*J.K.A.U. Mar. Sci.*, **Vol. 1**, pp. 55-65 (1410 A.H./1990 A.D.)

# Growth Rate of Gilthead Bream *Sparus aurata* L.

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ABSTRACT. In this study, growth rates of the gilthead bream *Sparus aurata* L. in their natural habitat (Egyptian Mediterranean waters) were determined. Absolute growth, annual increment and percentage annual gain (in length and weight) were estimated from scale reading. Regression equation representing fish length/scale radius relationship is given. The rate of increase in weight ($W$) with length ($L$) is described by the formula: Log W = – 2.1724 + 3.2216 Log. L. Maximum expected length ($L_\infty$ = 62.4 4 cm) and weight ($W_\infty$ = 4091.3 g) were computed using von Bertalanffy's growth equation.

## Introduction

Gilthead breams *Sparus aurata* L. (Sparidae) are marine teleosts distributed in tropical and temperate coastal waters. They are very common in the Mediterranean, particularly the French, Italian, Greek and North African coasts (Mathias and Salvy 1958), and patrol lakes and lagoons connected to the sea (Wassef 1978). In the Egyptian Mediterranean waters, it is known as "Denees". Although its catch did not exceed 499 tons in 1983 (3.6% of total fish yield from the Mediterranean), it is one of the important commercial fishes. The demand for the fish, in domestic as well as European markets, is high and consequently its selling price is also high. Thorough research on its various biological characteristics in local waters were carried out since 1975 (Wassef 1978), with a view to establishing its mariculture potential. Monthly growth rates of juveniles during the first year of life, food and feeding habits (Wassef and Eisawy 1984 and 1985), reproduction (Wassef 1985a), hermaphroditism (Kamel 1978 and Hafez 1981), biochemical composition (Wassef 1978, 1985b & c), have been also investigated.

The main objective of the present work is to determine the growth rate of the species in nature, so as to give useful information for the development of its fishery management and culture.

## Material and Methods

Gilthead bream samples were obtained several times a month, from the commercial catches caught mainly by trawls and long lines from near Alexandria fishing grounds. Sampling extended for 19 months, from July 1975 to January 1977. Total specimens (1003) were collected, ranging in length from 5 to 51 cm and in weight from 1.5 to 2620 g. Scale samples were collected from the 'pectoral area' for age determination (Paul 1968). Sex and sexual maturity were recorded. Scales were mounted dry between two glass slides and examined under a binocular microscope. Distances from the focus to each 'annulus' and to the margin (edge) of the scale were measured on an anterior diagonal line (magnification × 16).

Total length, from tip of snout to the end of caudal fin, was used throughout this study. Sexes were combined since male and female fish gave virtually identical results (Wassef 1978).

## Results

Both otoliths and scales were examined and found to exhibit a pattern of concentric rings (annuli) which in any fish is usually consistent both between different scales, and between scales and otoliths. Since scales are easily removed, handled and can be obtained with little or no injury to the fish, the scale method has been used for aging 'Denees'.

### 1. *Scale Examination*

The average *Sparus aurata's* ctenoid scale is almost rectangular, with fine circuli in the anterior field, and with small ctenii bordering the short posterior field (Fig. 1). The variable position of the first annulus was a source of confusion in scale-reading. Small and large first growth zones were recognized. Of the 1003 scales examined in the present work, the majority belongs to 0, $1^+$and $2^+$ age groups constituting 15.5, 66.6 and 13.8%, respectively. However, few larger fish constitute 2.3, 1.5 and 0.4% showed apparent ages of $3^+$, $4^+$ and $5^+$, respectively. Generally, most fishes between 20 and 40 cm have 1, 2 or 3 annuli, while smaller sizes (less than 20 cm) rarely show a distinct annulus on their scales. On the other hand, larger fish (40-51 cm) showed 4 or 5 annuli.

