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REPRODUCTION OF THE AFRICAN CATFISH *Clarias gariepinus* INHABITING THE RIVER NILE IN EGYPT

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ABSTRACT

The present work studied the reproductive cycle of the African catfish *Clarias gariepinus* inhabiting the river Nile main stream. This study aimed to assess the size at first sexual maturity, spawning season, ova-diameter and fecundity and to discuss the observations to reach optimum exploitation of spawning stock biomass of this species in the river Nile stream in Egypt. The relative coefficient of condition (Kn) for both sexes of *C. gariepinus* revealed a similar trend that reach its higher values during the warm seasons and that may be correlated to its maturation cycle or the higher feeding activity. The length-weight relationship did not differ significantly ($P > 0.05$) between males and females at the size less than 33 cm total length, however it differed significantly ($P < 0.05$) between males and females at the fish size more than 33 cm total length. Consequently, two predicted equations were obtained for describing the relationship between length and weight for both sexes. Fishes larger than 40 cm total length were found to be fully mature for both sexes. The length at first sexual maturity (Lm50) was found to be 33 cm and 32 cm for males and females, respectively. Gonado-somatic index (GSI) of *Clarias gariepinus* differed significantly ($P < 0.05$) between males and females, but it nearly exhibited the same trend for both, where GSI reached its maximum values (peaks) of 1.92 and 15.42 during May for males and females, respectively.

The mean values of egg–diameter were 0.36 and 0.45 mm in January and February, respectively, then an abrupt increase was observed during the period from March - May to reach its maximum value of 1.2 mm in May. Fecundity and its relationships with total length, total weight and age of fish are graphically represented. It appeared to be a linear relationship, and expressed mathematically by regression equations. Recommendations were included to improve the management and protection of the spawning stock biomass of *C. gariepinus* in the river Nile.

Key words: *African catfish, Clarias gariepinus, fisheries, reproduction, river Nile.*

1. INTRODUCTION

The reproductive cycle of the African catfish *Clarias gariepinus* starts in most African countries at the beginning of the rainy season. The final stimulus to spawn appears to be associated with a rise in water level and inundation of margined areas. Spawning takes place in large shoals of adult males and females in water often less than 10 cm deep and situated at the edges of lakes and pools. In captivity *Clarias gariepinus* spawns on a variety of other substrates, including sisal fibers, palm leaves and stones (Viveen *et al.*, 1986). However, life history patterns vary considerably among populations of the same fish species. This may be caused by direct influences of environmental factors, but may also be due to genetic adaptations to local environmental conditions (Schaffer and Elson, 1975; Leggett and Carscadden, 1978 and Hegge *et al.*, 1991).

In Egypt, some studies were carried out on *Clarias gariepinus* cultured with regards to the age and growth (El-Bolock and Koura, 1960; El-Bolock, 1972; and Bishai, 1976). Other studies investigated the harvested fishes from the inland fisheries, such as, Bahr Shebeen Nile canal and Rosetta Branch of the river Nile and dealt with growth and morphology (Khallaf *et al.*, 1993 a & b) and fecundity (Khallaf and Gaber, 1993; and Shenouda *et al.*, 1995). Despite the economic importance of the African catfish *C. gariepinus* inhabiting the main river Nile stream, its reproductive cycle has not been studied. Consequently, the present study was directed to investigate the

reproduction of *C. gariepinus* for the population inhabiting the river Nile main stream. This study aimed also to assess the size at first sexual maturity, spawning season, ova-diameters and fecundity and to discuss the observations to reach optimum exploitation of spawning stock biomass of this species in the river Nile stream in Egypt without breaking-down its reproductive cycle.

