Qatar Univ. Sci. Bull. (1986), 6 : 371 – 388

THE FECUNDITY OF GERRES OYENA FORSKAL 1775, (FAM. GERREIDAE) IN THE QATARI WATERS OF THE ARABIAN GULF

By

A. E. EL-AGAMY*

Marine Sciences Dept., Faculty of Science, University of Qatar

Key words : Fecundity relationships–Fish length–Weight–Age–Ovary–Absolute–Relative–Gonadosomatic Index (G.S.I.)–Cyclic changes

ABSTRACT

Fecundity estimates were made on a total of 180 mature fish *Gerres oyena* Forskal of different lengths and weights, collected during the early spring of 1985. Log – log relationships were estimated between fecundity (either absolute or relative) and fish length, weight, age and ovary weight. It was found that, absolute fecundity increased at a rate proportional to the power of 5.47, 1.79, 1.78 and 1.08 of the total length, the body weight, the age and the ovary weight, respectively. Results showed that fecundity, either absolute or relative, depended mainly on body length and to a lesser extent on body weight, fish age and ovary weight. Therefore, length is the best expression for fish fecundity and can be used for the prediction of *Gerres oyena* production in the Arabian Gulf waters.

INTRODUCTION

The Arabian Gulf is an important aquatic resource in Qatar, yet its fisheries are considered to be still virgin. *Gerres oyena* Forskal, is a widely distributed and economically important marine fish which is capable of adapting itself to diverse climatic conditions (ranging from tropical to temperate seas) or over nearly all the world (Kuronuma and Abe 1972). Successful exploitation of any fish requires a thorough knowledge of its reproductive biology. In view of the considerable variations reported in gonadal cycle, knowledge about spawning season and fecundity is urgently needed in order to maintain and manage this important fish species.

* *Permanent Address :* Zoology Department, Faculty of Science, Zagazig Univ., Egypt.

Estimation of fecundity is an important aspect of the biology of fishes. It can be used, for example, to determine the stock size and the characters for stock separation of a given fish (Burd and Howlett 1977). Hodder (1963) believed that fecundity studies may play an important role in determining the relation between spawning potential and recruitment.

The ease with which fecundity can be determined depends upon whether or not there is a clear size–separation between developing and resting oocytes (Hickling and Rutenberg 1936). It is, therefore, imperative to determine which oocytes will develop in the current season.

Fecundity has been reported as a function of length, weight and age of some fish species (Pitt 1964, Nikolsky *et al.* 1973, El–Agamy 1974, El–Maghraby *et al* 1974, Begenal and Braum 1978 and Al–Zahaby *et. al.* 1981, 1982, 1983).

Accordingly, the present study was undertaken to determine the pattern of the ovarian cycle, spawning season and fecundity of *Gerres oyena.*

MATERIAL AND METHODS

For fecundity estimation, a total of 180 mature female fish were randomly obtained biweekly during the period from April to June 1985, from the catch of a certain fishermen fishing in Qatari waters around Doha, where *Gerres oyena* is considered to be the predominant species. For each fish obtained, total length (to the nearest centimeter) and body weight (to the nearest gram) were recorded and scales were taken for age determination. The Gonado–Somatic Index (GSI) was calculated by the formula : $\frac{\text{Weight of ovary}}{\text{Weight of fish}} \times 100$

The ovaries from each fish were carefully removed, weighed (to the nearst 0.1 gram), and preserved in Gilson's fluid, as modified by Simpson (1951), for three months to clean the eggs by breaking the ovarian tissue. Two subsamples were usually taken for counting, but in a few cases two additional subsamples were taken when the first two ones showed counts quite different from each other. In such cases the average of all four counts was used for the fecundity estimate. The subsample was placed in a petri dish, and the ova were counted under a binocular microscope (X5). The total number of eggs in a female was determined from the total weight of the (two) ovaries and the mean count of the subsamples.

All of the ovaries were collected before the eggs were translucent, approximately one month prior to spawning. Thence, at this period there is no possibility of counting eggs that would mature the following year since the average diameter of maturing eggs of the present year is approximately 0.8 mm whereas that of the immature eggs is less than 0.2 mm.

RESULTS

CYCLIC CHANGES IN THE OVARY WEIGHT

The female *Gerres oyena* is provided with a pair of ovaries. These are more or less spindle - shaped organs, the anterior and particulary the posterior ends of which are slender. The spawning period covers about two and a half months (from the end of April to early July). Therefore the ovary changes in weight cyclically throughout the year. The change in gonadosomatic index is shown in table 1.