### 2. *Time of Annulus Formation*

An annulus is evident close to the scale's edge in April and May, while from June to October there is a large growth zone between the outer most annulus and scale's edge (Fig. 2). Minimal outermost zones were first observed in April as well as the maximal zones, *i.e.* the annulus became visible on the scales during that month. The width of the outer most zone increased rapidly until November, and then remained

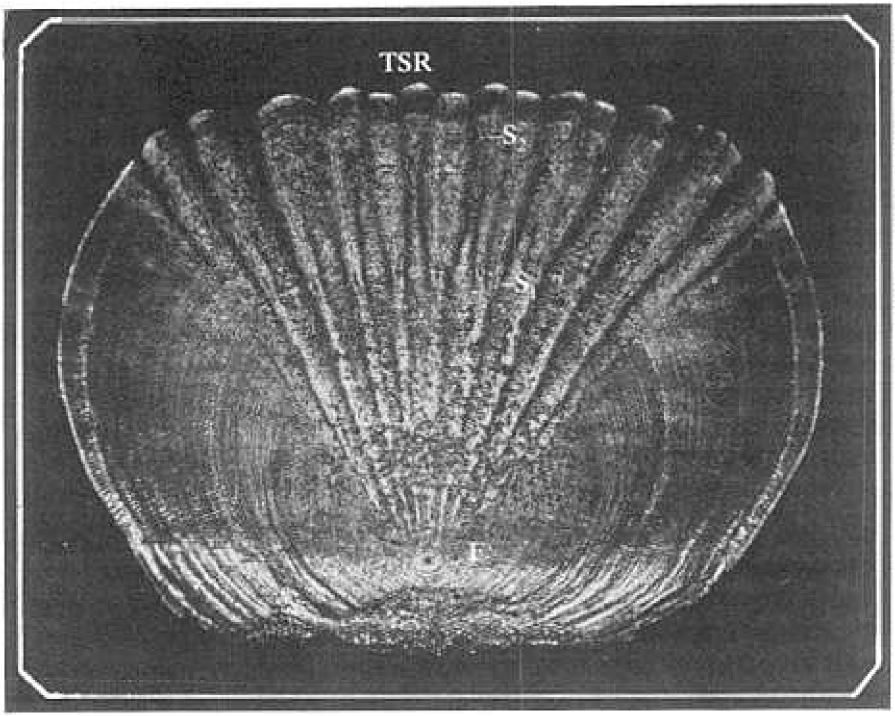



FIG. 1. Photo of *Sparus aurata's* scale, showing $2^+$ years. (Total fish length = 34 cm, caught on 10/5/1977).
F = focus of scale
$S_1$ = scale radius to the first annulus
$S_2$ = scale radius to the second annulus
T.S.R. = total scale radius (to the edge).

fairly constant at a large size until February. Little or no scale growth occurred during winter months (Fig. 2). Therefore, it is apparent that the annulus is formed during winter (December to February) but becomes visible three months later in April or May.

### 3. *Fish Length/Scale Radius Relationship*

The correlation between these two parameters differs for different fish species. For 'Denees', data represented on a scatter diagram approximated a straight line, accordingly the following regression equation was arrived at (Fig. 3).

$$L = 1.3103 + 6.248\ S \qquad (1)$$

where $L$ is fish length (cm) and $S$ is scale radius ($\times$ 16). Such equation gives hypothetical fish length at first scale formation ('*a*' value) of 1.3 cm. The calculated values of $L/S$ ratio showed no particular trend with the increase in fish length.

