Reproductive Cycle and Fecundity *Tristramella simonis* (Gunther, 1864) (Teleostei: Cichlidae) in the Northern Great River (Lattakia, Syria)

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**ABSTRACT**

This research was conducted to study the reproductive cycle and fecundity of the fish *Tristramella simonis* in the Northern Great River (Nahr Alkabeer Alshmali) north of Lattakia city. 263 individuals were collected from the northern great river, during the period between July 2017 and June 2018. Samples were collected every 15 days using gill nets, which its pores diameter ranged from 16 to 20 mm and using cages (1 × 1 × 1 m). The total length of the collected fish ranged from 9.5 to 16.5 cm, and their weights ranged from 19.5 to 112.27 g. Samples contained (128 females) and (88 males) and (47) undetected. Results of Gonado Somatic Index (GSI) showed that the reproduction period was between April and August with three obvious peaks of maturity. Where the highest value of GSI was (10.06±8.46) % for females and (0.13 ± 0.05) % for males. Results of Hepato Somatic Index (HSI) was concurrence highly with the ecological and physiological changes, which result from changes in sexual activity during the reproductive cycle. Where the highest value of HSI attained 3.79 ± 1.86 % for females and attained 3.95 ± 1.38 % for males. In the first sexual maturity, the length attained 13.31 cm for females and (14.87 cm) for males. The sexual rate was (1: 0.7), which means 40.7 % males and 59.3 % females in the population. The absolute fecundity ranged from 940 to 1229 egg. While the relative fecundity ranged between 158–215 egg/ g of ovary weight. Egg diameter during reproduction season ranged between 2.4-4 mm, with several sizes, which mean a relatively long reproduction term.

**INTRODUCTION**

The aquatic environment in Syria is exposed to many hazards, due to human activities on the freshwater runways (dam building, manufactories, Sewer systems etc.) (Ali *et al*., 2013). In addition to iniquitous and irregular catch of fish (as a catch in reproduction season or using small pores of gill nets), and illegal catch (using toxins and explosives) (El-Karachily et al, 2001). These led to the lack of natural stored fish in Syrian water and a fast decadence of the aquatic environment. Then led to distributing unwanted fish species in some aquatic Syrian environments, which compete with the economic species, in addition to causing settlement a new species, that was not existing previously in the Syrian water (Ali *et al*., 2015).

As the biology of one species differs from geographic region to another, knowing the nature and behavior of each fish species, its bio-characters and act with the
surroundings is important. Therefore, the present study was conducted to study biology and reproduction and feeding of the species *Tristramella simonies* (Günther, 1864), which was newly recorded in the Northern Great River (Nahr Alkabeer Alshmalee) (Borkenhagen and Freyhof, 2009). The effect of its removal on the local and foreign species, and on the farms of carp *Cyprinus carpio* in these river runways was also tested. This study aims to:

- Determine the reproduction periods of *Tristramella simonies* in the Nahr Alkabeer Al Shmalee
- Determine the fish length at the first sexual maturity, and
- Evaluate the fecundity of *Tristramella simonis*.

**MATERIALS AND METHODS**

**Study Area**

The Nahr Al Kabeer Al Shamalee is considered one of the longest rivers in Lattakia. Its length attained about 96 km. The total area of its basin is 1097 km². Most of the basin is surrounding by mountain area, covered in general with pines forests. The farming is spread intensively in the fluvial valleys and the direct versants. The fluvial net is intensive in the flow, but it dries in Summer, especially after building 16 Tishreen dam on the river at 12 km northeast of Lattakia (Figure1) (MOWR, 2010). The river locates on the northeast side of Lattakia. It flows at Louaa AL Eskandaroun on 1600 m latitude. Many small runways feed it, such as Almour Spring, Ein Aldelb, Ein Alsallour, Ein Alashraa, The Black River, Koufaria River, and many other small feeders (GORS, 2017).

