

**Reproductive biology of the tub gurnard *Trigla lucerna* (Linnaeus, 1758), in the Libyan eastern coast of Mediterranean Sea.**

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**ABSTRACT**

The reproductive biology of *Trigla lucerna*, (family: Triglidae) inhabiting Libyan eastern coast was studied during the period from January to December 2007. There were monthly variation in sex ratio, and a tendency for more females (731 fish, 52.2%) than males (669 fish, 47.8%) for the collected population. Overall sex ratio was 1: 1.09 for males to females. The male of *Trigla lucerna* attained its first maturity at the total length of 13.9 cm, while the first sexual maturity of female was attained at 15.3 cm. The gonado-somatic indices of males were lower than that of females. Males and females have a definite breeding season which extends from January till March. An increase in oocyte diameter was evident in November (with an average of 225  $\mu$ ) and this increase continued in the following months till March, with an average value of 498 $\mu$ . The absolute fecundity ranged from 678 to 10047 eggs for fish length ranging from 13.5 to 22.6 cm. Also, the fecundity increased from 755 to 10055 eggs with the increase of weight from 16.7 to 108.2 g.

**Key Words:** Triglidae, *Trigla lucerna*, reproductive biology, Mediterranean Sea, Libyan eastern coast.

**INTRODUCTION**

Family Triglidae includes bottom fish dwellers occurring over sand, muddy-sand or gravel at depth from 56 to 200m, but it is more common between 50 and 100m (Richards and Saksena, 1990). *Trigla lucerna*, called the tub gurnard, is the largest of the European gurnards, reaching a maximum length of 75 cm, although most individuals are between 50-60 cm (Bauchot, 1987). Like all gurnards, it has a large head covered by protective bony plates, and the lower three rays of the pectoral fin are separated and fleshy (Muus and Nielsen, 1999). The tub gurnard is usually found on mud or sandy seabeds from 2-20m deep (Frimodt, 1995). *Trigla lucerna* is now recorded in IUCN *Red list* (IUCN, 2010). It is very common in the Mediterranean Sea and the Sea of Marmara, and in the eastern Atlantic from the British Isles to the coast of Senegal. It mainly feeds on small fish like sand eels, small flatfish, gobies, dragonets and also crabs and shrimps (Moreira *et al.*, 1992). This species is spawned in Eastern Atlantic from December till July (Richards, 1968) and caught with bottom trawls but also with long lines and band lines (Lewis and Yerger, 1976).

Few studies have been published on the biology of Triglidae fishes especially in the Mediterranean Sea. Awad (1972) studied a comparative biological aspect on certain species of family Triglidae in the Mediterranean Sea off Alexandria. El-Mor (2002) studied some morphological characters of juveniles *Trigla lucerna* in Port Said Coast on the Egyptian Mediterranean Sea. Mytilineou *et al.* (2005) studied some ecological aspects on *Trigla lucerna* in Eastern Ionian Sea, but this is the first study

so far on the reproductive biology of *Trigla lucerna* (family Triglidae) in the Libyan eastern coast.

## MATERIAL AND METHODS

Monthly samples of *Trigla lucerna* were collected during the period from January to December 2007 by trawler net from Benghazi fishing areas and collected from the fishing harbor (32° 36' N and 20° 03' E) on the Mediterranean Sea (Fig. 1).

A total of 1400 specimens of *Trigla lucerna* were used for studying the reproductive biology of the fish. Each fish was wet weighed in grams and its total length was measured in cm, then it was dissected to determine sex then the gonads were removed and wet weighed to the nearest mg. State of maturity for each individual fish was distinguished into four stages: virgin/resting, developing, active and post spawning (Buxton, 1989).