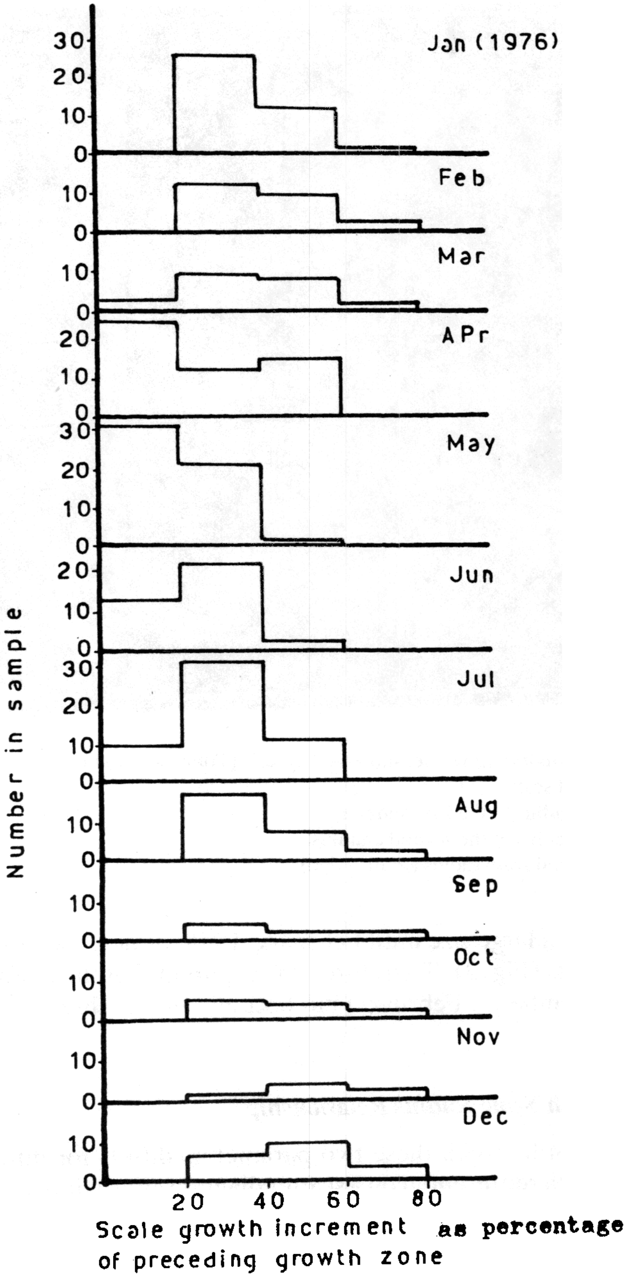
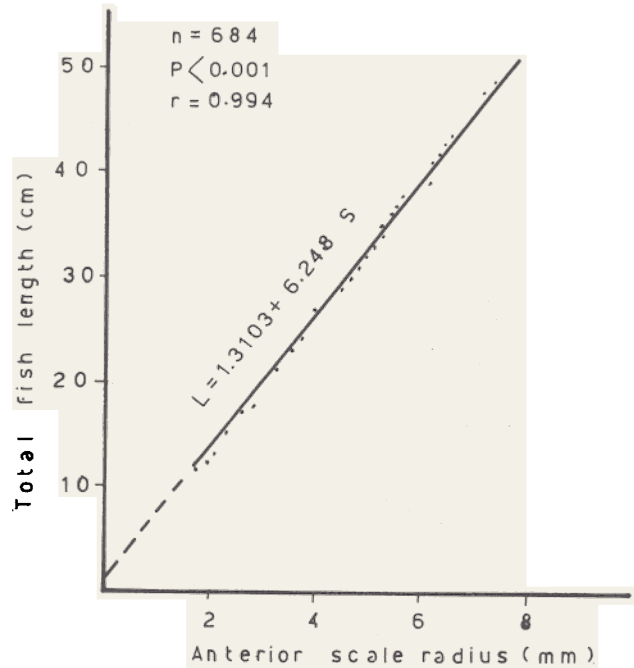



FIG. 2. Seasonal growth of outermost scale growth zone, for and $2^+$ fish, showing time of annulus appearance.




3. Fish length/scale size relationship for *Sparus aurata*.

## 4. *Growth in Length*

Lengths of fish at previous ages ($L_n$) were back-calculated using the corrected formula: $L_n = S_n/S\,(L - a) + a$, where $L_n$ is fish length at '*n'th* year, $L$ is length at capture, $S_n$ is scale radius to '*n'th* year, $S$ is total scale radius, and '*a*' is the constant previously obtained from equation 1, ($a$ = 1.31).

Two estimates of general growth rate are given in the bottom section of Table 1. One is based on the grand average calculated lengths, and the other on the summation of average annual increments of length. Growth studies, based on the latter, are held to be more descriptive of biological growth potential. A considerable agreement between average calculated lengths and average lengths at capture, for all age groups, could be easily detected (Table 1). Annual increment as well as percentage gain or relative growth are highest in the first year of life then decreased progressively with further increase in age (Fig. 4).

TABLE 1. Average calculated lengths at the end of different years of life of *Sparus aurata* (increment in parenthesis).

| Age group | Ave. length at capture | Average calculated lengths (cm) | | | | |
|---|---|---|---|---|---|---|
| | | $L_1$ | $L_2$ | $L_3$ | $L_4$ | $L_5$ |
| I | 23.7<br>668* | 17.67<br>( 0.0 ) | | | | |
| II | 29.0<br>138* | 16.15<br>( 0.0 ) | 26.16<br>(10.01) | | | |
| III | 35.1<br>23* | 16.23<br>( 0.0 ) | 25.59<br>(19.36) | 32.31<br>( 6.72) | | |
| IV | 42.7<br>15* | 17.01<br>( 0.0 ) | 27.27<br>(10.26) | 34.13<br>( 6.86) | 39.80<br>( 5.67) | |
| V | 46.7<br>4* | 16.57<br>( 0.0 ) | 26.67<br>(10.10) | 33.19<br>( 6.52) | 38.78<br>( 5.59) | 44.11<br>( 5.33) |
| Grand ave. calc. lengths | | 17.37 | 26.19 | 33.04 | 39.59 | 44.11 |
| Incr. of average | | 17.37 | 8.82 | 6.85 | 6.55 | 4.52 |
| Grand ave. incr. of length | | 17.37 | 9.95 | 6.75 | 5.65 | 5.33 |
| Sum of ave. incr. | | 17.37 | 27.32 | 34.07 | 39.72 | 45.05 |

*Number of fish analysed.