In August, the mean percentage of ovary weight per body weight had the smallest value, being only 2.6 % From that point on, the mean percentage showed a gradual month to month increase throughout autumn and winter. In March and April, ovaries develop quickly and become filled with large eggs with much yolk. The mean GSI value in April amounted to 11.8 % which was about two times that in winter. In May, the value became the highest and reaching 14,6 %. Eggs within these ovaries were seen from outside as large, yellow, spherical spots. The slow decrease in ovary weight along with spawning may be attributed to the asynchronous development of oocytes which causes the fish to spawn several times in a year. In late August and September ovaries decreased in size and their weight dropped to 2.6 % of body weight by the end of August. The above mentioned cyclic changes were repeated again during the following season.

FECUNDITY RELATIONSHIPS

The fecundity of this species has been related to length, weight, age and ovary weight. In all cases, it was found that a double logarithmic transformation gave linear relationships. The total number of the eggs in the ovary of the fish is termed as the absolute or total fecundity. The relative fecundity is the number of eggs per unit length or weight of the fish, and this is also used as an index of the fecundity.

Table 2 gives the constants for the various fecundity relationships together with the coefficients of correlation for each of these. Statistical comparisons were made using analysis of covariance by methods given by Snedecor (1956).

RELATION BETWEEN FECUNDITY AND FISH LENGTH

For any length of the fish, the absolute fecundity varies between wide limits. The mean absolute fecundity of *Gerres oyena* varied between 20 and 435 thousand eggs with change in fish lengths from 17 to 30 centimeters. When plotting total number of eggs with successive lengths, a curvilinear relation is evident (Fig. 1). It is apparent that fecundity increases at a rate greater than the length of the fish. The relationship between log fecundity and log length is expressed in the form,

$$\text{Log } F_{(\text{absolute})} = -2.430 + 5.47 \text{ Log } L$$

or

$$F_{(\text{absolute})} = 0.003715 \ L^{5.47}$$

where F is the total number of eggs and L is the total length in centimeters.

The resulting fecundity – length curve indicates that fecundity increases at a rate greater than the fifth power of the total length, the regression coefficient (n) being 5.47.

On the other hand, mean relative fecundity varied between 1,176 and 14,500 eggs (mean 6,157 eggs) per centimeter of length, for fish 17 – 30 centimeters in length.

A curvilinear relation exists between the relative fecundity and total fish (F.g 1) and the following formulae describe the relationship :

$$\text{Log } F_{(\text{relative})} = -2.430 + 4.47 \text{ Log } L$$

or

$$F_{(\text{relative})} = 0.003715 \ L^{4.47}$$

It is evident that there is a good fit between the empirical and calculated values of both the absolute and relative fecundity for all of the length intervals. The coefficient of correlation (r) for this relationship is highly significant (Table 2).

RELATION BETWEEN FECUNDITY AND FISH WEIGHT

Since fecundity has been shown to increase at a rate greater than the fifth power of the length, instead of length to the third power, it was considered necessary to examine the relationship between length and weight for the present data (Fig. 2). The log–log regression line fitted to the individual observations gives the relationship :

$$\text{Log W} = -2.04 + 3.103 \text{ Log L}$$

or

$$W = 0.008892 \; L^{3.103}$$

(where w = weight in grams, L = length in centimeters). The coefficient of correlation (r) for this relation is highly significant, r = 0.9987 ($p = < 0.001$)

Thus, the relationship between log fecundity and log weight, when treated by the usual method of least square should produce an equation of the form $F = aW^n$ where (n) is found to be of 1.79 (n = 5.47 for the log fecundity–log length relationship, and n = 3.103 for the log weight – log length equation. Hence, n = 5.47 / 3.103 or 1.76 for the log fecundity – log weight relationship). This is confirmed by the log fecundity log weight regression lines whose regression coefficient is 1.79. The calculated formula is as follows :

$$\text{Log } F_{(\text{absolute})} = 1.12 + 1.79 \text{ Log W}$$

or

$$F_{(\text{absolute})} = 13.18 \; W^{1.79}$$

(where F = fecundity and W = weight in grams)

It is evident that total fecundity increases at a rate of 1.79 power of the weight of the fish. Plotting total fecundity against total body weight, a slight curvilinear relation is obtained (Fig. 3). Only in a few cases was a difference between the empirical and calculated values and good coincidence was noticed on the whole.

On the other hand, relative fecundity, ranging between 333 and 1310 eggs (mean 778) per one gram of fish weight, plotted against fish weight (in grams) gives the relationship :

$$\text{Log } F_{(relative)} = 1.12 + 0.79 \text{ Log } W$$

or

$$F_{(relative)} = 13.18 \; W^{0.79}$$

The difference between empirical and calculated relative fecundity is noticed (Fig. 3), but the agreement between the calculated values and observed values is not as close as in the case of the absolute fecundity.

The correlation coefficient (r) of the fecundity–weight relationship is statistically significant, for both the absolute and relative fecundity. It was 0.9965 ($p = < 0.001$) and 0.9829 ($p = < 0.001$) respectively.