2. MATERIALS AND METHODS

During January – December 1999, total specimens of 330 males and 391 females of *Clarias gariepinus* , were collected monthly from the professional fishermen using the common trammel gill nets in the area extending from Giza to Assuit (about 500 Km, with a representative sample from each governorate) of the river Nile main stream. Fish total length was measured to the nearest millimeter and body weight was recorded to the nearest 0.1 gram for each fish. Sex was determined by visual examination of gonads, and the maturity stages of gonads were estimated according to the seven scales after Zaki *et al.,* (1986) and Tharwat (1990). Fish were identified as either immature (gonads were in stage 1 or two, the gonads were small and undeveloped) or mature (the gonads were enlarged, and in the case of females, recruiting vitellogenic oocytes were present). For both males and females, frequency data of the state of maturity were assembled on length and body weight. The length at which 50 % of fishes reach their sexual maturity was considered as the length at first sexual maturity "Lm_{50}" (Pitt, 1970) and was derived from the length frequency distribution of mature males and females. Ganado somatic index (GSI) was calculated by the following formula:

GSI = [Gonad weight / Body weight] X 100.

To estimate fecundity, each ripening pair of ovaries was obtained and immediately fixed in 10 % formalin in a glass tube with labels indicating date of capture, fish length, fish weight and gonad weight. Three subsamples, each approximately 3 % of gonad weight, were removed and weighed to the nearest 0.01 gm and the eggs were counted in a petri dish under a research microscope at a power of 20 X. The numbers of eggs in the three subsamples were averaged (n) , and then the total number of eggs in the two ovaries (N) was

estimated as follows: N = n X [weight of ovaries / weight of sample]. The absolute fecundity was calculated as the average number of eggs contained in the ovary per individual fish. Egg diameters were measured monthly using a research microscope aided with an ocular micrometer at a power of 100 X. Fish age was based on an age-length key according to Tharwat (2000). The relationships between the fecundity and length, weight and age of fish were estimated and the relative fecundity was calculated per cm, gm and year.

2.1.Statistical methods

The regression analysis was used to determine relationships between estimated fecundity and fish length, fish weight and fish age. The significance of differences between males and females in length-weight relationships and condition factors was tested with analysis of variance according to Schaffer and Elson, (1975) using SAS, (1985).

3. RESULTS AND DISCUSSION

3.1. Length-weight relationship

Length-weight relationship for both males and females are graphically represented in Figure (1). The variation in weight of the African catfish *Clarias gariepinus* with fish total length did not differ significantly ($P > 0.05$) between males and females at the size less than 33 cm total length. However, it differed significantly ($P < 0.05$) between males and females at the size more than 33 cm total length. Consequently, two predicted equations were used for describing the relationship between weight and length for both sexes, and they are as follows: $W = 0.03572\ L^{2.6018}$, $r = 0.9987$ for males, and $W = 0.02417\ L^{2.7547}$, $r = 0.9986$ for females.

Where: W is the total weight of fish (gm), L is the total length of fish (cm) and r is the correlation coefficient. The high values of r indicate a good measure for the strength of these equations and closeness of observed and calculated values of fish weight.

3.2. Condition factor

The values of the relative condition factor (Kn) according to fish length, and to different months are graphically represented in Figures (2) and (3) , respectively. The values of condition factor of

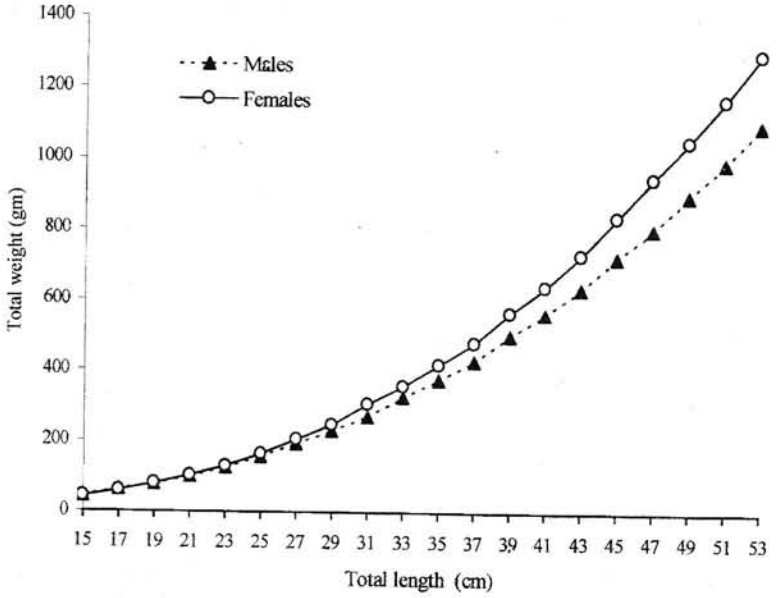

Fig (1): Length-weight relationship of the African catfish *Clarias gariepinus* collected from the river Nile.