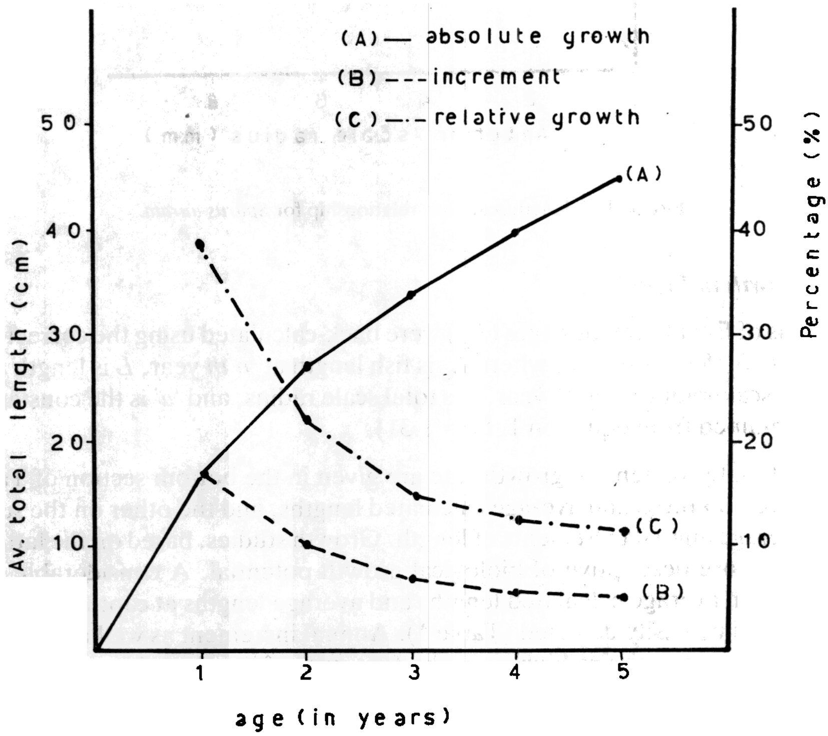



FIG. 4. Growth in length with age for *Sparus aurata*.

### 5. *Length/Weight Relationship*

Growth in weight in fish reflects how the ecological factors of a habitat affect the fish in which it lives, than does growth in length. Therefore, a length/weight formula was derived for *Sparus aurata,* taking all data together, as follows :

$$\text{Log } W = -2.1724 + 3.2216 \text{ Log } L \quad (2)$$

Where $W$ and $L$ are fish length (cm) and weight (g), respectively.

### 6. *Growth in Weight*

Likewise, weights at the end of different years of life (Table 2) were calculated by applying equation (2) to calculated lengths (sum of average increment, Table 1). Opposite to the trend of growth in length, the rate of increase in weight is minimum at the first year of life, increased, thereafter, with the increase in age (Table 3 and Fig. 5).

TABLE 2. Average calculated weights at different ages of *Sparus aurata* (increment in parenthesis).

| Age group | Average calculated weights (g) | | | | |
|---|---|---|---|---|---|
| | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ |
| I | 70.09 | | | | |
| II | 52.46 | 248.0 (195.54) | | | |
| III | 53.30 | 231.1 (177.8) | 489.9 (258.8) | | |
| IV | 62.00 | 283.6 (221.6) | 584.3 (300.7) | 959.0 (337.7) | |
| V | 56.99 | 264.0 (207.0) | 534.0 (270.0) | 881.8 (347.8) | 1336.0 (454.2) |
| Grand ave. calc. weights | 66.56 | 249.16 | 527.81 | 942.75 | 1336.0 |
| Incr. of ave. | 66.56 | 182.60 | 278.65 | 414.94 | 393.25 |
| Grand. ave. incr. of wt. | 66.56 | 195.70 | 274.83 | 369.04 | 454.20 |
| Sum of ave. increment | 66.56 | 262.26 | 537.09 | 906.13 | 1360.33 |

