meters and their openings was 20 to 40 cm. Sampling was not conducted between June 2022 to August 2022 as a result of stopping fishing efforts in the monsoon conditions. The samples were collected from the sampling sites randomly and transferred to the laboratory after counting and washing.


**Figure 2: Special circular trap containing a net bag and an iron frame for catching *Babylonia spirata***

*Length-weight relationship*

Biometry was performed using a caliper with an accuracy of 0.1 mm and a digital scale with an accuracy of 0.001 g, followed by recording the frequency rate. After that, the relationship between the total lengths and weights of the samples was calculated using the following formula (Mohan, 2007):

$W = aL^b$

In this relationship, (W) is snail weight in grams, (L) is the length of the existing shell in mm, (a) is a constant value, and (b) is regression coefficient

*Feeding behavior*

For each month, 50 snails were measured biometrically (the height, width, and length of the spiral), and the status of feeding and reproduction was examined in 450 samples.

Data were then analyzed statistically (the length at sexual maturity and spawning season) by Excel software. Feeding fell under three empty and weak, actively feeding, and full stomach states to examine the contents of the specimens.

In order to examine feeding, the snails were cut from the ventral part of the samples to remove their digestive system. Then, their stomach was separately weighed. Afterward, the digestive system was split and the stomach content was examined in terms of fullness and emptiness. The weights of stomach contents were measured after their separation. The undigested and semi-digested parts were also identified using a stereomicroscope based on valid identification keys. The stomach fullness index was investigated. *B. spirata* is a scavenger species that feeds on decaying materials and animal carcasses located in the bed. This index was based on three-quarters (3/4), one second (1.2), and one-quarter (1.4) of the space occupied by foodstuffs in these stomachs.

3/4 = three-quarters of the stomach space is occupied and the stomach is full with full feeding.

1/2 = half of the stomach is occupied and the snail is actively feeding.
1/4 = less than a quarter of the stomach is occupied, suggesting empty stomachs and poor feeding (Mohan, 2007).
The gastric index GaSI was calculated based on the following formula:
*GaSI = Ws/Wb * 100*
Where, *Ws* is the stomach weight (g) and *Wb* is the body weight (g) (Biswas, 1993).

*Reproduction*
In this snail species, the gonads are located on the right side of the head behind the tentacles. Male and female gonads were distinguished by dissecting the samples. The stage of sexual maturation was determined using the 4-stage method, in which stage 4 represents a fully mature snail (in general, the females of stages 3 and 4 were considered to be mature). To determine the sex composition and sex ratio, the number of male and female samples was recorded monthly during the research period. The gonadosomatic index (GSI) was also examined monthly for both males and females and computed as a follow (Mohan, 2007):
*GSI = GW/BW * 100*
Where, *GW* (g) is the weight of sexual organs and *TW* (g) is the total body weight.

*Length at first maturity*
The length (TL) at first maturity (LM50) was estimated by the Logistic model using the formula Y=1/1+exp (-a-bX). In this equation, (Y) is the ratio of all mature males and females to all individuals in a group, (x) is the total length (cm), and (a) and (b) are constant correlation coefficients (King, 2007). The biological data obtained in this project were statistically analyzed using Excel and R Software.

**Results**
xamination of the stomachs of *B. spirata* shows that this snail shell had a scavenger diet and on the remains of animals. In general, the majority of the stomachs were full with full feeding from April to May and from September to October while the stomachs with actively feeding/weak feeding/relatively empty status were observed from November to March. The study of the breeding of this species revealed two peak season of spawning, with weaker and stronger peaks in autumn and winter, respectively. The majority of the empty stomachs with poor feeding were observed at the season of reproduction.
The results of the relationship between the lengths and the weights of *B. spirata* show in Figure 3. The length and the weight ranges observed in the examined samples were 20-50 mm and 5-30 g, respectively. The snail shells with lengths of about 30-32 mm were matured.