females were significantly higher than those of males. However, the graphical representation for both sexes shows a similar pattern of monthly variation in Kn, which indicates an increase in the coefficient of condition starting from early spring (March) to the peak of the spawning season in early summer season (May and July). A continuous decrease in Kn occurs afterwards till October. Hence, the relative coefficient of condition of the African catfish *Clarias gariepinus* may be correlated either to its maturation cycle, the higher feeding activity during warm season or both of them.

3.3. Sexual maturity and spawning season

3.3.1. Fish size at first sexual maturity

Maturity stages of gonads can be successfully applied in the field for getting an approximate idea about the spawning season and its duration . Investigation of the maturity stages of the ovaries and

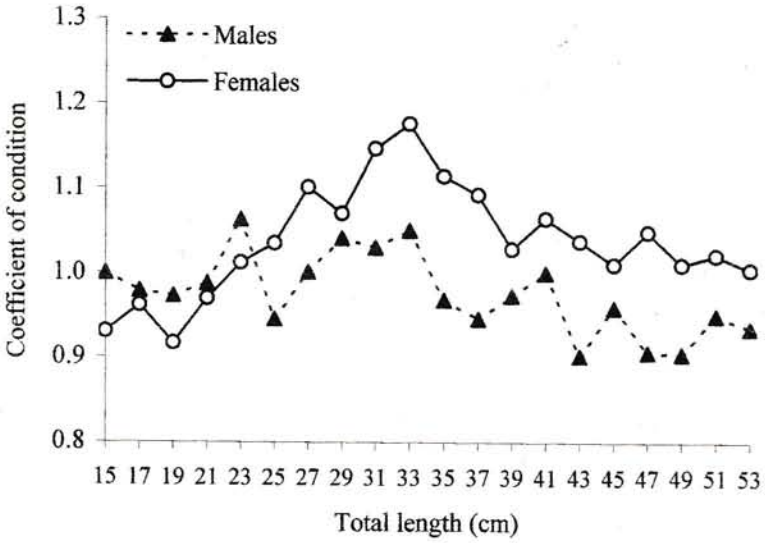

Fig.(2): Variation of condition coefficient according to total length of the African catfish *Clarias gariepinus* collected from the river Nile.

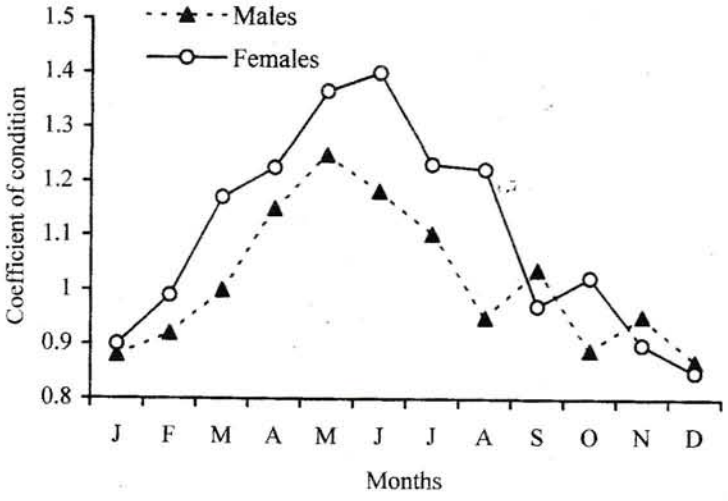

Fig.(3): Monthly variation of condition coefficient of the African catfish *Clarias gariepinus* collected from the river Nile.

testes for each specimen of *C. gariepinus* during all months of the year revealed that females attained their first sexual maturity slightly earlier than males. The progression of the percentage of mature males and females of the African catfish *Clarias gariepinus* for the length ranging from 15 to 55 cm is represented graphically in Figure (4). Specimens larger than 40 cm total length are found to be fully mature for both sexes. The length at first sexual maturity (Lm50) was found to be 33 and 32 cm for males and females, respectively.