TABLE 3. Comparison between calculated (sum of average increment) and theoretical (Bertalanffy's equation) lengths and weights at different ages of *Sparus aurata.*

| Age (yr) | Average length (cm) | | | Annual increm. | Average weight (g) | | Annual increm. |
|---|---|---|---|---|---|---|---|
| | at capture | calc. | theor. | | calc. | theor. | |
| 1 | 23.7 | 17.4 | 17.5 | 17.4 | 66.6 | 67.4 | 66.6 |
| 2 | 29.0 | 27.3 | 26.8 | 9.9 | 262.3 | 269.5 | 195.7 |
| 3 | 35.1 | 34.1 | 34.1 | 6.8 | 537.1 | 592.2 | 274.8 |
| 4 | 42.7 | 39.7 | 40.2 | 5.6 | 906.1 | 986.1 | 369.0 |
| 5 | 46.7 | 45.1 | 44.8 | 5.4 | 1360.3 | 1403.7 | 454.2 |

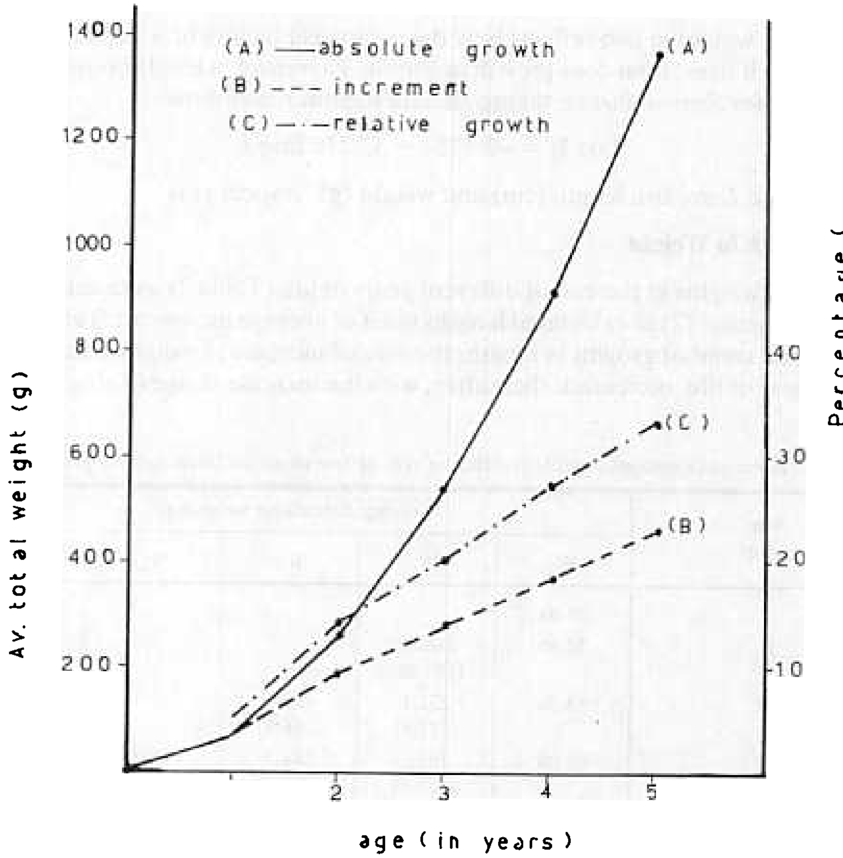



FIG. 5. Growth in weight with age for *Sparus aurata*.

## 7. *Theoretical Growth Rate*

The parameters of the von Bertalannffy's growth equation were computed for *Sparus aurata* adopting Gulland's method (1965) to calculated lengths (Table 1) as follows :

$$L_\infty = 62.44 \text{ cm} \; ; K = 2.34 \text{ and } t_o = -0.4013.$$

Theoretical growth in weight was also estimated by converting the theoretical lengths into weights using the length/weight equation (2). $W_\infty$ is estimated to be 4091.3 g. Close agreement between theoretical and calculated lengths and weights is evident (Table 3). The values arrived at ($L_\infty$, $W_\infty$, $K$ and $t_o$) are useful in fishery management of the species. Whereas the growth rates, particularly that of weight, are highly valuable in culture fields.

