Reproductive Biology of the Bunni Mesopotamichthys sharpeyi (Günther, 1874) from Southern Missan Province Marshes, Southern Iraq

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INTRODUCTION

The Bunni, Mesopotamichthys sharpeyi (Family: Cyprinidae) is a very highly exploitable species, which suits the consumer’s desires in the central and southern Iraq (Mohamed & Al-Jubouri, 2019). The genus of this species was shifted to Mesopotamichthys after it was inserted under the Barbus genus (Borkenhagen, 2014). The species is native to the Tigris-Euphrates basin. After being inserted under the Barbus genus, the genus of this species was changed to Mesopotamichthys (Abdullah, 2020).

It was necessary to re-evaluate the species’ reproductive strategy and compare it with previous studies carried out in the region and its vicinity. There is a crucial need to study the reproductive biology of fish in order to develop appropriate strategic plans for the
management and maintenance of fishery resources associated with the collected information about the species life history. The assessment of the effects of environmental changes on current fish population dynamics and knowledge of the reproductive pattern require a development in the commercial aquatic aquaculture sector (Muchlisin et al., 2010; Muchlisin, 2014).

The reproduction is an important process that indicates the continuity of life. It enhances recruitment maintenance and offspring survival, and assesses the effects of habitats shifting on fish assemblages, the success of the commercial aquaculture, and on stocks potential as well (Muchlisin, 2014; Kant et al., 2016). The reproductive strategies in fish are mainly responses to the anatomical differences between males and females. The targeted reproductive strategy depends on the magnitude of passing the genes to subsequent offspring, forming new generations capable of reproducing and recruiting new individuals (Abdullah & Al-Noor, 2015).

Fecundity in fishes includes the total number of matured oocytes released from females at the spawning season and is species-specific (Abdullah et al., 2017). Fecundity can be split into several types, viz. potential annual fecundity, total fecundity, annual realized fecundity, relative fecundity, annual population fecundity and batch fecundity (Muchlisin, 2014).

The reproductive biology of M. sharpeyi was recorded in the study of Marammazaei et al. (2000) who stated that Bunni spawns in Shadigan marsh (Khuzestan Province) in March. Al-Mukhtar et al. (2006) discussed the reproductive biology of M. sharpeyi in Al-Huwaizah Marsh in southern Iraq. They recorded the spawning time of this species in March and it prolonged to April. Hashemi et al. (2014) investigated some biological aspects of M. sharpeyi in Shadegan wetland, Iran and they mentioned that the spawning occurred from April to July. Mohamed and Al-Jubouri (2020) conducted a comparative study on the growth, reproductive, and food habits of M. sharpeyi in the Al-Diwania River, in the middle of Iraq.

Due to the continued stock reduction in southern Iraq, there was no available data on the reproductive biology of M. sharpeyi from the southern Missan Province Marshes. Thus, the present study aimed to highlight the gonado-somatic index (GSI), absolute fecundity, relative fecundity, and condition factor, evaluating some relationships between reproduction and morphometric characters. The current data was implemented to be compared to the results of previous studies.

**MATERIALS AND METHODS**

A total of 496 specimens (312 females and 184 males) of Mesopotamichthys sharpeyi were monthly caught during the period from June 2020 to May 2021 in southern Missan Province Marshes (N 31° 15’ 57.6", E 47° 07’ 39.36"). Various fishing methods were used to obtain the fish samples, gill nets (22×22, 27×27, 30×30 and 57×57mm mesh size, 30m long), cast nets and electro-fishing. Samples were deposited in the ice-box and brought to the laboratory for further work. Several measurements were implemented for mature fishes. The total length was measured to the nearest 0.1cm; body weight and gonad weight were recorded to nearest 0.1g; gonad length to nearest 0.1cm; egg diameters in microns (µ). Fishes were identified following the description of Fricke et al. (2021). The gonadosomatic index (GSI) is examined two to three times in a month and calculated according to the following equation:

\[
\text{GSI} = \frac{\text{gonad weight}}{\text{Body weight}} \times 100
\]
Absolute fecundity was determined using gravimetric methods application (Bagenal, 1978). Gonads of ripe females were exacted; an average of three subsamples of gonad eggs were counted taken from various locations to obtain the absolute fecundity. Relative fecundity was determined by the successive equation:

\[
\text{Relative fecundity} = \frac{\text{Absolute fecundity}}{\text{body weight (g)}}
\]