Examination of the average lengths and weights of this species showed an upward trend from September 2021 to December 2022, reaching its maximum value in December, with a downward trend until April. In fact, while the

snails were at the stage of sexual maturity to stage 3 and finally stage 4, the maximum lengths and weights were observed in December (Fig. 4).

Estimation of the GSI of *B. spirata* showed that the peak season of sexual maturity in both males and females of this species occurred from November to March, and the highest sexual maturity (the sexual stages 3 and 4) occurred in these months.

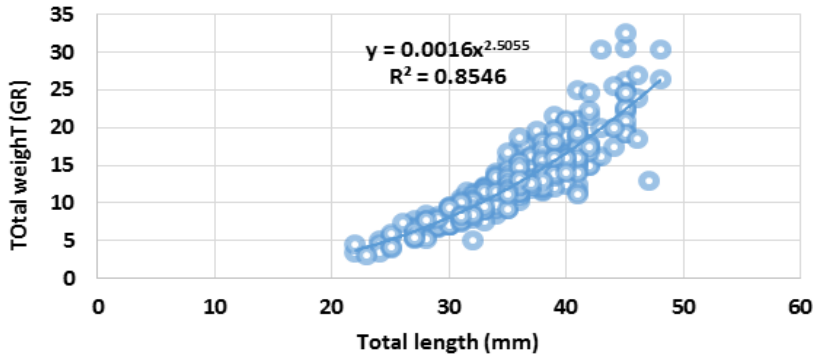


**Figure 3: The length–weight relationship of *Babylonia spirata* in the northern Oman Sea.**

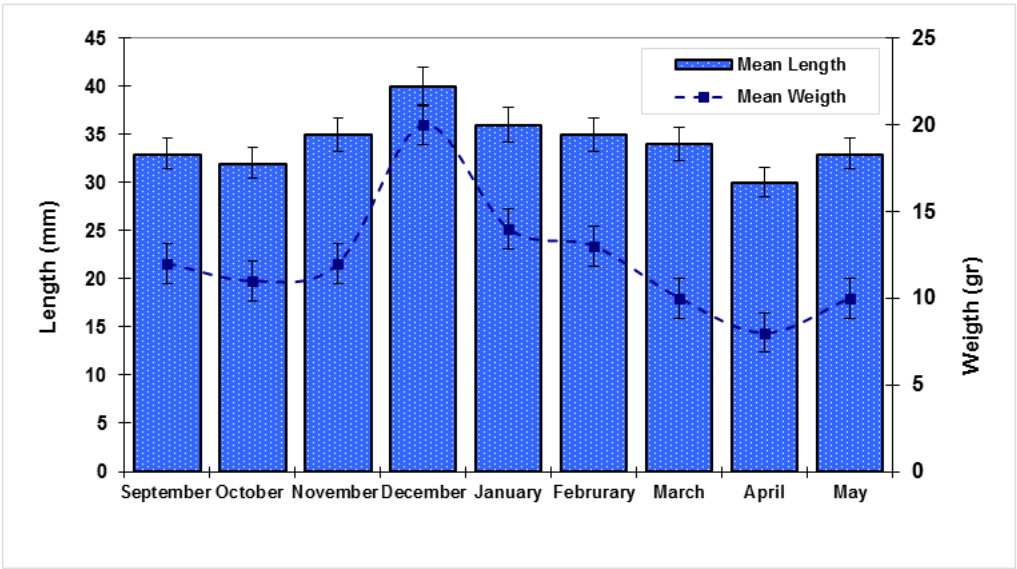


**Figure 4: The average length and weight of *Babylonia spirata* in the northern Oman Sea.**

Moreover, the gastric index showed that the stomach fullness index reached its lowest value in these months, that indicated poor feeding status in the peak months of sexual maturity, It reached its lowest and highest values in November and April, respectively (Fig. 5).

The results of the spawning season in this species showed that stage 4 of sexual maturity occurred from November to January, that indicated the peak season of female spawning of snail shells in this study occurred in these months. In fact, the highest value of stage 4 was observed in November, December, and January (Fig. 6).