![Map of the Northern Great River](https://images.app.goo.gl)

**Figure 1. Study Area: Nahr al-Kabeer Alshmalee (https://images.app.goo.gl).**

**Fish Samples Collect**

**Fieldwork:** Fish samples were collected every 15 days, from 16 Tishreen dam (N 35°38'36" - E 35°55'53") and river water (figure 2), using gill nets having pores diameters ranged between 16-20mm, and length ranged between 10-300m, with 2-5m height. The cages (1 × 1 × 1 m) had 25 mm² pores. The cages and nets were put in the river in the afternoon and fishes were collected in the morning, next day. This process was done between July 2017 until June 2018. After collecting, fish was put in formaldehyde (9%), and brought to the laboratory. The samples attained (263...
individuals) had total length ranged from 9.5 to 16.5 cm (just one male attained 18 cm as a long). The weight ranged between 19.5 and 112.27 g. Individuals contained 128 females and 88 males and 47 undetected individuals because these individuals did not attain sexual maturity.

![Image of sample locations](image)

**Figure 2. Locations of samples (google earth).**

**Laboratory work:** Fish samples were moved directly to the Laboratory of Marine Sciences, Tishreen University at Lattakia, Syria and were classified morphologically (Beckman, 1962; Coad, 2010). Morphometric measurements were taken as total length (T.L) and Standard Length (S.L) (Pravdin, 1966). These fishes were then dissected, gonads were insulated and weighted, and then fixated by formaldehyde (5%) to calculate Gonado Somatic Index (GSI) percentage using the following equation (Bougis, 1952): 

\[
\%\text{GSI} = \frac{Gw \times 100}{Ew}
\]

Where GSI: Gonado Somatic Index. GW: Gonads Weight (g), EW: Eviscerated Weight (g).

Then the liver was insulated and weighted (hitherto 0.01g) to calculate HIS % (Hepato Somatic Index) using the following equation (Pravdin, 1966): 

\[
\%\text{HSI} = \frac{LW \times 100}{Ew}
\]

Where HIS: Hepato Somatic Index, LW: Liver Weight (g), EW: Eviscerated Weight (g).

The length in the first sexual maturity was determined when 1+50% of a group attained a specific length, it was the sexual maturity degree (Gunderson, 1977; Love, 1970).

To study the fecundity and egg diameters, the wet weight method was followed. 11 adult females were taken. Eggs were washed, put on filtered paper to absorb the extra water. 0.1 g of gonad eggs were weighted. This process was repeated several times to different regions of the ovary (the upper- meso and lower part). Results were treated to get eggs number in 1 g of ovary weight (Sabour, 1995; Saad et al, 2006) (figure 3).

The absolute and relative fecundity was calculated using the formulas given by Bagenal (1978).

**The Absolute fecundity:** The absolute fecundity was calculated as:

\[
\text{Fa} = Gw \times D
\]

Where Fa: the absolute fecundity, GW: gonads weight (g), D: Eggs number/ 1 g of ovary weight.
Relative Fecundity: Similarly, relative fecundity was calculated as (Bagenal, 1973):
\[
Fr = \frac{Fa}{Sw}
\]
Where Fr: relative fecundity, Fa: absolute fecundity, SW: The total weight or ovary weight (g).

Statistical Study
The statistical study was done using SPSS-V 18 to analysis the results and drawing the graphic lines.

RESULTS AND DISCUSSION:
Morphological characters
The morphological study was performed depending on body shape. The fish head was medium in size while the lower jaw was longer than the upper one. Teeth were located on the two jaws in 3-4 rows. 3-4 rows of scales were located on the chap. A black spot was also located on the gills covering. The pectoral fins almost reached the anus fins origin.

The color of fishes was olive brown on the dorsal and sidling sides while the abdomen was lighter. About 8 dark lines were located on the body side in younger individuals (Kullander, 1998). The mean body length attained 9.8 cm as minimum while 25 cm as maximum (Snoeks, Teugels, 1991) (figure 4).

Monthly changes of GSI % (Gonado Somatic Index)
For females: Results showed that GSI began increasing during March and the maximum value observed was 2.46 ± 2.41 %. The curve in figure 5 shows the number of peaks, where it was notably increasing during April and reached a maximum of 8.46 ± 10.06 %. Then it showed a reduction during May and reached 3.65 ± 4.48 %. The return showed an increase during June, where its value reached 5.40 ± 4.54 %. In addition to this, the third peak was observed during August which was 1.99 ± 1.97 %.

The index after that showed another reduction to attain
the least value of it after the reproduction period in September with the value of 0.08 ± 0.33 %. The last reduction may be returned to lay eggs from the mature ovary.