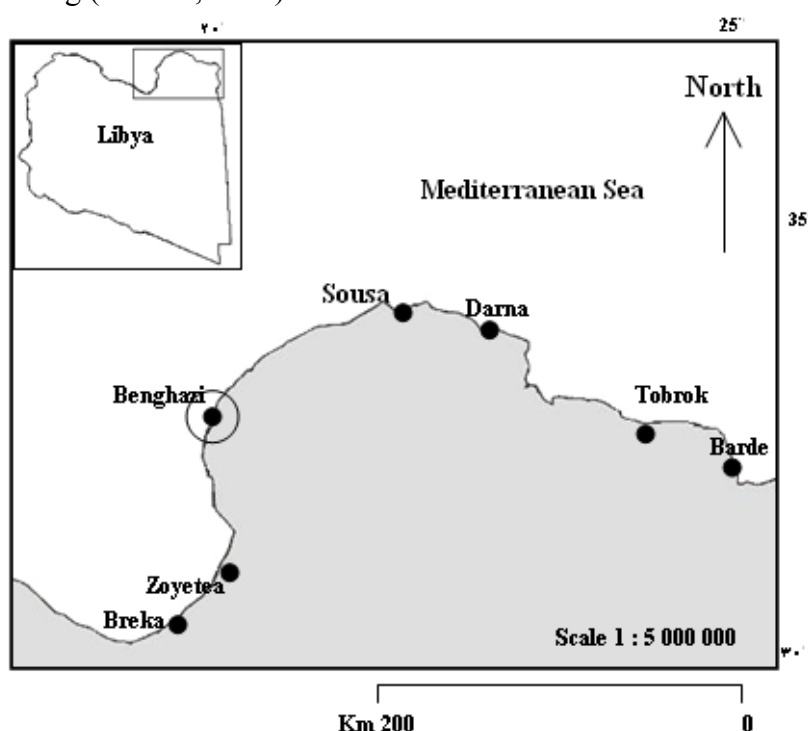


Fig. 1: Benghazi fishing harbor, on the Mediterranean Sea, Libya

The monthly Gonado-somatic index (G.S.I.) was calculated according to the following formula:

$$\text{G.S.I.} = \frac{\text{wet weight of gonad (g)}}{\text{wet weight of fish (g)}} \times 100$$

Such indices were expressed as the monthly averages and plotted against months.

Oocyte diameters were measured to the nearest 0.01 mm by using an eye-piece micrometer. Oocytes were separated from the ovarian tissue and put in saline solution (0.9% NaCl) for 24 hours, then they were measured under the microscope at 40 X, then 20 oocytes were taken randomly and their diameters were measured. The average oocyte diameters for mature specimens were calculated.

Fecundity was estimated by counting all ripe eggs found in the female ovary just prior to spawning season. Fish ovary was put in small divided Petri-dish; ova were separated from the ovarian tissue with the aid of a dissecting needle, and all ripe ova were counted under a binocular microscope. Fish length and total weight were

recorded separately for each individual fish and plotted graphically against fecundity. The relationships between these variables and fecundity were estimated according the following formula:

$$\text{Log } F = a \pm b \text{ Log } x \quad (\text{Bagenal, 1978})$$

Where F = absolute fecundity;

X = independent variables;

a = constant;

b = an exponent.

## RESULTS

### Sex ratio

Generally, there is a tendency for more females (731 fish, 52.2%) than males (669 fish, 47.8%) for the collected population. Overall sex ratio was 1: 1.09 for males to females (Table 1). The sex ratio was not constant throughout different months. The numbers of females exceeded males in all months except in the period from April till August.

Table 1: Monthly variations in sex ratio of *Trigla lucerna* from Benghazi coast.

Months	No. of fish	Males		females		Sex ratio
		No.	%	No.	%	
Jan.	121	48	39.7	73	60.3	1 : 1.52
Feb.	82	32	39.0	50	61.0	1 : 1.56
Mar.	57	22	38.6	35	61.4	1 : 1.59
Apr.	82	49	59.8	33	40.2	1 : 0.67
May	140	78	55.7	62	44.3	1 : 0.80
Jun.	198	109	55.1	89	44.9	1 : 0.81
Jul.	180	93	51.7	87	48.3	1 : 0.93
Aug.	173	88	50.9	85	49.1	1 : 0.96
Sep.	81	40	49.4	41	50.6	1 : 1.02
Oct.	80	40	50.0	40	50.0	1 : 1.00
Nov.	105	39	37.1	66	62.9	1 : 1.70
Dec.	101	31	30.7	70	69.3	1 : 2.26
Total	1400	669	47.8	731	52.2	1 : 1.09