Every aquatic organism matures after reaching a certain size. Therefore, similar to the length-age guide, the length-maturity guide will be useful in evaluating the maturity stages of aquatic species. In this study, the length at sexual maturity of *B. spirata* was obtained for females and males 31.1 and 32.5 mm, respectively (Figs. 7 and 8).

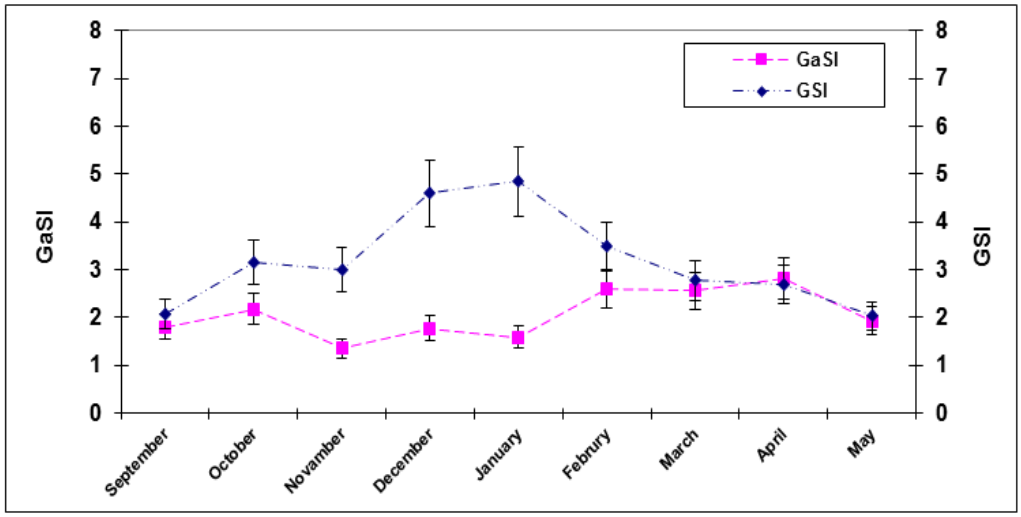


**Figure 5: The trend of the GaSI and GSI of *Babylonia spirata* throughout the sampling period.**

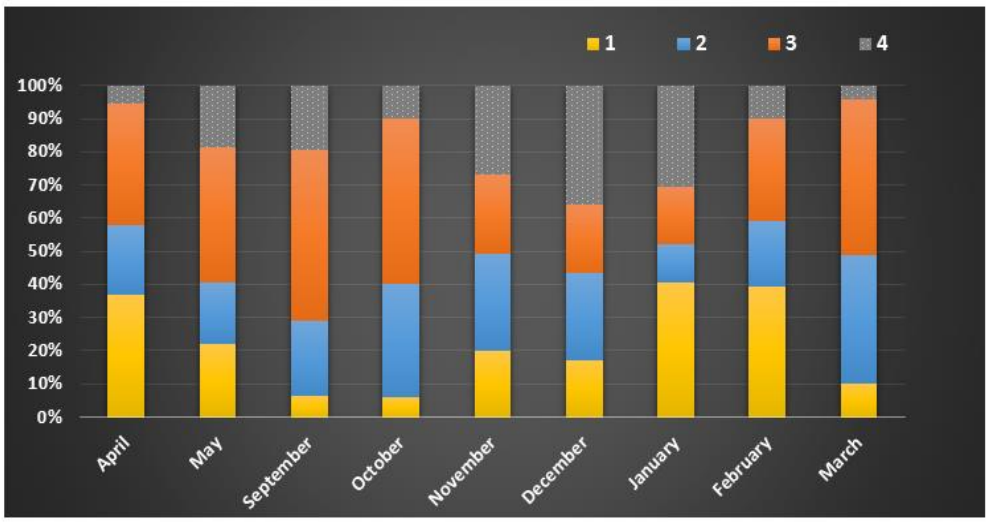


**Figure 6: The trend of sexual maturity and spawning season of female *Babylonia spirata* in the northern Oman Sea.**

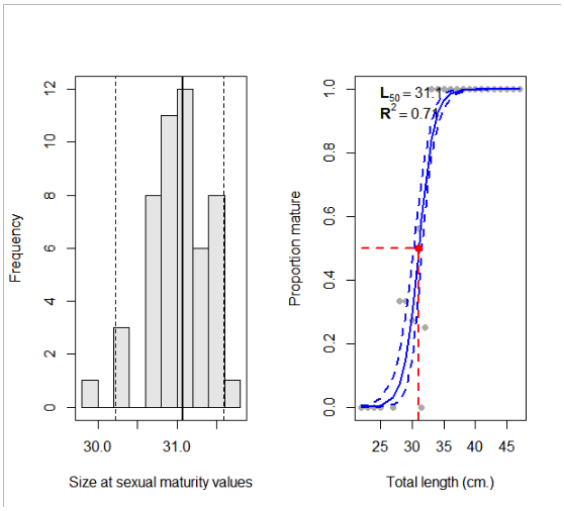