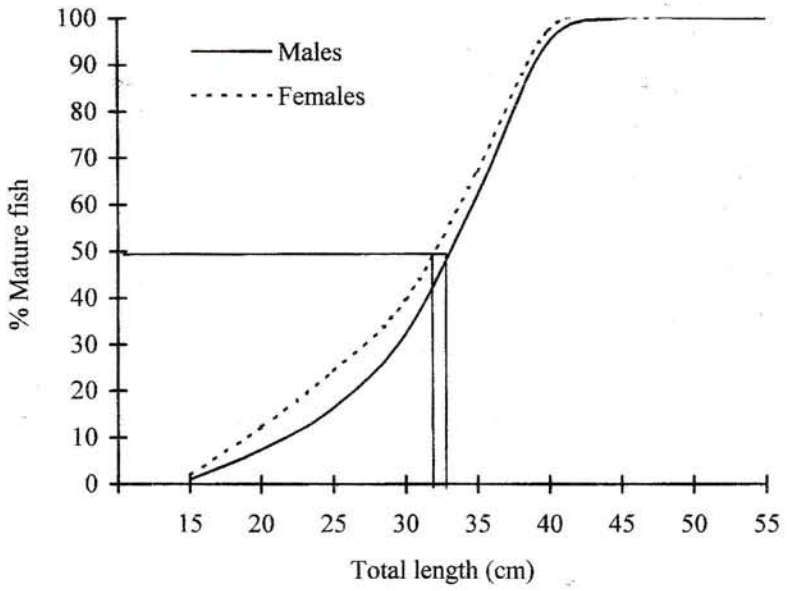

Fig. (4): Length frequency distribution of mature males and females of the African catfish *Clarias gariepinus* used to estimate length at first sexual maturity (Lm50).

3.3.2. Gonado-somatic index

Among the widely accepted measures of sexual activity in fishes are the Ganado-somatic index (GSI). The average values of the GSI for males and females are graphically represented in Figure (5). It is obvious that G.S.I. values were much higher for females than

males. This was expected in view of yolk accumulation in female ovaries, which is much heavier than the spermatozoa in male testes. The GSI of *Clarias gariepinus* nearly exhibited the same trend for both sexes, where its average values increased during the period from March - August and decreased during the period from September - February throughout the year. The GSI reached its maximum values (peaks) of 1.92 and 15.42 during May for both males and females respectively. This result indicated that the African catfish *Clarias gariepinus* in the river Nile main stream spawns once a year, and the spawning season is long, extending from March - August as a partial spawning fish. The reproductive cycle and gonad maturation in fishes may differ for the same fish species in the different months of the year. The different maturity stages of the African catfish *Clarias gariepinus* were defined according to the seven scale applied by Zaki *et al.*, (1986) on the same species in lake Manzalah. According to this scale, ripe and spawning fishes were found during March – August period in the present study, so the spawning season was expected to extend through these months and the peak of sexual activity occurs in May. Similar result on the same species in Rosetta branch of the river Nile was obtained by Shenouda *et al.*, 1995 and on other species inhabiting the river Nile (Tharwat & Emam, 1997 and Tharwat & El-Dawi, 1997).

3.3.3. Egg diameters

The monthly variation of the egg-diameter and the percentage frequency distribution of the different egg-diameters in the ovaries of ripe and prespawning females of the African catfish *Clarias gariepinus* are graphically represented in Figures (6) and (7). The mean values of egg-diameters were 0.36 and 0.45 mm in January and February, respectively, then an abrupt increase was observed during the period from March - May to reach its maximum value 1.2 mm in May. A gradual decease took place afterwards; recording relatively high values during the successive months from June - August with a