The objective micrometer (\(\mu\)) was used to measure the egg diameter. The morphometric and reproductive variables were determined using the relationship between weight (g) and length (cm). Then the equation was converted to a linear regression by using the consequential log equation: \(W = a L^b\) (Le Cren, 1951)

\[
\log W = \log a + b \log L
\]

Where, (a) and (b) are constants. Furthermore, the calculated weight (Wc) was estimated using the above weight-length relationship, referring to the observed weight as (WO). The relative condition factor (Kn) was determined according to the consequent relationship:

\[
K_n = \frac{W_O}{W_c}
\]

Statistical analysis

The data were analyzed using the SPSS program, version 20, and the statistical application of ANOVA was used to determine the significance of differences in GSI between males and females. The same program was implemented to estimate the correlations among morphometric and reproductive parameters. A student t-test was done due to the negative allometric growth (less than 3) value of coefficient (b).

RESULTS

Fish length and weight frequency distribution

A total of 496 individuals of bunni M. sharpeyi were sampled from the southern marshes of Missan Province during the study periods, with 23 fish in August to 56 fish in March (Table 1). The specimens’ length varied from 18 cm in June to 46cm in September and January. The length means fluctuated between 31.28±4.77cm in December to 43.46±1.36cm in January. The weight ranges of fishes differed from 143g in June to 1400g in January 2021, while the weight mean values ranged from 513.08±191.90g in December to 1080.43±153.41g in January.

Gonadosomatic index (GSI)

Mature individuals (males and females) witnessed gradual variations in the gonadosomatic index (GSI) from June 2020 to May 2021. In females, the GSI mean values revealed a slow monthly increase from June (0.02), reaching a high value (16.93) in January and peaking (17.55) in March, then a decline was recorded with 8.81 in April and 0.09 in May. The mean values of the males slowly rose from June (0.05), attaining the peak of 8.39 in March, then started to decline to record 4.15 and 0.01 in April and March, respectively (Fig. 1).

The results showed that all individuals have a single spawning season that begins in two batches in March and lasts until April, but most specimens sampled in April were partial spawners. Whereas in May, all females and males were in the spent stage and the ovaries sacs
Reproductive biology of *Mesopotamichthys sharpeyi* from southern marshes, southern Iraq

were empty and strikingly red. No significant differences (P > 0.05) were detected in GSI values between females and males (Sig. = 0.060, F= 3.941).

**Table 1.** The total length and weight frequency distribution (ranges & means) of *Mesopotamichthys sharpeyi* from southern Missan Province Marshes

<table>
<thead>
<tr>
<th>Month</th>
<th>No. of Fish</th>
<th>Total length (cm)</th>
<th>Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Range</td>
<td>Mean ± SD</td>
</tr>
<tr>
<td>June 2020</td>
<td>39</td>
<td>18 - 42.20</td>
<td>32.12 ±7.97</td>
</tr>
<tr>
<td>July</td>
<td>28</td>
<td>26.9 - 40</td>
<td>34.40 ±4.19</td>
</tr>
<tr>
<td>August</td>
<td>23</td>
<td>25.60 - 42</td>
<td>35.81 ±5.99</td>
</tr>
<tr>
<td>September</td>
<td>53</td>
<td>24 - 46</td>
<td>34.52 ±6.50</td>
</tr>
<tr>
<td>October</td>
<td>46</td>
<td>23 - 45</td>
<td>32.75 ±6.87</td>
</tr>
<tr>
<td>November</td>
<td>42</td>
<td>21.60 - 41</td>
<td>32.07 ±6.56</td>
</tr>
<tr>
<td>December</td>
<td>37</td>
<td>21.40 - 36.50</td>
<td>31.28 ±4.77</td>
</tr>
<tr>
<td>January 2021</td>
<td>41</td>
<td>41.50 - 46</td>
<td>43.46 ±1.36</td>
</tr>
<tr>
<td>February</td>
<td>54</td>
<td>26 - 41.4</td>
<td>38.35 ±5.26</td>
</tr>
<tr>
<td>March</td>
<td>56</td>
<td>24.3 - 45</td>
<td>39.67 ±7.10</td>
</tr>
<tr>
<td>April</td>
<td>44</td>
<td>25.2 - 41</td>
<td>38.11 ±5.04</td>
</tr>
<tr>
<td>May</td>
<td>33</td>
<td>29 - 37.20</td>
<td>34.73 ±2.88</td>
</tr>
</tbody>
</table>