### Size at first sexual maturity

The first appearance of mature males was recorded at a length group of (12-12.9 cm) by 24.5% and the smallest male of *Trigla lucerna* attained its first maturity (50% of males) at 13.9 cm. length (Fig. 2). On the other hand, the sign of mature females was recorded at a length group of (13-13.9 cm) representing 12.5% of females examined. The size at which 50% of females were mature could be taken as 15.3 cm.

### Maturity stages

Data of monthly changes of sexual maturity are represented in Figure (3). Males had virgin / resting testes (stage I) in August (100%). During the following two months (September and October) virgin / resting testes dominated the population, being 81.9.3% and 64.5% respectively. The first sign of developing stage appeared during the period from September (18.1%) till March (2.3%). An active testes appeared in January by 52.2% of the population increased during February (82.5%) and December (91.9%). Post spawning (stage IV) testes amounted to 2.3% in February and 5.8% in March of the examined specimens.

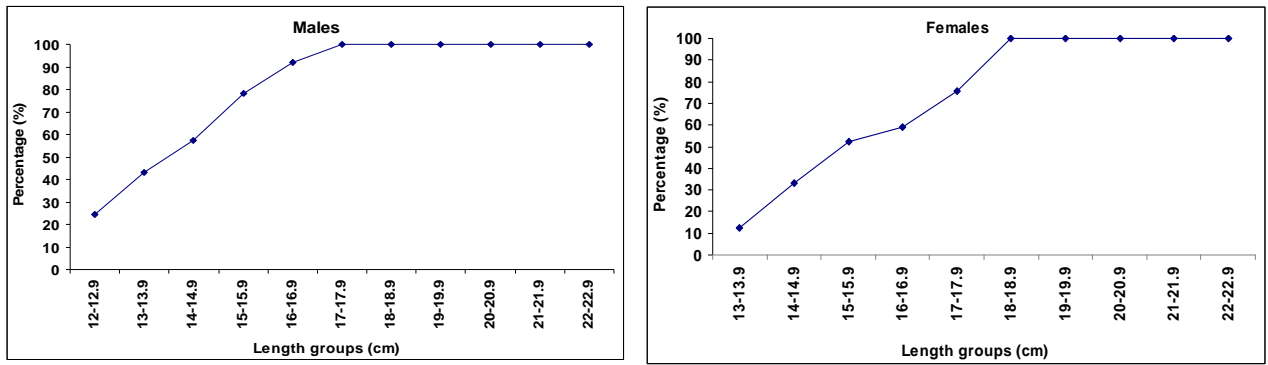


Fig. 2: Length at first maturity of *Trigla lucerna* from Benghazi coast

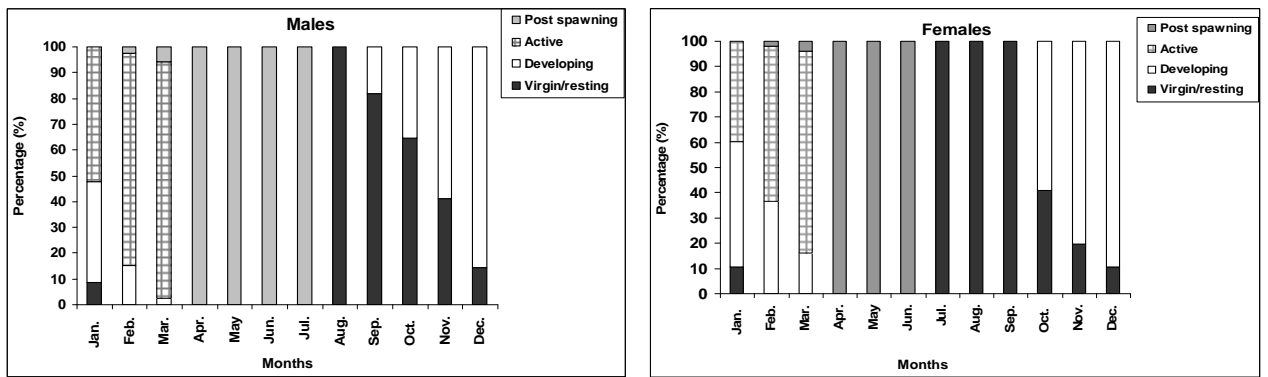


Fig. 3: Monthly changes in the stages of sexual maturity in *Trigla lucerna* from Benghazi coast.

Females with a virgin / resting (stage I) were dominant during July, August and September (100%). The first appearance of developing ovaries was present in October (58.8%), November (80.4%), December (89.5%), January (49.5%), February (36.5%) and March (16.1%). The first sign of active ovaries (stage III) appeared in January by 39.9% and continued in February by 61.6%, reaching the maximum value in March by 79.8%. During February and March, females were post spawning (stage IV) with a ratio between 1.9% and 4.1% respectively. The stage (IV) of post spawning was represented by 100% for males and females in the study area during April and June.