RELATION BETWEEN FECUNDITY AND AGE

Table III shows the mean fecundity (absolute and relative), mean body length, and ranges in fecundity and in body length by age–classes in all the samples. Fecundity varies widely within each age–class and there is a considerable degree of overlapping in fecundity ranges between age–classes. F.g 4 gives the fecundity of different fish individuals plotted against age. The equation for the relationship between fecundity and age is as follows :

(i) $$\text{Log } F_{(absolute)} = 4.12 + 1.78 \text{ Log } A$$

or

$$F_{(absolute)} = 1.3035 \times 10^4 \; A^{1.78}$$

and for the relative fecundity :

(ii) $$\text{Log } F_{(relative)} = -2.68 + 4.65 \text{ Log } L_n$$

or

$$F_{(relative)} = 0.002089 \; L_n^{4.65}$$

(where F = fecundity, A = age in years and L_n = the calculated length at the end of n*th* year).

The highly significant coefficients of correlation (r) for (i) of 0.9758 ($p = < 0.001$) and for (ii) of 0.9984 ($p = < 0.001$), mean that older fish are more fecund than the younger ones, a phenomenon which is known in several other fish species.

The results also show that the variation in fecundity between fishes of the same age is greater than the variation between fishes of the same length or weight. This is mostly due to the wide range of lengths within the different age groups. It is necessary to mention that within any age group fecundity increases with the fish length also.

RELATION BETWEEN FECUNDITY AND OVARY WEIGHTS

The ovaries of mature female *Gerres oyena* that are approaching spawning contain three types of eggs :

(a) minute grey–coloured yolkless eggs les than 0.2 mm in diameter,
(b) larger opaque yellow–coloured eggs 0.3 – 0.8 mm in diameter,
(c) still larger translucent eggs about 1 mm in diameter.

Ovaries examined 1 – 2 months subsequent to spawning still contain the grey–coloured masses of minute eggs, but rarely are the larger opaque or translucent eggs found. It would seem, therefore, that only the eggs of the last 2 types are involved in the immediate spawning, the first type being eggs which would develop for spawning in the following or subsequent years.

The increase in fecundity with respect to weight of the ovary (Fig. 5) can be expressed as follows :

$$\text{Log } F_{(\text{absolute})} = 4.19 + 1.0762 \text{ Log } G$$

and for relative fecundity

$$\text{Log } F_{(\text{relative})} = 4.19 + 0.0762 \text{ Log } G$$

(where F = fecundity, and G = weight of ovary in grams).

Using the average log fecundity at each log, ovary weight gives a correlation coefficient (r) for absolute fecundity 0.9927 ($p = < 0.001$) and 0.9491 ($p = < 0.001$) for relative fecundity.

DISCUSSION

Fecundity of 180 samples of female *Gerres oyena* Forskal from the Arabian Gulf, Qatari region, was found to be directly related to length and to somewhat lesser extent, weight, age and ovary weight of the fish. This is confirmed statistically by the correlation coefficients for the various fecundity relationships, which are highly significant for all parameters, indicating good linear relationships (Table 2). Therefore, the length of the female *Gerres oyena* is the best expression of its absolute fecundity, where the two parameters were statistically more significantly correlated with each other. The same results were obtained by Raitt (1933), Simpson (1951), Bagenal (1973), El-Agamy (1974), El-Maghraby *et al* (1974), Bagenal and Braum (1978) and Al-Zahaby *et al* (1981, 1982, 1983), in dealing with other different fish species. They concluded that, the fecundity depends mainly on the body length of the fish because the weight of a fish at a given length and age varies seasonally. Hart *et al* (1940) showed that a considerable loss in weight of fish occurs during the period of egg maturation, while the body length is not affected.

Botros (1962), Hodder (1963, 1972) and May (1967) claimed that the fecundity-weight relationship gives the best description of egg production, however length measurements are usually more easily and more accurately obtained during field sampling than weights.

It appears from this study that fecundity of *Gerres oyena,* varies widely within fish of the same weight. This is dependent on the condition factor of the fish which might affect the number of oocytes that mature in a particular season.

When fecundity is related to age, irrespective of length for *Gerres oyena,* it is found that there is a definite positive correlation between these two parameters. However the difficulty in adopting age arises from the fact that variation in fecundity at any one age is even greater than that observed between fish of the same length or weight as shown in (Fig. 4, Table 3). Moreover the probability of error in age interpretation and the subsequent erroneous calculation of fecundity could not be completely excluded.

The ovary of most fish changes cyclically in weight in accordance with its reproductive cycle. In *Gerres oyena,* the gonad index begins to increase gradually from about 3.1 % in September to 11.8 - 14.6 % by the spawning season. Then it falls to the minimum after spawning. More than 45 % of the oocytes having a diameter less than 0.2 mm are present in the ovaries throughout the year. Especially in Autumn they are most abundant and comprise more than 90 % of the total eggs. These minute oocytes are not considered in fecundity estimations as they have a great significance in supplying the eggs to be spawned in the following seasons. Hickling (1930) called these oocytes reserve fund eggs, while Raitt (1933), Valdykov (1956), Macer (1972, 1974) and El-Agamy (1974) called them recruitment stock eggs.