**Fig. 1.** Monthly variations in gonadosomatic index (GSI) of *M. sharpeyi* sampled from southern marshes of Missan Province

Error bars are referring to standard deviation

**Absolute fecundity and relative fecundities**

The total length of spawned females of the Bunni brooder ranged from 37.4 to 46 cm. Body weight varied from 755.50 to 1299.50g. The lowest absolute fecundity was recorded at 34371 eggs at a total length of 40.8 cm and a total body weight of 889.60g. The highest absolute fecundity was recorded at 224495 eggs at a total length of 44.1 cm and a total weight of 1171.30g. The relative fecundity varied between 38.64 (40.8 cm total length and 889.60 g weight) and 208.74 (44.1 total length with 1171.30g weight). Gonad weight ranged between 50.3g at 40.8cm total length to 351.1g at 45 cm total length, while gonad length varied from 13 cm at 37.4cm total length to 19 cm at a total length, ranging from 44.1cm to 46cm. Eggs’ diameters oscillated from 1352μ at a total length of 40.8cm to 1888μ at a total length of 40.5cm (Table 2).

The relationships between absolute fecundity and morphometric parameters of female *M. sharpeyi* from the southern marshes of Missan province are presented in Table (3) and
Fig. (2). A strong correlation coefficient \((r=0.81)\) appeared between absolute fecundity and fish total length; the equation inserted was as follows:

\[
\log F= 8.9939 + 8.5554 \log L.
\]

The relationship between absolute fecundity and fish body weight was forceful with correlation coefficient \((r=0.81)\), and the equation can be expressed as follows:

\[
\log F= -0.2899 + 4.2512 \log W.
\]

A powerful relationship was found between absolute fecundity and fish gonads weight, with a correlation coefficient \((r=0.85)\), and it can be addressed as:

\[
\log F= -4.0223 + 2.9664 \log W_g.
\]

A Strong positive relationship was detected between absolute fecundity and gonad length, the correlation coefficient \((r=0.82)\), and it can be expressed in the consequent equation:

\[
\log F= -0.2899 + 4.2512 \log L_g.
\]

A weak positive correlation was recorded between absolute fecundity and egg diameter, the coefficient of correlation \((r=0.32)\), and it can be recorded using the equation as follows:

\[
\log F= 4.2757 + 0.2079 \log D_{egg}.
\]

A strong positive relationship was showed between fish body weight and total length, the correlation coefficient \((r=0.85)\), and we can express it in the equation as

\[
\log BW= -0.9681 + 2.4481 \log TL.
\]

**Table 2.** Monthly changes in gonadosomatic index (GSI) values of Bunni, *M. sharpeyi* from southern Missan Province Marshes