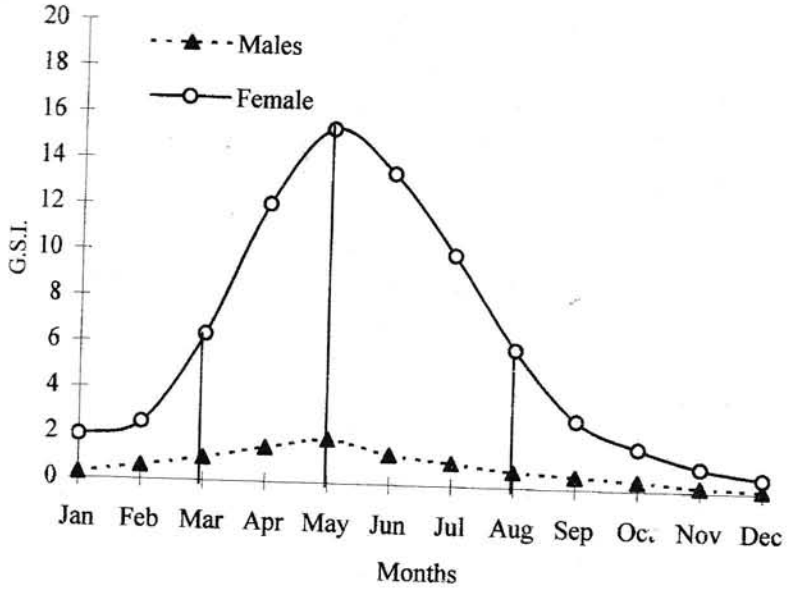

Fig.(5): Gonado-somatic index (G.S.I.) of the African catfish *Clarias gariepinus* harvested from the river Nile.

mean of 0.81 mm, followed by a sharp decrease to reach its minimum value (0.15 mm) in December (Figure 6). It is obvious that, the monthly egg-diameters distribution of *Clarias gariepinus* followed nearly a similar pattern of GSI. It is well known that oocytes attain their maximum developmental size just before or during the breeding season (Shenouda, 1988). Therefore, the present result is considered a new indication to confirm that the spawning season of *C. gariepinus* occurs during the period from March - August throughout the year. Estimation of the mean egg diameter in the different months gives an idea about the maximum size of the eggs and duration of the spawning season whether short or long. It also shows the number of spawning during the year. These data confirmed the previously deduced results, from the GSI calculations, about the number of spawning per year and the prolongation of the spawning season. According to Oven (1971), the presence of one or two peaks in the variation curve with the presence

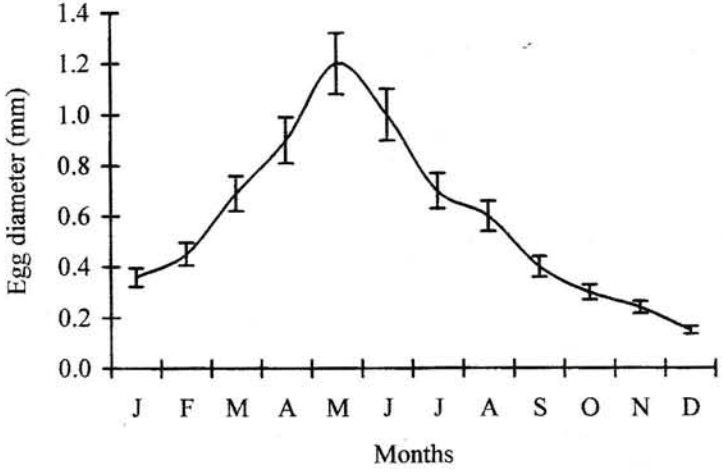

Fig.(6): Monthly variation of the average egg-diameter values for the African catfish *Clarias gariepinus* collected from the river Nile.