In conclusion, in the ripe ovary of *Gerres oyena* there is a continuous gradation in oocyte size. Fecundity either absolute or relative is related to the length of the fish. Values of fecundity ranged from 20,000 for a fish length of 17 cm to 435,000 oocytes for a fish length of 30 cm. Moreover, the number of oocytes actually released in a particular year apparently depend upon the condition factor of the fish. Thus, length can be used for prediction in production studies of these fish in the Arabian Gulf waters. Otherwise, length measurements are usually more easily and more accurately obtained during field sampling than the other parameters.

ACKNOWLEDGEMENT

The author wishes to express his hearty thanks to Prof. E. M. Hassan, head of marine science department and Prof. A. M. El-Maghraby for their helpful encouragement and valuable criticisms and for their kind reading of the present manuscript.

Table 1

Seasonal change in the ovary weight represented by the Gonado–Somatic Index (GSI) of the fish

Month	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Gonado–Somatic Index (GSI)	5.3	6.0	9.1	11.8	14.6	12.3	7.7	2.6	3.1	3.9	4.2	4.9

Table 2

Summary of the intercepts, regression coefficients and correlation coefficient of the various fecundity relationships

Log–fecundity in related to	Intercept (a)		Regression coefficient (b)		Correlation coefficient (r)		Test of statistical significance	
	absolute	relative	absolute	relative	absolute	relative	absolute	relative
Log length	−2.43	−2.43	5.47	4.47	0.9972	0.9959	p = < 0.001	p = < 0.001
Log weight	1.12	1.12	1.79	0.79	0.9965	0.9829	p = < 0.001	p = < 0.001
Log age	4.12	−2.68	1.78	4.65	0.9758	0.9984	p = < 0.001	p = < 0.001
Log ovary weight	4.19	4.19	1.08	0.08	0.9927	0.4491	p = < 0.001	p = < 0.001

Table 3

Mean fecundity (absolute & relative) and mean body length, by Age-group (number of specimens are given in parentheses)

Age group	Range in body length (cm)	Mean body length (cm)	Range in fecundity observed	Mean fecundity observed	Relative fecundity / (no. of egg cm)
II	17 – 21	19.7 (34)	13 369 – 44 367	35 347	1794
III	20 – 24	22.5 (39)	33 392 – 146 031	113 488	5044
IV	22 – 26	24.8 (48)	85 050 – 264 710	186 073	7503
V	24 – 28	26.5 (19)	108 418 – 283 060	244 511	9227
VI	26 – 29	28.1 (15)	122 789 – 341 188	278 884	9925
VII	27 – 30	29.5 (11)	286 403 – 420 240	367 307	12451