<table>
<thead>
<tr>
<th>Total length, L (cm)</th>
<th>Body weight, W (g)</th>
<th>Gonad weight, W_g (g)</th>
<th>GSI</th>
<th>Gonad length, L_g (cm)</th>
<th>Absolute fecundity, F</th>
<th>Relative fecundity F/W*100</th>
<th>Eggs diameter, D_{egg} (µ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>37.4</td>
<td>903.90</td>
<td>76.5</td>
<td>8.46</td>
<td>13</td>
<td>45692</td>
<td>50.55</td>
<td>1456.00</td>
</tr>
<tr>
<td>39</td>
<td>755.50</td>
<td>80</td>
<td>10.59</td>
<td>15</td>
<td>51600</td>
<td>68.30</td>
<td>1340.00</td>
</tr>
<tr>
<td>40.5</td>
<td>878.30</td>
<td>71.6</td>
<td>8.15</td>
<td>15</td>
<td>42664</td>
<td>48.58</td>
<td>1356.00</td>
</tr>
<tr>
<td>40.5</td>
<td>789.80</td>
<td>125.1</td>
<td>15.84</td>
<td>17</td>
<td>37530</td>
<td>47.52</td>
<td>1888.00</td>
</tr>
<tr>
<td>40.8</td>
<td>889.60</td>
<td>50.3</td>
<td>5.65</td>
<td>15</td>
<td>34371</td>
<td>38.64</td>
<td>1352.00</td>
</tr>
<tr>
<td>40.8</td>
<td>1027.30</td>
<td>76.7</td>
<td>7.47</td>
<td>14</td>
<td>45766</td>
<td>44.55</td>
<td>1510.60</td>
</tr>
<tr>
<td>40.9</td>
<td>1024.00</td>
<td>85.1</td>
<td>8.31</td>
<td>16</td>
<td>48013</td>
<td>46.89</td>
<td>1566.50</td>
</tr>
<tr>
<td>41.4</td>
<td>920.90</td>
<td>145</td>
<td>15.75</td>
<td>16</td>
<td>85256</td>
<td>92.58</td>
<td>1653.60</td>
</tr>
<tr>
<td>41.6</td>
<td>973.20</td>
<td>92.4</td>
<td>9.49</td>
<td>17</td>
<td>75738</td>
<td>77.82</td>
<td>1378.00</td>
</tr>
<tr>
<td>42.3</td>
<td>1096.40</td>
<td>108</td>
<td>9.85</td>
<td>18</td>
<td>115457</td>
<td>105.31</td>
<td>1534.00</td>
</tr>
<tr>
<td>43.3</td>
<td>1036.00</td>
<td>186.1</td>
<td>17.96</td>
<td>17.5</td>
<td>113431</td>
<td>109.49</td>
<td>1560.00</td>
</tr>
<tr>
<td>44.1</td>
<td>1171.30</td>
<td>241.2</td>
<td>20.59</td>
<td>19</td>
<td>244495</td>
<td>208.74</td>
<td>1534.00</td>
</tr>
<tr>
<td>44.8</td>
<td>1299.50</td>
<td>279.5</td>
<td>21.51</td>
<td>19</td>
<td>158411</td>
<td>121.90</td>
<td>1682.00</td>
</tr>
<tr>
<td>45</td>
<td>1273.90</td>
<td>351.1</td>
<td>27.56</td>
<td>19</td>
<td>167523</td>
<td>131.50</td>
<td>1596.40</td>
</tr>
<tr>
<td>45.5</td>
<td>1267.20</td>
<td>285.3</td>
<td>22.51</td>
<td>19</td>
<td>114521</td>
<td>90.37</td>
<td>1485.60</td>
</tr>
<tr>
<td>46</td>
<td>1172.50</td>
<td>140</td>
<td>11.94</td>
<td>19</td>
<td>130815</td>
<td>111.57</td>
<td>1451.33</td>
</tr>
<tr>
<td><strong>Mean 42.12</strong></td>
<td><strong>1029.96</strong></td>
<td><strong>149.6</strong></td>
<td><strong>13.9</strong></td>
<td><strong>16.7</strong></td>
<td><strong>94455</strong></td>
<td><strong>87.14</strong></td>
<td><strong>1526.13</strong></td>
</tr>
<tr>
<td><strong>S.D 2.45</strong></td>
<td><strong>171.26</strong></td>
<td><strong>92.0</strong></td>
<td><strong>6.54</strong></td>
<td><strong>1.99</strong></td>
<td><strong>59540.99</strong></td>
<td><strong>44.76</strong></td>
<td><strong>138.53</strong></td>
</tr>
</tbody>
</table>