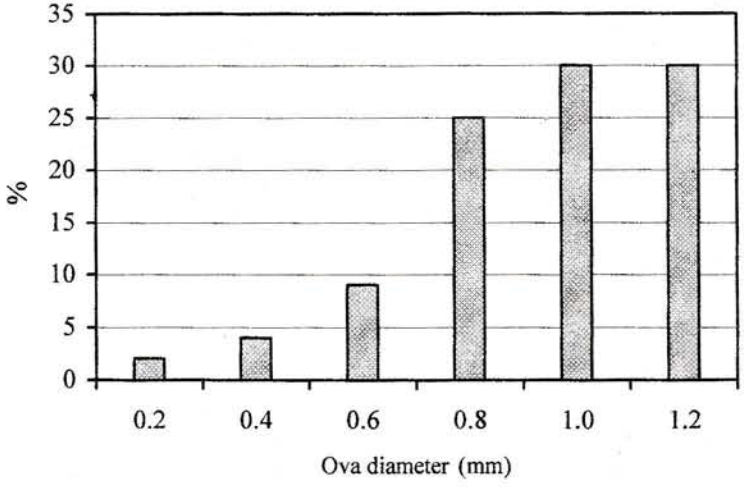

Fig. (7): Frequency distribution as a percentage (%) of ova-diameter in ripe ovaries of the African catfish *Clarias gariepinus* harvested from the river Nile.

of a stock of intermediate oocytes , does not mean that the fish discharges one or two egg-portions, but much more, since this growth of oocytes corresponds to the continuous type and points out to a polyportional spawning.

3.4. Fecundity

Two terms are usually applied in fecundity studies; these are the absolute and relative. The absolute fecundity denotes the total number of ripe eggs in the ovary, whereas the relative fecundity denotes the number of these eggs per unit of length or weight of fish. Since the African catfish *Clarias gariepinus* is a multispawner fish, all groups of the yolky eggs present in the ovary were counted depending on the expectation that each of them has the chance to be spawned in the current spawning season.

3.4.1. Relationship between fecundity and fish length

The absolute fecundity ranged from 17436 to 127724 for the fish ranging in total length from 29 to 53 cm. The relationship between the absolute fecundity and fish total length of *Clarias gariepinus* is graphically represented in Figure (8). It appeared to be a linear relationship, and can be expressed mathematically by the following regression equation: $AF = -122073 + 4713 * L$, $r = 0.9891$, where AF is the absolute fecundity, L is the total length of fish (cm), r is the correlation coefficient of the regression line. It is obvious in figure (8) that the relative fecundity per cm increases regularly from 589 to 2410 with increasing fish length from 29 to 53 cm. The relationship between them is also linear and can be expressed as follows: $RF = -1494 + 76.26 * L$, $r = 0.9896$,
where RF is the relative fecundity per cm.

It was interesting to compare the present results with those obtained for *Clarias gariepinus* inhabiting other Egyptian waters. It was found that the absolute fecundity ranged between 4651 and 60655 eggs in Muess Canal in Sharkia Province (AL-Zahaby *et al.*, 1983), between 7650 and 98085 eggs in Bahr Shebeen Nile canal (Khallaf and Gaber, 1993), and between 18690 and 179900 eggs in Rosetta branch of the river Nile (Shenouda *et al.*, 1995). Consequently, in the present study, *Clarias gariepinus* inhabits the main river Nile stream

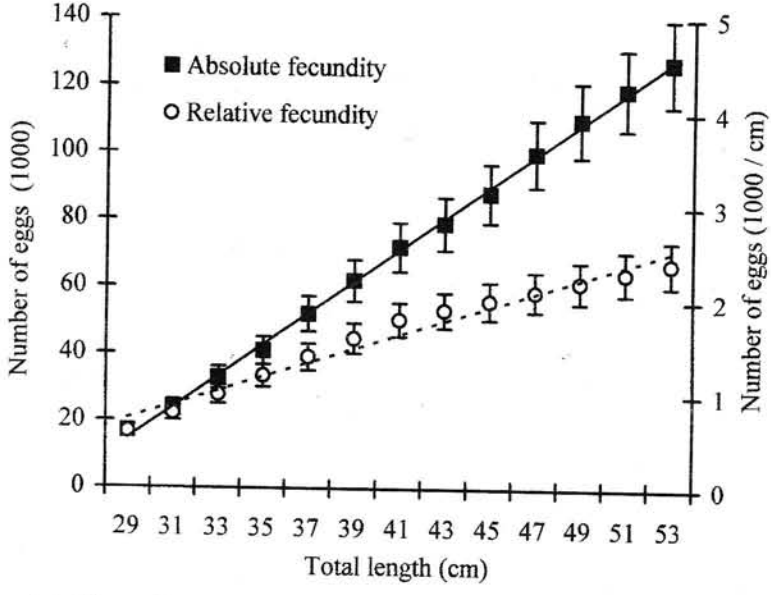

Fig (8):The relationship between fecundity and total length of the African catfish *Clarias gariepinus* collected from the river Nile.

is more fecund than those in Muess Canal and in Bahr Shebeen Nile Canal but less fecund than that in Rosetta branch of the river Nile.