**Gonado-somatic indices (G.S.I.)**

The monthly changes in G.S.I. are represented in Fig. (4). *Trigla lucerna* showed a definite breeding season, which extends from January till March in the Libyan eastern coast.

The male G.S.I. attained lower values than those of females. The average male G.S.I. increased from November (1.78) till December (2.23), then increased sharply from January (3.79) till February (3.91). The highest value of males G.S.I. was recorded in March (4.12).

In females, the values of G.S.I. was recorded in September, October, November and December, being 2.26, 2.47, 2.58 and 2.72 respectively, then increased sharply from January (4.45) till February (4.91). The highest value of females G.S.I. (5.25) was recorded in March.

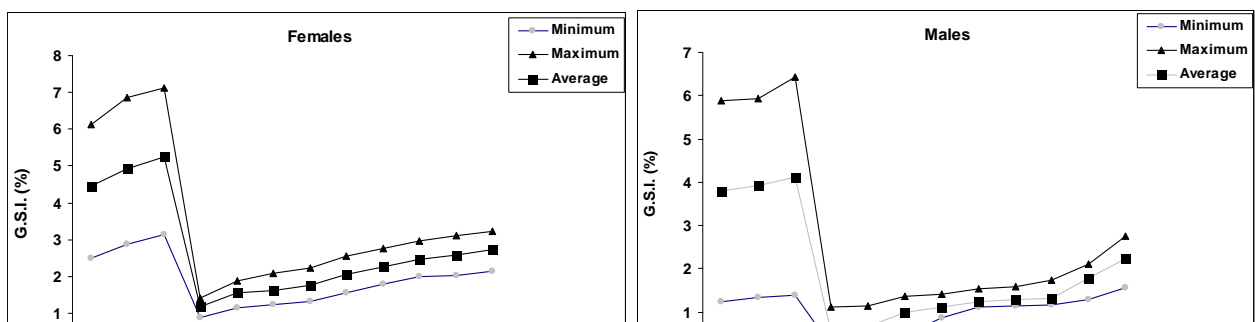


Fig. 4: Monthly variations in the average gonado-somatic indices of *Trigla lucerna* ferom Benghazi coast.

### Oocyte diameter

The recorded average oocyte diameters of *Trigla lucerna*, during the whole period of the study are represented in Table (2). The smallest average oocyte diameter was recorded in August (139  $\mu$ ), then gradually increased in November (225  $\mu$ ) and December (270  $\mu$ ), and this increase continued in the following months, reaching (465  $\mu$ ) in January then (480  $\mu$ ) in February and reched the maximum value in March, with an average of (498  $\mu$ ). The egg diameter in fish samples was very minute and difficult to measure in April, May, June and July.