\(D_{egg}\) = egg diameter; \(F\) = absolute fecundity; \(GSI\) = gonadosomatic index; \(L\) = total length; \(L_g\) = gonad length; \(W\) = body weight; \(W_g\) = gonad weight.
Table 3. The relationships between reproductive and morphometric parameters of *M. sharpeyi* female from southern marshes of Missan Province

<table>
<thead>
<tr>
<th>Relationships</th>
<th>a</th>
<th>b</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute fecundity</td>
<td>Total length</td>
<td>-8.99</td>
<td>8.55</td>
</tr>
<tr>
<td>Absolute fecundity</td>
<td>Body weight</td>
<td>-4.02</td>
<td>2.97</td>
</tr>
<tr>
<td>Absolute fecundity</td>
<td>Gonad weight</td>
<td>3.01</td>
<td>0.9</td>
</tr>
<tr>
<td>Absolute fecundity</td>
<td>Gonad length</td>
<td>-0.29</td>
<td>4.25</td>
</tr>
<tr>
<td>Absolute fecundity</td>
<td>Egg diameter</td>
<td>-4.28</td>
<td>0.21</td>
</tr>
<tr>
<td>Body weight</td>
<td>Total length</td>
<td>-0.97</td>
<td>2.45</td>
</tr>
</tbody>
</table>

Fig. (2). The correlations between absolute fecundity and the total length, body weight, gonad length, gonad weight, egg diameter, body weight, and total length of *M. sharpeyi* female from southern Missan province marshes.

Length-weight relationship

The general equation for the relationship of length-weight of *M. sharpeyi* in southern Missan Province Marshes presented in Fig. (3) is as follows:

$$W = 0.0504 L^{2.6516}$$

The exponent (b) in the present relationship showed different values during the months for population length groups, which ranged from 18 to 46 cm, and weights fluctuating from 143 to 1404 g (Fig. 3). It was lower than 3 in January at 2.65 and was recorded 2.51 in February. The value rose to 2.95 in March and declined in April to 2.43. Since the (b) value
in the present equation is lower than 3.0, then it refers to negative allometric growth (t-test, b < 3, P < 0.05).

**Fig. 3.** Length-weight relationship of *Mesopotamichthys sharpeyi* from southern Missan Province Marshes

**Relative condition factor**

The relative condition factor ($K_n$) exhibits a fluctuation during the study period for fish length, with ranges from 18 to 46 cm. A high value was recorded in June 2020 (1.08), and then it started to decline to record 0.96 in September; whereas, a progressive rise was detected from October to January, then started to mark a steady depression reaching its lowest (0.93) in March to attain the highest 1.13 in May with the mean of 1.01±0.06 (Fig. 4).

**Fig. 4.** Monthly changes in the condition factor ($K_n$) values of *M. sharpeyi* from marshes of southern Missan Province

**DISCUSSION**

Generally, length and weight frequency distribution are two important variables used in measuring size development in organisms that exhibit growth in both length and weight. They represent basic parameters applied in biological information and fishery management (*Tagaraö et al.*, 2020). The two parameters are widely used to establish the mathematical equation between these variables, which is used to find one of the variables in terms of the other in the length and weight groups of fish, and there is a close correlation between reproductive and morphometric parameters (*Abdullah et al.*, 2017). However, there were some differences in the distribution of length and weight in the monthly catch samples due to the increase in the means of length and weight and the abundance of catgut in February,
March, and April, which included a large ratio of males. This is attributed to the spawning migration of Bunni for the purpose of reproduction, which facilitated fishing (Al- Mukhtar et al., 2006; Taylor et al., 2016).