3.4.2. Relationship between fecundity and fish weight

The relationship between absolute fecundity and fish weight followed the straight-line formula. The relation between these two variables could be expressed by the equation:

$AF = -3494.10 + 102.53 * W$, $r = 0.9985$,

where AF is the absolute fecundity, W is fish weight (gm), r is the correlation coefficient of the regression line. The calculated mean numbers of eggs for the different weight groups are shown in Figure (9). The results revealed that the absolute fecundity increased with increasing weight of the fish. It increased from 20703 to 125796 eggs for the different weight groups ranged between 300 to 1300 gm. On the other hand, the relative fecundity-weight values did not vary greatly in the different weight-groups, but on the whole it is fluctuated slightly between 72 – 110 eggs / gm with the mean of 97 eggs / gm.

This relationship is linear and can be estimated by the following regression equation: RF = 65.58 + 0.4 * W, (r = 0.9488) , where RF is the relative fecundity per gram.

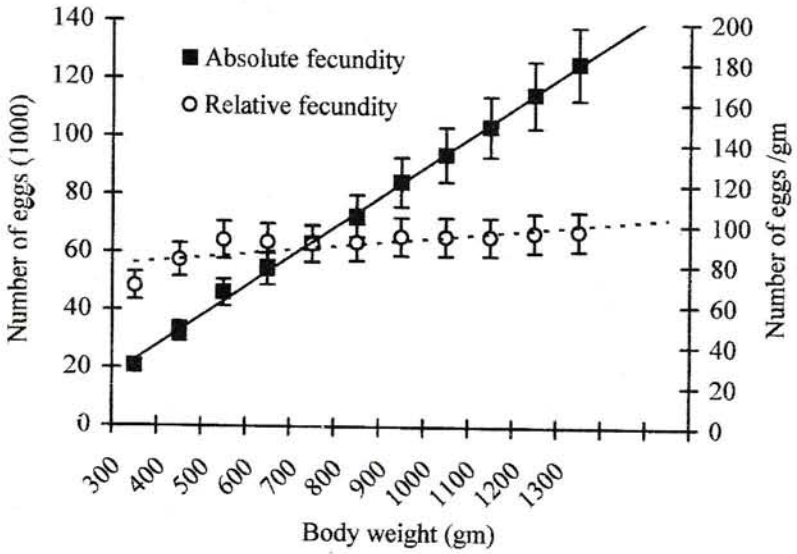

Fig (9): The relationship between fecundity and body weight of the African catfish *Clarias gariepinus* collected from the river Nile.

3.4.3. Relationship between fecundity and fish age

The average number of eggs for the successive age groups for *Clarias gariepinus* fishes are shown in Figure (10). It is noticed that within any age group, the number of eggs varied greatly. This variation is greater than what was found between fishes of the same length or weight groups. The relationship between absolute fecundity (AF) and fish age can be estimated from the regression equation as follow: AF = -14357 + 26982 * G , r = 0.9975 , where G is the fish age per year, r is the correlation coefficient of the regression line. Generally, the mean number of eggs increased, as the fish got older. Thus, it increased from 13981 eggs in fishes of age group I to 120554 eggs in fishes of age-group V. The result indicates that fish *Clarias*

CONCLUSION

From the present study of the spawning indices and fecundity for *Clarias gariepinus* inhabiting the river Nile, the following can be concluded:

1) The spawning season is long and increases during the period from March - August with a high peak in May, which means that partial spawning is exhibited.
2) The egg-diameter distributions are significantly variable and has one peak revealing that many generations of eggs are present in the ovaries, each matures one after the other *i.e.* multi-spawning is occurring.
3) Fecundity increases with increasing length, weight and age of the fish. This increase exhibited a linear trend with fish length, fish weight and fish age.
4) *Clarias gariepinus* inhabiting the main river Nile stream is more fecund than those inhabiting Muess canal and Bahr Shebeen Nile Canal, but less fecund than those inhabiting in Rosetta branch of the river Nile.
5) The maximum percentage of increase in the fecundity was found between age groups I and II, followed by that between age groups II and III.
6) It was suggested to protect the spawning stock biomass from capturing until they reach their third year of life at a length not less than 33 cm.