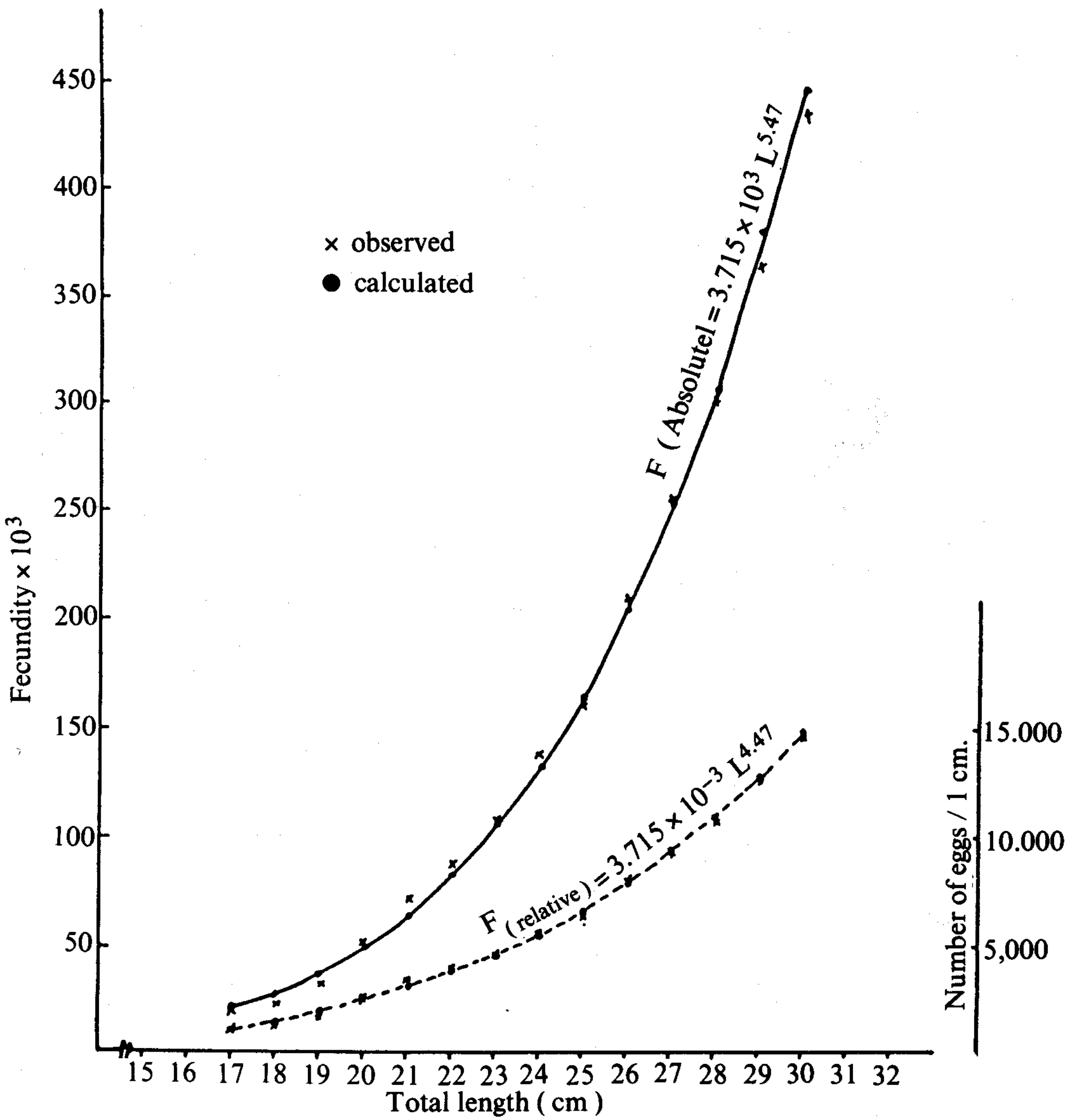

Fig. 1 The relation between fecundity and Length of *Gerres oyena* during the period of investigation.