Table 2: Monthly variations of oocyte diameters of *Trigla lucerna* from Benghazi coast.

Months	Number of fish	Egg-Diameters ( $\mu$ )		
		Minimum	Maximum	Average
Jan.	58	411	522	465
Feb.	43	426	536	480
Mar.	32	439	545	498
Apr.	33	A	A	A
May	62	A	A	A
Jun.	89	A	A	A
Jul.	87	A	A	A
Aug.	85	89	187	139
Sep.	41	103	206	155
Oct.	40	112	277	198
Nov.	66	145	305	225
Dec.	70	196	345	270

A = The egg diameters were very minute and difficult to measure

### Fecundity

Two terms are applied in fish fecundity studies; the absolute fecundity which is the total number of mature eggs in the ovary and the relative fecundity which is the number of eggs per unit length or weight of the fish (Nikolsky, 1963). Ovaries of 133 *Trigla lucerna* were examined. The smallest mature female had a total body length of 12.9cm and body weight of 21.9 g. Its ovary weight was 0.34 g. (2.1% of the body weight), with absolute fecundity of 133 ripe eggs. The largest female had a total body length of 23.2cm and body weight of 116.9 gm, whereas its ovary weight was 8.33g and its absolute fecundity was 10047 ripe eggs.

The relationship between the body length and absolute fecundity of *Trigla lucerna* is given in Table (3) and Fig. (5). The absolute fecundity of 133 ripe females ranged from 678 to 10047 with an average of 5010 ripe eggs/fish and with an average

relative fecundity of 254 ripe eggs/cm. It is clear that both the absolute and relative fecundity increased with the increase of total length. Data of absolute fecundity with total length are represented by the following equation:  $F=0.0005L^{5.4891}$  Where, F is absolute fecundity and L is the total body length. The relation is highly significant and a correlation coefficient 0.965 was calculated.

Table 3: Relation between fecundity and total length (cm) of *Trigla lucerna* from Benghazi coast.

Total length (cm)		No.	Absolute Fecundity				Relative Fecundity
Range	Mid length		Minimum	Maximum	Average	Calculated	F/T.L. (cm)
12.9-14.1	13.5	35	542	714	678	801	50
14.2-15.4	14.8	26	817	1243	1036	1326	70
15.5-16.7	16.1	15	1989	3429	2557	2106	159
16.8-18.0	17.4	12	2453	4521	3742	3225	215
18.1-19.3	18.7	10	4238	6235	5124	4789	274
19.4-20.6	20.0	10	5888	8429	7147	6926	357
20.7-21.9	21.3	12	9754	9754	9754	9785	458
22.0-23.2	22.6	13	9858	10236	10047	13546	445

No.= number of specimens

T.L.= total length

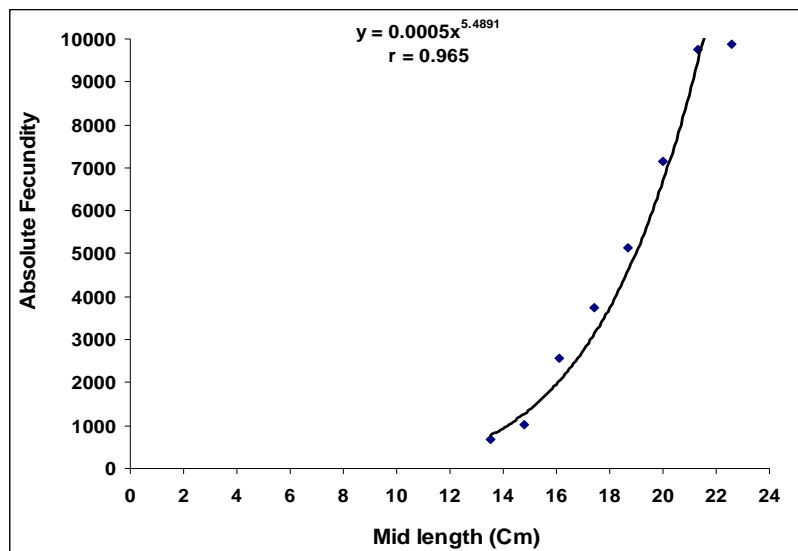


Fig. 5: Relation between mid length and absolute fecundity of *Trigla lucerna* from Benghazi coast.