During the analysis of the monthly collected data, it was discovered that the males began their reproductive migration at a similar or slightly smaller size than the females. These findings correspond to those recorded by several authors that have been reported from various aquatic bodies from the middle and south of Iraq, referring to male and female length-frequency distributions. Al-Hakeim (1976) in Al-Razaza Lake postulated that males were smaller than females, while Jasim (1988) pointed out that most size population range from 21 to 23.4 cm in the South Al-Hammar Marsh, whereas Al-Mukhtar et al. (2006) in Al-Huwaizah Marsh found an increase of mean length at the spawning season, starting with small-sized fish, which are mostly males. On the other hand, Mohamed & Al-Jubouri (2020) in Al-Diwaniya River, central of Iraq, mentioned that mean values of length group ranged between 11 to 40 cm.

The GSI mean values of the M. sharpeyi population reached their highest in March and April, then they were found in a spent stage in May for both sexes, suggesting that females lay eggs in batches during the spawning period. Jasim (1988) in Al-Hammar Marsh stated that the spent period of M. sharpeyi is in April, while Al-Mukhtar et al. (2006) reported that the spawning stage in Al-Huwaizah Marsh begins in March and span to April, these results are closely similar to those of the present findings. Hashemi et al. (2014) mentioned that the spawning occurs from April to July in Shadegan wetland, Iran. In addition, Mohamed and Al-Jubouri (2020) reported that the highest level of GSI in the Al-Diwaniya River, in the middle of Iraq, was in April. The differences in the spawning time in poikilothermic organisms could be attributed to geographical differences and other environmental conditions. However, gonad development is related to other several factors, i.e. nutrition, genetics, brood fish, spawning frequencies, fish health, and status, which have a great role in specifying the reproductive time of fishes (Abdullah et al., 2017).

Fecundity differs due to differences in species reproductive strategy. Most studies linked the high fecundity value to fishes that live in open water compared to those building nests or Ovovivi-parus or Vivi-parus species, which are distinguished by the low number of eggs, large size, and parental care (Robart & Sinervo, 2019).

Fecundity studies play a significant role in possessing more reproductive biology knowledge which is essential to spawning success and transferring the genes feature to the next new offspring until it attains maturity and recruitment (Tagarao et al., 2020). Population fecundity is specific to species. Its common phenomenon differs from one species to another, and among individuals. It fluctuates in terms of time and locality and is affected by many factors, such as total length, weight, age, type of fish species, food availability and season. Fishes with large oocytes and parental care behavior have fewer eggs account than those spawning in open waters or nest building. In general, the current results are consistent with those of Nandikeswari et al. (2014), Abdullah et al. (2017) and Mohamed and Al-Jubouri (2020). Eggs’ size and the larvae status are critical factors, mostly related to fish size, condition factors, adult individuals’ age, food availability, maximum species size (genetic), and eggs' biochemical composition. Mandic and Regner (2014) reported that larger eggs include a large amount of yolk, which results in large larvae hatching, giving the larvae brooder more chance of survival in the worst habitat condition to succeed the reproductive cycle. While, Abdullah et al. (2017) mentioned the extent of reproductive success depends on the amount of yolk in the eggs, which is crucial in crossing the larva through the difficult conditions that go through after hatching in order for the fast growth to avoid predators.
However, the temperature is the most important parameter that could help to accelerate the process of egg hatching and larvae growth to pass the critical time after hatching (Imslanda et al., 2018).

Reproductive effort and morphometric parameters showed strong positive relationships among absolute fecundity, length, body weight and gonad weight. The present results are compatible, in the general direction, with those of Al-Mukhtar et al. (2006), Abdullah and Al-Noor (2015), Abdullah et al. (2017) and Mohamed and Al-Jubouri (2020) in different aquatic bodies in Iraq. Nevertheless, there was a weak positive correlation between absolute fecundity and egg diameters. This could be attributed to the type of reproductive strategy according to which fish spawning in open water are characterized by high fecundity with small-size eggs (Mandic & Regner, 2014; Robart & Sinervo, 2019).