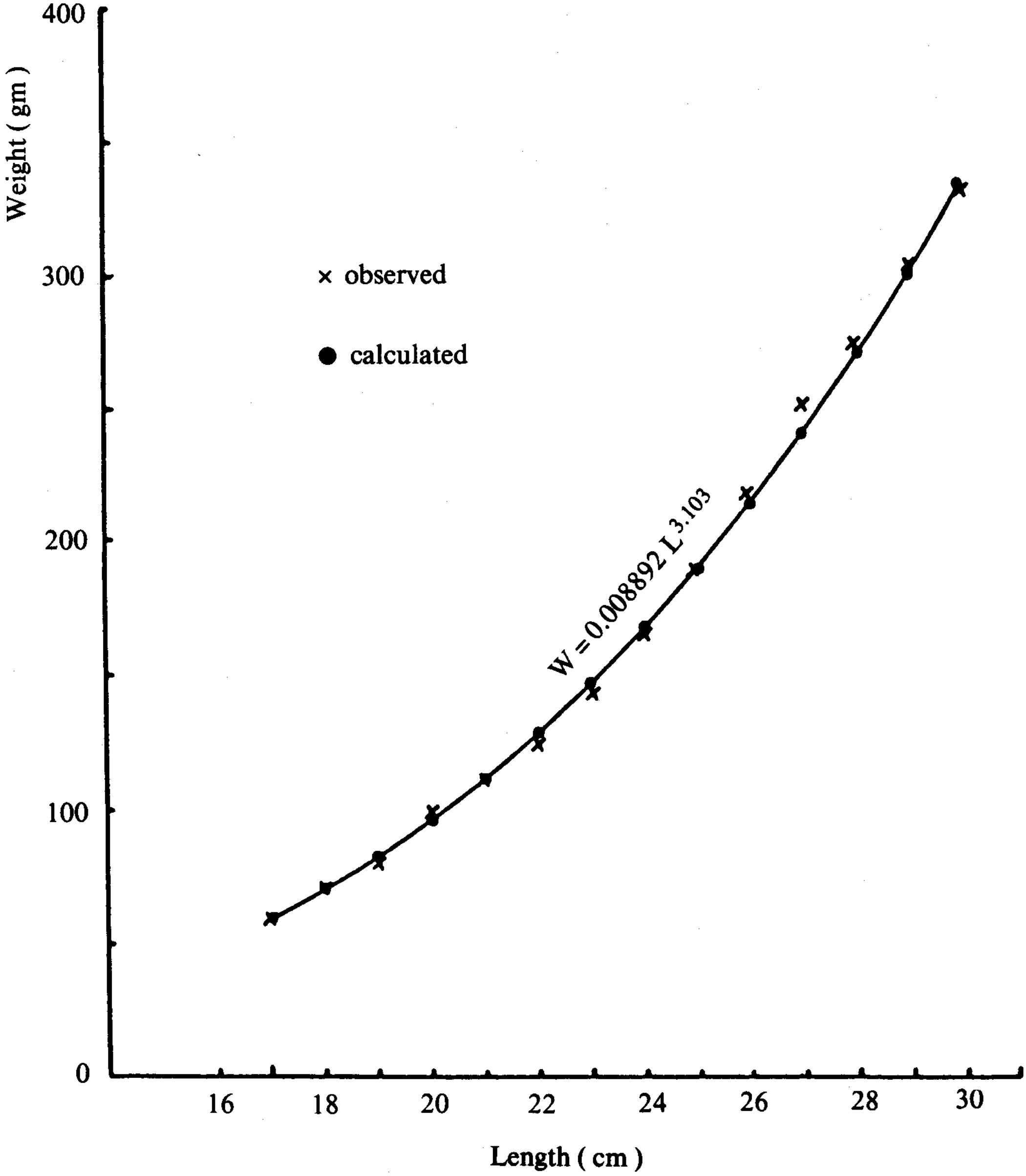

Fig. 2 The length–weight relationship of the female *Gerres oyena* specimens used for the fecundity estimations.

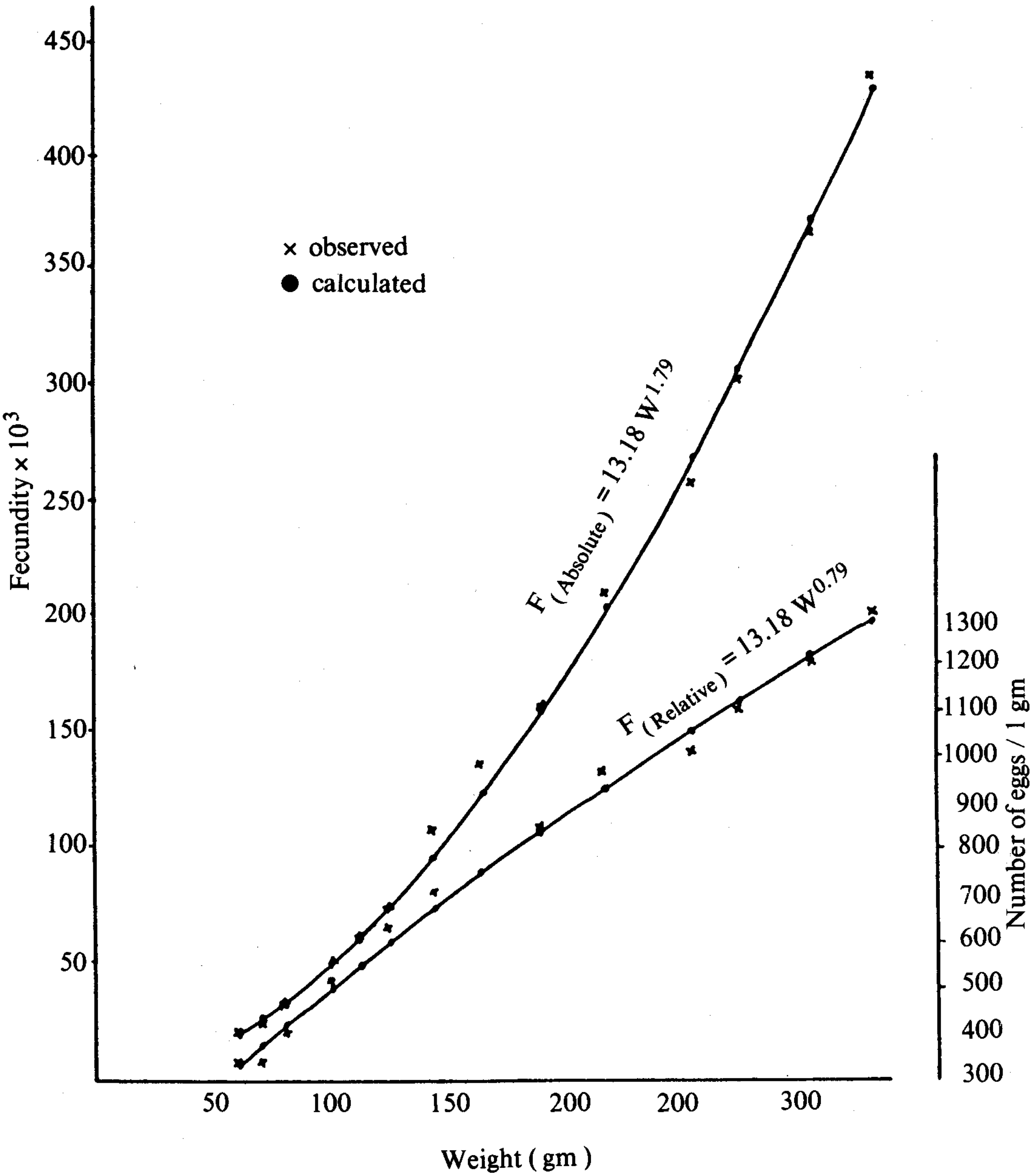

Fig. 3 The relation between fecundity and Weight of *Gerres oyena* during the period of investigation.