**For males:** Results showed that GSI for males began increasing during March with the value of 0.04 ± 0.05 %. The curve showed different peaks. The GSI value increased during April, where it reached 0.05 **0.013 %** and decreased during May (0.08 ± 0.011 %). The return increase was observed during June with a value of 0.03 ±0.012 %. In addition to this, the third peak can be seen during August where it reached 0.05± 0.08 %. It attained the least value after the reproduction period during November and reached 0.02± 0.05% (figure 6). The reason for this reduction is due to voidance of sperm by mature castrate.

![Figure 4. General form of the species Tristramella simonies (13 cm as long, 55.26g as weight).](image)

![Figure 5. Changes of GSI % value to the females of the species T. simonis.](image)
Figure 6. Changes of GSI % value to the males of the species *T. simonis*.

**Monthly changes in HSI % (Hepato Somatic Index)**

**Females:** Results show that the highest value of HSI in the females was 1.86±3.79 % during reproduction months. That means females of this species did not depend on the liver reserves to consume energy which is necessary to gonads growth, but it depends on the nutrient from the surrounding and stored the extra as energy in the liver. This causes an increase in HSI values. The least value observed was 0.77±1.41 % during December. This low value fit winter and the bad nutrient conditions, so fish go to use all available energy to do their biological processes (figure 7).

**Males:** Results show the highest value of HSI was observed during March 1.38±3.95 %. This period is directly prior to the reproduction period. When it compared with the curve of GSI %, it was notable that the peak followed directly by a peak in gonads growth. This could be explained due to the males get the energy to gonads growth from liver reserves (figure 7).

Figure 7. Monthly changes of HSI % to each of females and males of the species *T. simonis* (F= Female, M= Male).

**Length at the first sexual maturity**

All fishes having a length of less than 10 cm were immature in both females and males. With an increase in length, the number of mature individuals increased to become more than 50 % at the length of 13.31 cm (females) and 14.87 cm (males) as shown in table 1 and figure 9. Differences in the length at the first sexual maturity may be attributed to fish origin from different regions, genetic factors and ecological conditions. Temperature changes may be one of the factors behind the varying density of the fish population.
Table 1. Changes in sexual maturity rates according to length groups in the species *Tristramella simonis*.

| Length Group (cm) | Males | Females |
|------------------|-------|---------|
|                  | mean of length ± SD | n | immature % | mature % | length group (cm) | mean of length ± SD | n | immature % | mature % | length group (cm) |
| 0                | 0.0   | 5 | 100 | 0.0 | 10.1-11 | 11 | 7 | 85.71 | 14.29 | 10.1-11 |
| 12 ± 0           | 10.1-12 | 10 | 80 | 20.0 | 12.1-13 | 18 | 83.33 | 16.67 | 11.1-12 |
| 12.78 ± 0.45     | 12.1-13 | 9 | 55.6 | 44.4 | 13.1-14 | 26 | 50 | 50 | 12.1-13 |
| 13.89 ± 0.18     | 13.1-14 | 16 | 50 | 50.0 | 14.1-15 | 32 | 46.87 | 53.13 | 13.1-14 |
| 14.87 ± 0.25     | 14.1-15 | 24 | 45.8 | 54.2 | >15 | 23 | 34.78 | 65.22 | 14.1-15 |
| 16.26 ± 0.52     | >15 | 22 | 40 | 60.0 | >15 | 22 | 16.24 ± 0.29 | 77.27 | >15 |

Figure 8. The length in the first sexual maturity in the females of the species *Tristramella simonis* during reproduction season.

Figure 9. The length at first sexual maturity in the males of the species *Tristramella simonis* during reproduction season.
Fecundity

Absolute fecundity: Values of absolute fecundity in females was estimated by counting eggs that ranged between 940-1229 egg with their length ranged between 13-16.5 cm, and weights ranged between 45.28-98.42 g. It attained the highest value 1229 egg at the length of 14 cm and the weight of 61.11 g (table 2). It was a clear trend for increased absolute fecundity as the ovarian weight increased and the relationship appeared positive and strong (Fa = 104.544 Gw +421) (R² = 0.97) (Figure 10). As for the relationship between the total female weight and absolute fecundity, it was a very weak linear inverse relationship, and by observing the value of the coefficient of determination (R = -0.031), it can be said that the total weight of the individual has no significant effect on the value of absolute fecundity (Figure 11). Study of the correlation between absolute fecundity and total body length was performed and was found to be an inverse weak relation (figure 12).