## Discussion

The validity of scales for aging *Sparus aurata* was assessed by many workers (Mathias and Salvy 1958, Audouin 1962, Lassèrre and Labourg 1974, Ben Tuvia 1979, Arias 1980). Both spawning and annulus formation take place in winter (December-February). Growth is arrested during this period and resumed the following spring (Fig. 2). Variations in the first growth zone were due to variations in the time of spawning, *i.e.* fish spawned early in the season would have a longer growth zone on scales and vice versa. The present work's results of the size of bream at first scale formation are in the line with those given by Paul (1968) who suggested that scales are first formed on the caudal peduncle of *Chrysophrys aurata* when the fish are about 10 mm long, and that they progressively form more anterior regions until fish is fully scaled at about 23 mm. However, there is considerable debate on this matter, since for some fishes '*a*' may be a negative value. The value of the exponent '*n*' in length/weight equation ($n = 3.22$) proves the robustness and well being of the species in local waters, when compared with that given by Arias (1980; 3.12) for fish inhabiting the Bay of Cadiz (Spain).

Previous growth estimates were based on average lengths or weights at capture, determined from scale-readings and length frequency methods (Heldt 1943, Mathias and Salvy 1958, Audouin 1962, Lassèrre and Labourg 1974, Suau and Lopēz 1976, Arias 1980 and Chauvet 1981). It seems that growth rate is extremely variable, even when fish were taken from the same location. Of course, this variability is linked to variations in the ecological conditions in each habitat. Results obtained proved that growth rate is usually higher in lagoons than at sea (Lassèrre and Labourg 1974, Chauvet 1981). Results also confirmed that in nature *Sparus aurata's* growth is very rapid, particularly during the first year of life. From the first to the second year, the increase in weight is three times the initial weight (Suau and Lopez 1976) or even four times (Table 3).

It may be worthy mentioning that the present work's data does not reveal Lee's phenomenon.

Lassèrre and Labourg (1974), Ben Tuvia (1979) and Arias (1980) have estimated $L_\infty$, $K$ and $t_0$ for the species under study and gave, each, different values. It should be noted that these parameters are not constant values, but vary according to fish age considered in computing these values.

### *Acknowledgments*

The authors thanks Prof. Dr. A.M. Eisawy, president of National Institute of Oceanography and Fisheries and Prof. Dr. M. Salama, Faculty of Science, Cairo University for their help and support.

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# دراسة معدلات النمو لأسماك الدِّ ب

**إلهام واصف***

المعهد القومي لعلوم البحار والمصايد الإسكندرية

جمهورية مصر العربية

**المستخلص**

تعتبر أسماك الدنيس من الأسماك الهامة من الناحية التسويقية في مصر والمرغوبة في الأسواق الأوربية أيضا . وقد ثبت نجاح تربيتها في المزارع في السنوات الأخيرة . ومن ثم ، كانت أهمية دراستها من الناحية البيولوجية .

ويتضمن هذا البحث تقديراً للعمر ومعدلات النمو في الطول والوزن لأسماك الدنيس القاطنة لمياه البحر الأبيض المتوسط المصرية . وتعتمد دراسة تحديد العمر على قراءة وقياس القشور وتحديد عدد الحلقات السنوية عليها .

وقد تمت دراسة القشور وعلاقتها بالطول ، وثبت أنها علاقة خطية ، واستنتجت المعادلة الرياضية التي تُمثل تلك العلاقة . كما أثبتت الدراسة أن الحلقات السنوية على قشور أسماك الدنيس تتكون في شهر فبراير أو مارس وتظهر في شهر إبريل أو مايو التالي .

وعند حساب معدلات النمو في الطول ، اتضح أن الزيادة في الطول تكون كبيرة في السنوات الأولى ثم تقل تدريجا مع التقدم في العمر . كما تمت دراسة العلاقة بين طول الأسماك ووزنها ، وبذلك أمكن تقدير معدلات النمو في الوزن في سنين العمر المختلفة ، إذ أثبتت النتائج أنها تتخذ منهجا عكسيا لمعدلات النمو في الطول . وتكون أقل ما يمكن في الأسماك الصغيرة وترتفع تدريجا بزيادة عمر السمكة .

وأخيراً ، تم تطبيق معادلة « بيرتا لانفى » الرياضية لحساب أقصى طول ووزن يمكن أن تصل إليهما الأسماك في المنطقة المدروسة .

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★ العنوان الحالي : كلية التربية للبنات بجدة الرئاسة العامة لتعليم البنات