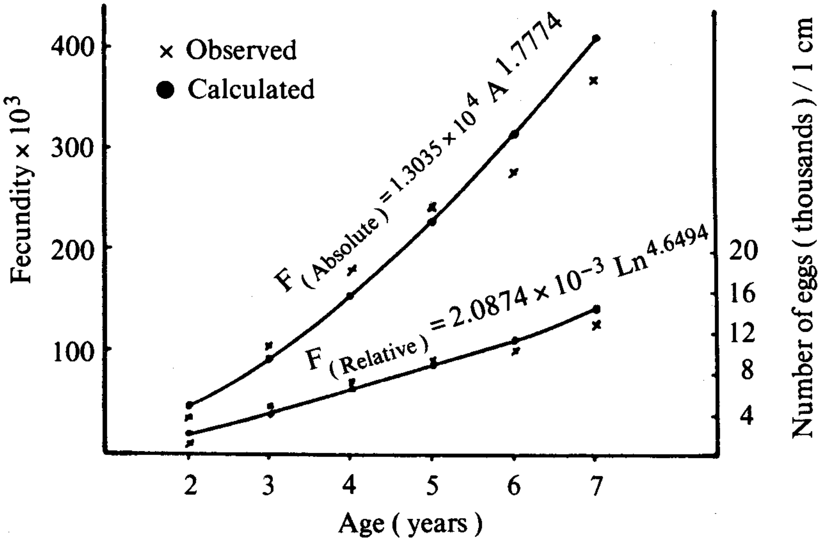

Fig. 4 The relation between fecundity and Age of *Gerres oyena* during the period of investigation.

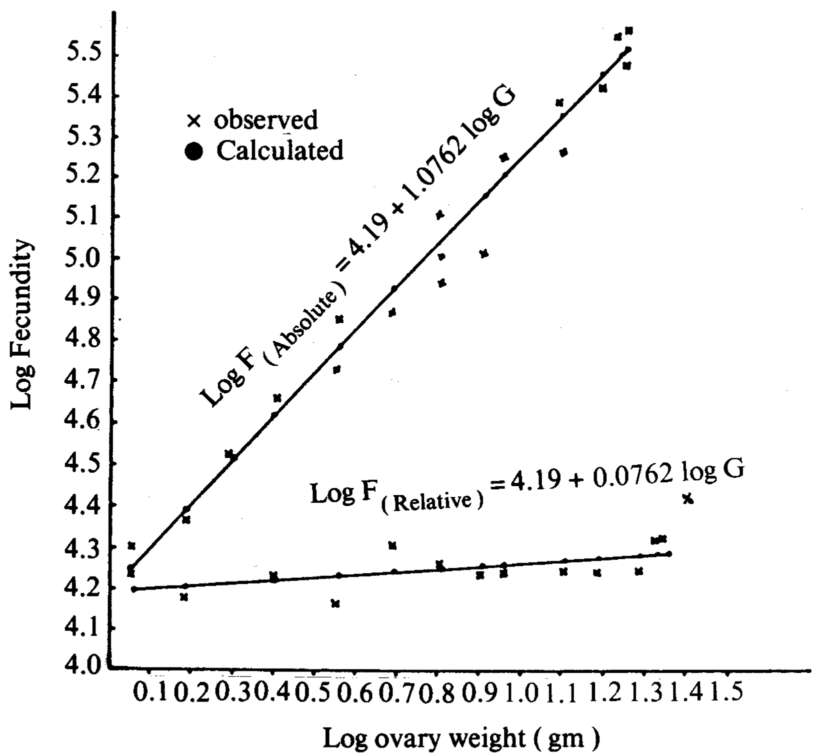

Fig. 5 The relation between Log fecundity and Log ovary weight of *Gerres oyena* during the period of investigation.

REFERENCES

Al-Zahaby, A. S., A. E. El-Agamy, and A. M. Abd El-Gawad, 1981. Fecundity of *Tilapia nilotica* in lake Manzalah. Res. Bull. No. 282. Fac. of Agri. Zag. Univ., 1 - 7

Al-Zahaby, A. S., A. E. El-Agamy, and A. M. Abd El-Gawad, 1982. Fecundity of *Tilapia zillii* in lake Manzalah. Bull. Fac. Science, Zagazig Univ. 4 : 278 - 920.

Al-Zahaby, A. S.; A. E. El-Agamy and A. Z. Moustafa 1983. On the fecundity of *clarias lazera* inhabiting fresh-water Muess canal in Sharkia province, Egypt, Bull. Fac. Sci. Zagazig Univ. 5, 533 - 550

Bagenal, T. B. 1973. Fish fecundity and its relation with stock and recruitment. Rapp. P.; V. Reun. Cons. Perm. Int. Explor. Mer 164 : 186 - 198.