Results of the relationship between the absolute fecundity and body weight of *T. lucerna* are given in Table (4) and Figure (6). Absolute fecundity ranged from 755 to 10055, with an average of 5018 ripe eggs / fish and with an average relative fecundity weight of 72 ripe eggs / g, so the fecundity increased with increasing body weight. The regression relationship was represented by the following equation:

$$F = 11.618 W^{1.4538}$$

Where, F is the absolute fecundity and W is the total body weight. The relationship is highly significant with correlation coefficient of 0.9941.

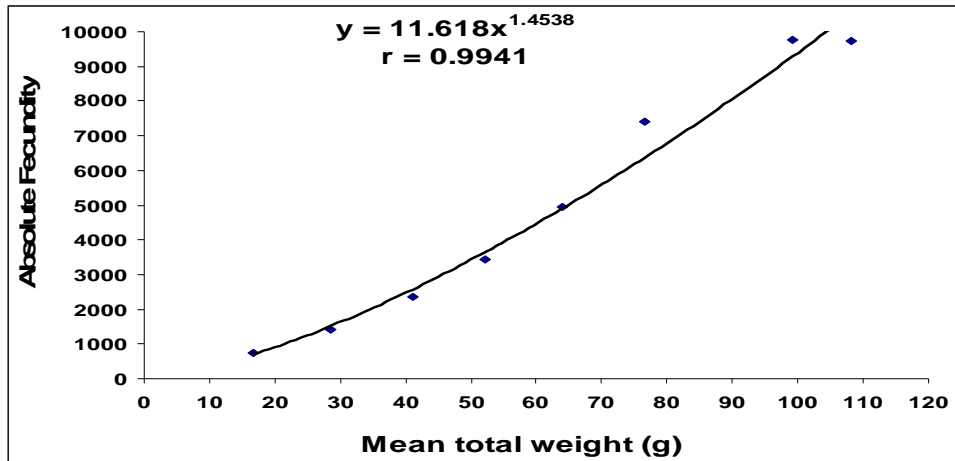


Fig. 6: Relation between mean total weight and absolute fecundity of *Trigla lucerna* from Benghazi coast.

## DISCUSSION

Triglid fishes inhabit tropical and temperate coastal water. They are found near the shore in shallow inlets and bays less often at moderate depths (Frimodth, 1995). *Trigla lucerna* is the largest and oldest of the Eutopean gurnards, reaching a maximum length of 75 cm and 15 years (Baron, 1985). It is usually found on mud or sand seabeds from 2-20m depth (Frimodth, 1995).

In the current study, the overall sex ratio was 1: 1.09 for males and females of *Trigla lucerna* and these results are in full agreement with sex ratio of other species of family Triglidae in the Mediterranean Sea (Mytilineou *et al.*, 2005). In the present work, the sex ratio was not constant throughout different months, particularly during the breeding season of each species (Oren, 1975). In the period from April till August (after the spawning season), the males of *Trigla lucerna* were dominant over the females in agreement with Baron, (1985) who studied sex ratio of *Trigla lucerna* in the French Mediterranean Sea. Also these phenomena were shown by other fish species such as mullet species (Mohammad, 1982 and El-Mor, 1993). In addition, Wijeyaratne and Costa (1986) concluded that it is possible that males of grey mullets are more active before spawning season and get caught in the gear in large numbers, resulting in an unbalanced sex ratio.

In the period from September till March, the numbers of females exceeded males since the males might migrate for spawning elsewhere before females as recorded by Awad (1972) that such phenomena of sex ratio for *Trigla lucerna* in the Mediterranean Sea off Alexandria.