On the other hand, the length-weight relationship can be calculated from all the samples collected from the study area. The coefficients (b) of M. sharpeyi in the present work refer to the negative allometric growth (b = 2.6516), indicating that fish are becoming more streamlined or longer, whereas Al-Hakeim (1976) reported a value of b = 3.254 when he studied the morphology and length at first maturity of Bunnei, M. sharpeyi and Barbus grypus in Al-Razaza Lake. Jassim (1988) studied the reproductive biology of M. sharpeyi population south Al-Hammar marsh and found that value of b= 2.046. Mohamed and Barak (1988) mentioned that the value of b= 3.245 of M. sharpeyi population in Al-Hammar Marsh. Additionally, Al-Mukhtar et al. (2006) calculated the value of b of M. sharpeyi in Al-Huwaizah Marsh and obtained b=2.7097; while, Hashemi et al. (2014) analyzed some biological aspects of M. sharpeyi in Shadegan wetlands, Iran and recorded that b= 3.14 in females and 3.11 in males. Mohamed and Al-Jubouri (2020) referred to b =2.7017 of M. sharpeyi in Al-Diwaniya River in the middle of Iraq. The differences in the values of b can be attributed to the status of fishes being affected by several factors, including condition factors, fish size, gonad growth, sexes, season, fish health and feeding intensity (Cuadrado et al., 2019; Robart & Sinervo, 2019). Therefore, differences in the values of b are in normal position in overall previous studies conducted on the species population.

The relative condition factor (K_n) is a common parameter widely used to determine the fish status (Jisr et al., 2018). K_n values of the evaluated species in the present study oscillated between 0.93 and 1.13. The deviation in the Kn values between this range revealed the variance in the fish life cycle, especially in the availability of food and physicochemical interactions between biotic and abiotic factors with other interactions inside the fish body. High values of Kn were observed during hot periods or months (May, June, July, and August). These increases may be explained by the availability of large amounts of food or increased feeding intensity when the temperature is suitable for increased feeding activity and growth. Kn values were recorded greater than one (De Giosa et al., 2014; Jisr et al., 2018). The result showed a slight rise in k_n values from November to February, and this may be attributed to gonad development (Sharma et al., 2016). However, when comparing the range of relative condition factors in the present work with the finding of previous papers it was noticed that the present values are within the range of previous studies. Broadly, Al-Hakeim (1976) documented the K_n range from 0.73 to1.02 in Al-Razaza Lake.; Mohamed and Barak (1988) in Al-Hammar Marsh mentioned the range between 1.03 to1.33, Al-Mukhtar et al. (2006) recorded values from 0.91 to 1.25 in Al-Huwaizah Marsh, Mohamed et al. (2012) in Al-sweb marsh stated K_n range from 0.75 to 1.16 and Mohamed and Al-Jubouri (2020) spotted the values from 0.81to1.01 in Al-Diwaniya River. Generally, these slight fluctuations mostly depend on gonad development, feeding intensity and fish size (Jisr et al., 2018; Mohamed & Al-Jubouri, 2020).
The present consequences showed that the spawning season prolonged from March to April in southern Missan Province Marshes in two batches, but that all individuals were in a spent stage during May. Moreover, fecundity increased with the increase in length, weight, gonad weight, suitable condition factors, and availability of food. The present paper highlighted some reproductive aspects of the most exploitable species due to the decline in population stock to enhance species abundance and support fisheries management, maintenance, and aquaculture with more information about the reasons causing the reduction in the abundance of species in southern Missan Province.

**CONCLUSION**

The current study recorded no variations in the species’s fecundity compared to previous studies. Nevertheless, the shrink in the reproductive ground areas, overfishing, the absence of stock support for the current species and fishing during the breeding season caused the lack of stock of the current species.

**ACKNOWLEDGMENT**

The authors would like to thank the staff of the Department of Marine Vertebrates, Marine Sciences Center, and the University of Basrah for providing us with all the facilities to support the research and making laboratories available to complete the research.

**REFERENCES**


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