Bagenal, T. B. and **E. Braum, 1978.** Eggs and early life history, IBP Hand-book No. III. Methods for assessment of fish production in fresh water. pp. 101 - 130.

Botros, G. A. 1962. Die fruchtbarkeit des doaches (*Gadus morhua* L.) in der westleichen Ostsee und Westnorwegischen Gewassern, Kiel. Meeres forch. 18; 67 - 80.

Burd, A. C. and **G. Y. Howlett, 1971.** Fecundity of Bank and Downs herring. ICES Pelagic fish (N) Committee, C. M. 1971, H. 18 (mimeo).

El-Agamy, A. E., 1974. Fruchtbarkeitsbestimmung bie Decapterus rhonchus (Geoffr.) und die Dynamik dieser Bestande in Gewassern vor Nordwest Afrika. Disser. Univ. Rostock.

El-Maghraby, A. M.; M. T. Hashem and **H. M. El-Sedfy, 1974.** Sexual maturity, spawning migration and fecundity of *Mugil capito* (Cuv.) in lake Borollus. Bull. Inst. Ocean. & Fish., A. R. E. Vol. 4, 35 - 56.

Hart, J. L.; Tester; D. Beall and **J. P. Tully, 1940.** Proximate analysis of British Columbia herring in relation to season and condition factor. J. Fish. Res. Can.; 4; 478 - 490.

Hickling, C. F., 1930. The natural history of the Hake. III. Seasonal changes in the conditions of the Hake. Fish. Invest. 12, 1 - 78.

Hickling, C. F. and **E. Rutenberg, 1936.** The ovary as an indicator of the spawning period in fisheries. England Min. Agr. Fish. Invest. 2 Vol. 21 : 311 – 317.

Hodder, V. M., 1963. Fecundity of Grand Bank haddock. J. Fish Res. Bd. Can.; 20; 1465 – 1487.

Hodder, V. M., 1972. The fecundity of herring in some parts of the Newfoundland area. Res. Bull. Int. Comm. Northw. Atlant. Fish., No. 9, pp. 99 – 107.

Kuronuma, K. and **Y. Abe, 1972.** Fishes of Kuwait. Kuwait city, KISR 153 p.

Macer, C. T. (1972). A method for determining the fecundity of the horse mackerel (*Trachurus trachurus* L.) ICES Pleagic Fish (S) Committee, C. M. I : 6.

Macer, C. T. 1974. The productive biology of the horse marckerel "*Trachurus trachurus* (L.)" in the North Sea and English channel. J. of Fish Biology 6 : 415 – 438.

May, A. W., 1967. Fecundity of Atlantic Cod. J. Fish. Res. Bd. Canada; 24; 1531 – 1551.

Nikolsky, G. V.; A. Bogdanov and **Y. Lapin, 1973.** On fecundity as a regulatory mechanism in fish population dynamics. Rapp. P. V. Reun. Cons. Perm. Int. Explor. Mer. 164: 174 – 177.

Pitt, T. K., 1964. Facundity of the American plaice, *Hippoglossoides platessoides (Fabr) from the Grand bank and Newfoundland areas. J. Fish. Res. Bd Can. 21 : 597 – 612.*

Raitt, D. S., 1933. The fecundity of the haddock Fish Bd. Scot. Sci. Invest., no. 1 : pp. 1 – 42.

Simpson, A. C., 1951. The fecundity of the plaice. U.K. Min. Agric. and Fish., Fish. Invest., Ser. 2, 17 (5) : 1 – 27.

Snedecor, George W., 1956. Statistical methods. Iowa State college Press, 5th ed.., 534 pp.

Vladykov, V. D., 1956. Fecundity of wild speckled trout (*Salvelinus fontinalis*) Canada; 13; 799 – 841.

خصوبة أسماك البدح (عائلة الجرّة)
في المياه القطرية من الخليج العربي

أنور الحسيني العجمي

لدراسة خصوبة أسماك البدح تم فحص عدد ١٨٠ مبيض لإناث ناضجة جُمعت في أوائل ربيع ١٩٨٥ م ووُجد أن هناك علاقة بين العدد الكلي للبيض (الخصوبة المطلقة أو النسبية) وكل من طول ووزن وعمر ووزن المبيض .

كما وُجد بأن الخصوبة المطلقة تزداد بمعدل يتناسب مع أس ٥,٤٧ ، ١,٧٩ ، ١,٧٨ ، ١,٠٨ لكلٍ من الطول والوزن والعمر ووزن المبيض على الترتيب .

ويمكن القول بأن الخصوبة سواء المطلقة أو النسبية تتصل إتصالاً وثيقاً لطول السمكة وبدرجة أقل بالوزن وعمر ووزن المبيض ، وأن العلاقة بين طول السمكة والخصوبة هي أصدق تعبير عن إنتاجية أسماك البدح في المياه القطرية من الخليج العربي .