**Figure 7: The length at sexual maturity for females of *Babylonia spirata* in the northern Oman Sea.**

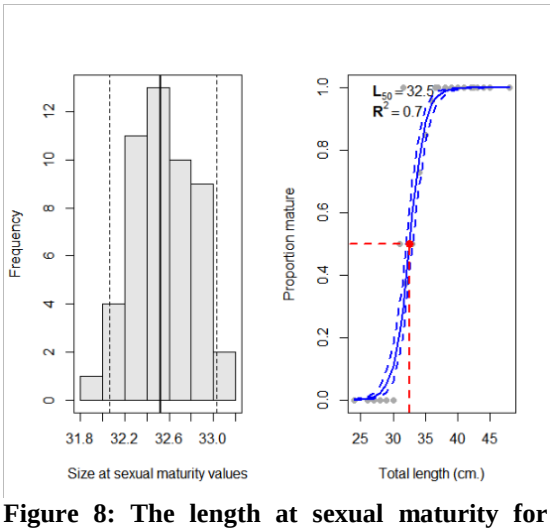


**Figure 8: The length at sexual maturity for males of *Babylonia spirata* in the northern Oman Sea.**

Examination of the trend of changes in the female GSI showed that it increases with decreasing in temperature and had a direct relationship with decreasing in water temperature. There was an increasing trend of GSI from November to March, and the highest GSI was observed in January (Fig. 9).

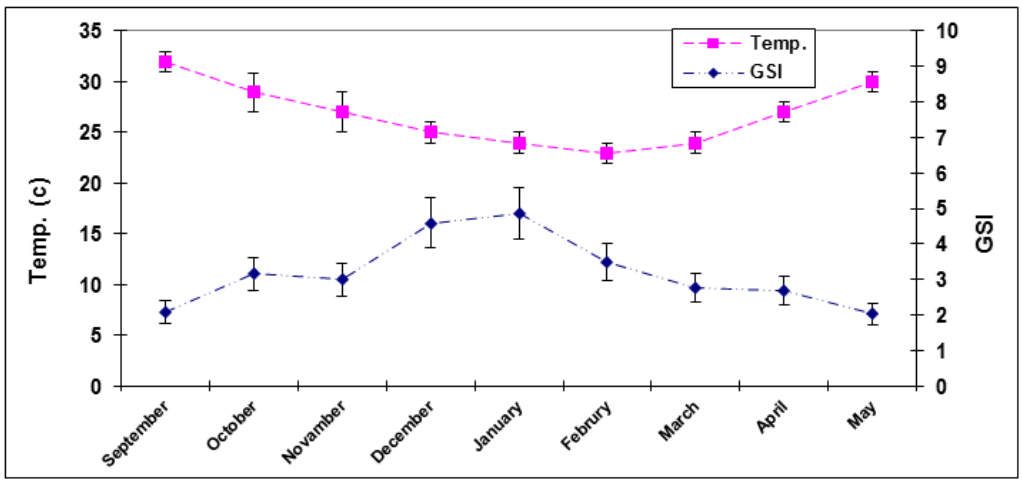


**Figure 9: The trend of changes in the female GSI of *Babylonia spirata* with temperature changes in the northern Oman Sea.**