Table 2. The absolute and relative fecundity of females of the species *Tristramella simonis*.

| Relative fecundity (egg/ g) | absolute fecundity (egg) | ovary weight (g) | total weight (g) | total length (cm) | individual number | sample collect date |
|-----------------------------|--------------------------|------------------|------------------|-------------------|------------------|-------------------|
| 192                         | 941                      | 4.9              | 97.0             | 16.5              | 14               | 18-8-2017         |
| 188                         | 940                      | 5                | 98.42            | 16.5              | 15               | 18-8-2017         |
| 158                         | 1229                     | 7.78             | 61.11            | 14                | 5                | 20-4-2018         |
| 167                         | 1112                     | 6.66             | 55.26            | 13                | 6                | 20-4-2018         |
| 214                         | 815                      | 3.81             | 62.99            | 14                | 2                | 24-5-2018         |
| 206                         | 935                      | 4.54             | 57.21            | 14.5              | 6                | 24-5-2018         |
| 174                         | 1039                     | 5.97             | 63.47            | 14                | 8                | 24-5-2018         |
| 206                         | 917                      | 4.45             | 60.69            | 14.5              | 9                | 24-5-2018         |
| 178                         | 1061                     | 5.96             | 56.26            | 14                | 1                | 17-6-2018         |
| 180                         | 927                      | 5.15             | 45.28            | 13                | 3                | 17-6-2018         |
| 215                         | 755                      | 3.51             | 51.75            | 13.5              | 6                | 17-6-2018         |

Figure 10. The relation between the absolute fecundity and the ovary weight in females of the species *Tristramella simonis*.

Figure 11. The relation between the absolute fecundity and the total weight in females of the species *Tristramella simonis*. 

Fa = 104.544Gw +421
R = 0.986
R² = 0.971

Fa = -0.242Tw + 985.721
R = -0.031
R² = 0.01
Relative Fecundity: Results showed that the relative fecundity of the species *T. simonis* females whose length ranged between 13- 16.5 cm, and weight ranged between 45.28 - 98.42 g had relative fecundity of 158- 215 egg/ 1 g of ovary weight. It attained the highest value of 215 egg at a length of 13.5 cm and a weight of 51.75 g (Table 2).

Development of egg diameters

Egg diameters of 10 adult females ranged between (2.4 – 4 mm) during reproduction season, in the females having length ranged between 13- 16.5 cm. At the sexual maturity peak, the diameters ranged between 3- 3.3 mm. The highest diameter of the egg during the reproduction season was 4 mm, but the rate of egg like this was very low that attained about 4 % of the total mature egg. Results showed that the existing of several sizes of egg in the studied samples, a relatively long reproduction season in the studied species was observed (Figure 13 a-c).

Also, the number of times the eggs are laid at the Tilapia fish is an adaptation to the exploitation of food, and it is also part of the requirements of the reproduction strategies for these fish to secure a number of eggs to meet the changes in environmental conditions and provide the environment with a new number of larvae to ensure the continuity of the species (Khalifa, 2017).

Results also showed three peaks in the curve of egg diameters, which means three reproduction periods in the year (figure 14).
Figure 13 (b). Development of egg diameters and their percentages of females of the species *Tristramella simonis* during reproduction season (June).

Figure 13 (c). Development of egg diameters and their percentages of females of the species *Tristramella simonis* during reproduction season (August).

Figure 14. Cumulative frequency curve of egg diameters of females of the species *Tristramella simonis*. 
CONCLUSION
The reproduction period of T. simonis was between April and August with three obvious peaks of maturity. The length at first maturity (L50), is 13.31 cm for females and 14.87 cm for males. The absolute fecundity ranged from 940 to 1229 egg. While the relative fecundity ranged between 158-215 egg / g of ovary weight.

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CONFLICT OF INTEREST STATEMENT
We declare that we have no conflict of interest.

AUTHOR'S CONTRIBUTION
All authors contributed equally to this research work.

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