Generally, in the natural fish community males mature first before females, and become ready to participate in spawning activity (Mohammad, 1982 and El-Mor, 1993). In the present study, the first appearance of mature males was recorded at length group (12-12.9cm) by 24.5% and the smallest male of *T. lucerna* attained its first maturity at the total body length of 13.9cm. On the other hand, the first sign of mature females was recorded at length group of 13-13.9cm, representing 12.5% of the examined females, while the first sexual maturity of the female was attained at size at which 50% of females were mature could be taken as 15.3cm. This nearly agrees with what had been recorded by Baron (1985) who stated the smallest male of *Trigla*

*Lucerna* inhabiting the French Mediterranean Sea attained its first maturity at the total body length of 14.1cm and 15.5cm for females.

In the present study, the average gonado somatic indices (G.S.I.) of males were lower than those of females. The males and females of *T. lucerna* showed a definite breeding season, which extends from January till March, with maximal G.S.I. of 4.12 and 5.25 in March for males and females respectively. The increase of G.S.I. during the breeding season is mainly due to the deposition of large amounts of proteins and lipids in the developing eggs and spermatozoa. A part of these materials comes directly from ingested food but a major proportion comes from the reserve of food deposits, during the active season, in organs such as liver, muscles and fat bodies (Larson, 1974). The spawning season of the target species agrees with that, in other sites on the Mediterranean Sea as reported by Baron (1985) that it extends from January till April, and then from December till March in the Eastern Ionian Sea (Mytilineou, *et al.*, 2005). The time of spawning season in the present study coincided with the appearance of the juveniles and fry of the fish in the Mediterranean Sea. El-Mor (2002) recorded juveniles of *Trigla lucerna* in Port Said coast on the Egyptian Mediterranean Sea in the period from April till July while the eggs and fry of the same fish were detected in British water by Russel (1976).

In the current work, the increase in the oocyte diameters of *T. Lucerna* was evident in October with an average of 277  $\mu$  and this increase continued in the following months till March, with a maximal average value of 545  $\mu$ . In April till July, all fish samples were immature and the egg diameters were very minute and difficult to measure. These results coincide with those recorded by Mytilineou *et al.* (2005) and Baron (1985) who stated that the egg diameters reached 512  $\mu$  and 550  $\mu$  in February and March respectively.

The number of eggs produced by females varies greatly according to species, size, age, region, period and techniques used, thus a considerable variability has been shown in different populations (Oren, 1975).

Baron (1985) found that the absolute fecundity ranged from 606 to 9004 for females ranging from 13.9 to 24.8cm in total length. In the present study, the absolute fecundity of 133 ripe females ranged from 678 to 10047 with the growth in length from 13.5 to 22.6 cm. Also, the fecundity increased from 755 to 10055 with the increase in weight from 16.7 to 108.2 g.

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بيولوجية التكاثر لسمكة الفرخة (تريجلا لوسرينا), (LINNAEUS, 1758) في الشاطئ الشرقى الليبي  
للبحر المتوسط

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في هذا البحث تم دراسة بيولوجية التكاثر لسمكة الفرخة القاطنة للشاطئ الشرقى الليبي من خلال التجميع الشهري للعينات في الفترة من يناير الى ديسمبر 2007. و قد وجد ان الشق الجنسي العام بنسبة 1 : 1.09 يتفوق للاناث (731 عينة بنسبة 52.2%) عن الذكور (669 عينة بنسبة 47.8%) وكانت بداية النضج الجنسي للإناث عند طول  $L_{50} = 15.3$  cm وللذكور عند طول  $L_{50} = 13.9$  cm و كان موسم تكاثر محدد يمتد من يناير إلى مارس وتحدث الزيادة في أحجام البويضات في نوفمبر ( $225\mu$ ) ثم تستمر الزيادة وصولاً لشهر مارس ( $498\mu$ ).

و كانت الخصوبة المطلقة للسمة تتراوح بين 678 إلى 10047 بويضة للأطوال من 13.5 إلى 22.6 سم كما كانت تتراوح بين 755 إلى بويضة 10055 للاوزان من 16.7 جرام الى 108.2 جرام .