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التكاثر في سمكة القرموط الأفريقي *Clarias gariepinus* في نهر النيل بمصر

عادل أحمد ثروت

قسم الإنتاج الحيواني – كلية الزراعة – جامعة القاهرة – الجيزة – مصر

ملخص

تناول البحث دراسة دورة التكاثر لأسماك القرموط الأفريقي *Clarias gariepinus* في المجرى الرئيسي لنهر النيل . كان من أهداف هذه الدراسة تحديد حجم الأسماك عند بداية النضج الجنسي (Lm50) ، تحديد موعد أو موسم تكاثر الأسماك ، أحجام البيض في مراحل النضج الجنسي ودراسة خصوبة الأسماكِ . نوقشت النتائج المتحصل عليها بهدف الوصول إلى الإستغلال الأمثل للمخزون السمكي من أسماك القراميط الناضجة جنسيا في نهر النيل في مصر. وجد من خلال دراسة معامل الحالة النسبي أنه يزداد في الإناث عن مثيله في الذكور ولكن هناك تشابه إلى حد كبير في الاتجاه العام لمنحنى معامل الحالة الشهري من حيث ارتفاع القيم خلال موسمي الربيع والصيف . ومن المرجح أن هذا الارتفاع يرتبط بنمو ونضج المناسل أو بزيادة معدل تغذية الأسماك خلال هذه الفترة أو كليهما. وقد تم دراسة العلاقة ما بين طول ووزن الأسماك ووجد إختلاف معنوي بين أوزان الذكور والإناث في الأسماك التي يزداد طولها عن 33 سنتيمتر طول كليٍّ وتم وَصْفِ هذه العلاقة بين الطول والوزن رياضيا من خلال معادلتين . تبين من خلال دراسة مراحل النضج الجنسي أن بداية النضج الجنسي للأسماك (50 % من قطيع الأسماك يكون ناضج جنسيا) يحدث عند طول 33 سنتيمتر في الذكور و 32 سنتيمتر في الإناث ، وأن الأسماك الأكبر من 40 سنتيمتر طول كلى في كلا الجنسين تكون كلها ناضجة جنسيا . كما وجد إختلاف معنوي في قيم معامل المناسل الجسدي (GSI) بين كلا من الذكور والإناث حيث تزداد القيم كثيرا في حالة الإناث ولكن كلاهما يتبع نفس الاتجاه تقريباً حيث يصل إلى أقصى قيمة له في شهر مايو وهى 1.92 للذكور و 15.42 للإناث . وجد من دراسة أقطار أو أحجام البيض في مبايض الأسماك الناضجة جنسيا وتوزيعاتها الشهرية وجد إنخفاض قِيَم أقطار البيض خلال شهري يناير وفبراير حيث كانت 0.36 و 0.45 مليمترَ على التوالي ، بينما لوحظ زيادة كبيرة في قطر البيض تبدأ من شهر مارس حتى تصل إلى أقصى قطر لها وهو 1.2 ملليمتر في شهر مايو.

كما تم دراسة الخصوبة وعِلاقاتها بطُول ووزن وعُمر الأسّماكِ ووجـــد أن هذه العلاقات توصف بمعادلة إنحدار الخط المستقيم وتم تمثيلـــها بيانيـــا . وقـــد تضمنت الدراسة بعض التّوصياتِ التي تهدف إلى إدارةِ وحمايةِ وتنميـــة قطيـــع الأسماك الناضج جنسيا لاستكمال دورة التكاثر بكفاءة وزيادة إنتاجية الأسماك فـــي نهر النيل على المدى الطويل.

المجلة العلمية لكلية الزراعة -جامعة القاهرة - المجلد (51) العدد الرابع (أكتوبر 2000): 411 - 430 .