## Discussion

Food preference and composition of *Babylonia spirata* in India, the feeding season of different organisms was examined as a food source, including oyster (*Crossostera madrasensis*), green mussel (*Perna viridis*), clam (*Meretrix meterix*), squid (*Loligo* sp.), mantis shrimp (*Oratosquilla* sp.), prawn (*Penaeus indicus*), and fish (*Leiognathus* sp.). The results showed that the snails spent less season finding oyster meats and more season finding

crab ones Gittenberger and Goud (2003).

In another study carried out by Indian researchers, the peak season of spawning in this species was estimated after the monsoon from January to March, and it continued until May (Shanmugaraoi *et al.,* 1994). The morphometric and meristic characteristics was examined and compared by Gittenberger and Goud (2003).

A Study eco-biology and fisheries of two species of *B. spirata* (Gastropoda) on the coasts of India, indicated that this species spawned throughout the year, and its peak season of spawning was reported on February, May, September, and October. In fact, the males and females were sexually mature throughout the year, and the females had two peak season of spawning, with a weaker peak from July to November and the stronger spawning peak from December to April (Mohan, 2007).

A study of *B. spirata* which was first reported in Singapore (Fraussen and Stratmann, 2013), indicates that there were about 15 pelagic species in the genus *Babylonia* that dispersed in Indian and the Pacific Ocean. Furthermore, these species are used as seafood in many countries, including China, India, Indonesia, Japan, Thailand, Taiwan, and Vietnam. Trawls and traps with baits are the main catch method of these species (Tan and Low, 2013).

In a study on *B. spirata* in the Gulf of Mannar, this species was found to be gonochronic, and snails with a shell length of about 20 mm were considered mature, with a sex ratio of 1:1 between the males and females. Furthermore, the color of the testis varied from yellow to orange, the eggs were dark brown, and the fertilization potential was internal. In addition, this species has a great impact on the tradition and economy of India and is very popular with ordinary people (Duria, 2018). In the present study, the length at sexual maturity for this species was calculated to be 31.9 mm, that was higher than that from the Gulf of Mannar. A study on the regional pollution on the coasts of Indonesia in 2017 showed that some marine species in the region including *B.spirata* were exposed to a serious danger of extinction due to regional pollution (Nuraini *et al.,* 2020).

The optimal catch rate of *B. spirata* on the coasts of the Indus River in Pakistan (the main catch area of this species in Pakistan) was estimated to be less than 200 tons per year, It may have been due to its over-exploitation in the long term which made reservation of this species. Catching at the peak season of spawning and increasing pollution will also cause problems in the reserve status of this species (Muhammad *et al.,* 2018).

A recent survey on the exploitation status of *B. spirata* in the northern Oman Sea indicated that this species showed recruitment patterns in all months of the year and has two major peak seasons of recruitment pattern during the year. Based on the P/B index, this species seems to have high

rates of production. Additionally, the utilization factor was hyper-optimal (presence of overfishing), and measures such as reducing exploitation have been recommended to maintain and sustain the catch of this species (Hashemi, 2022).

Northern Oman Sea is the natural habitat of these snails, Thus, the feeding and biology of reproduction of this species is very important in Iran. Therefore, the data of this project can be used by ecological and biological department for management of its population. As a result of this study and previous researches, the catch of this species should be managed during its peak season of spawning. However, further studies on feeding and reproductive biology of this aquaculture species should be carried out in Iran.

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