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SELECTIVITY COEFFICIENT OF WIRE BASKET TRAPS FOR *TILAPIA NILOTICA*

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ABSTRACT

Most methods of estimating growth and mortality rates require samples representative of the population with respect to size of one or more age groups. There is no fishing gear that exhibits equal selectivity towards fish of all size even with a particular species.

It is attempted in the present work to define the mesh size of wire basket traps for *Tilapia nilotica* before its catch data may be used for fish population studies in the Egyptian lake Borollus.

Traps with different mesh sizes were tried in comparative fishing experiments. The selectivity coefficient and mean selection lengths were calculated according to Baranov's, Holt's and Olsen's methods.

It is concluded that the most convenient method of calculation is that suggested by Olsen.

For the proper management of *Tilapia nilotica* fisheries, it is recommended that the wire basket traps mesh size should not be less than 30 mm (mesh bar) to give mean selection length of 15.0 cm. It is expected according to this recommendation that the total catch of Tilapia may increase more than three times annually.

INTRODUCTION

It is a matter of fact that most of the fishing gears will not catch fish throughout the length range of a species; this is due to the selective action of the mesh. It is therefore essential to define the size selection characteristics of the fishing gear before its catch data can be used for fish population studies.

Gill and trawl nets selectivity have been dealt by various authors in many countries of the world. Several methods were suggested to calculate the selectivity coefficient of these gears. Little is published about the selectivity of traps.

The only investigation dealt with this subject in Egypt was that carried out by El-Zarka *et al.* (1970).

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Baranov (1914) suggested a method to calculate the selectivity coefficient of gill nets. His method is based on the assumption that the model length of fish caught by a certain net is proportional to its mesh size.

Holt (1957) described a general method for defining the selection characteristics of gill nets. His method is based on the assumption that the length frequency distribution of gill-net catches of a single species may be normally distributed with a mode at a length where the girth of the fish is approximately equal to the circumference of the net mesh.

Olsen (1959) showed that Holt's method may require some modifications according to the skewnes of the selection curve of fish species being considered.

Ezzat *et al.* (1979) adopted the methods proposed by Baranov (1914), Holt (1957) and Olsen (1959) for studying the selectivity of trammel nets. They believed that the inner layer of the net has a selective action, and the length frequency distribution of trammel net catch from Tilapia fish is unimodal.

It is aimed in the present investigation to study the selectivity of wire traps. Fishing experiments were carried out in lake Borollus during 1974 using three groups of wire basket traps having three different mesh sizes.

The length frequency distribution of *Tilapia* fish caught by each mesh has been found to be unimodal.

Baronov's, Holt's and Olsen's methods of calculation have therefore been adopted in the present study to calculate the selectivity coefficient of wire basket traps for *Tilapia nilotica.*

The application of these methods in the analysis of this experimental fishing data is being based on the criteria that the unimodal length frequency distribution curves of fish caught by each mesh seems to be fairly sharply peaked and slightly skewed.

It is therefore believed that any of the proposed methods, or even all of them may be valid for application for the calculation of the selectivity coefficient of wire basket traps.

Determination of the selectivity coefficient of such common fishing method in the Egyptian lakes besides its mere valuable meaning assists in suggesting the necessary recommendations to conserve *Tilapia nilotica* population in these lakes.

DESCRIPTION OF TRAPS AND METHOD OF FISHING

The wire traps used in the Egyptian Northern-delta lakes, are of the non-return basket types, manufactured from galvanised wire-meshing are similar to that described by El-Zarka (1970). "The trap has one hoop horizontally elliptical, 100 cm long and 50-60 cm in diameter. The meshes of the trap are hexagonal and the wires are usually triple twisted at the junctions. The cone at one end of trap has an elongated and vertical opening for the passage of fish. The blind end has no hoop and the trapped fish are removed through an opening at this end, which is closed by a clasp." (Fig. 1). (El-Zarka, 1970).

The wire basket traps are usually set among aquatic vegetation in the lakes. Small mesh traps are set sometimes in openings through artificial mud-barriers. A satisfactory fluctuation of the water level must be present in order to fill the basin behind this barrier with water. The water flows in and out through the openings in the mud-barrier where the traps are placed. The fish caught in some cases are usually large in number.

Experimental wire basket traps with three mesh sizes were used in the present investigation. The mesh size was measured as mesh bar, by stretching or pressing the mesh so as to take a flattened and elongated form, instead of a hexagonal one. Measurements of the bar were taken from the tip of the compressed mesh to the middle of the twisted junction. In this way the three different mesh sizes of the traps used in this investigation were identified as 14.3 mm, 19.7 mm and 29.5 mm.

Five traps from each mesh were used in the fishing operations in lake Borollus during 1974 fishing season. During each experiment, the traps were left in water for 24 hours, after which the catch was collected. The catches from each mesh size were measured to the nearest half centimeter and afterwards grouped in one centimeter length groups. The experiments were carried out seven times seasonally and durated for one year.

METHOD OF CALCULATION

The selectivity coefficient (K) is calculated according to the equation suggested by Baranov as follows:

$$K = \frac{2a_1a_2}{L_0(a_1 + a_2)}$$

where a_1 and a_2 are the mesh sizes of each pair of gears compared, and L_0 is the optimum length of fish caught by both gears, as appears from their length selection distribution.

The calculated values of selectivity coefficient (K) for every two meshes compared are shown in Table (2).

The mean value of the selectivity coefficient has been calculated as 0.1823. Therefore the mean selection lengths of the three meshes A, B and C will be 38.44 cm, 108.06 cm and 161.82 cm respectively. These mean selection lengths are calculated according to the formula:

$$\text{Mean selection length} = \frac{\text{Mesh size of gear}}{\text{Selectivity coefficient}}$$

The second method adopted in the present study to calculate the selection coefficient is that one suggested by Holt (1957). This method is based on the assumption that, for two net units A and B, the meshes of which differ slightly in size, the shape of their selection curves is the same and the mean selection lengths are proportional to the mesh size.

According to this method it is assumed also that the growth of fish is isometric, then the selection curve of each mesh is expected to be normally distributed.

The calculated selection curves which describe selection by meshing for the three meshes used, A, B and C are shown in Fig. (2).

Consequently the log ratios of the number of fish corresponding to the various size groups caught by two meshes (B/A, C/B or C/A) are plotted against total length of fish as shown in Fig. (3).

Table (1)
The length distribution of *Tilapia nilotica* caught by wire basket traps from Lake Borollus

Length (mm)	No. of fish caught by mesh of		
	14.3 (mm)	19.7 (mm)	29.5 (mm)
60	35		
70	150		
80	138	1	
90	68	10	
100	40	33	1
110	18	73	7
120	12	55	19
130	9	34	23
140	8	7	10
150		2	10
160		2	9
170			9
180			5

Table (2)
The selection coefficient and mean selection lengths of *Tilapia nilotica* for different mesh sizes, calculated according to Baranov's method.

Gears used	Mesh size (mm)	Gears compared	Selection coefficient (K)	Mean selection coefficient	Mean selection length (mm)
A	14.3	B/A	0.1744		73.44
B	19.7	C/B	0.1890	0.1823	108.06
C	29.5	C/A	0.1835		161.82

The selection coefficient (K) is calculated for each two units according to the equation given by Holt as:

$$K = \frac{-2b}{a(\varnothing_1 + \varnothing_2)}$$

where (a) and (b) are coefficients of the equation: log ratio = aL + b describing the line of best fit for the long ratios; $\varnothing_1$ and $\varnothing_2$ are the mesh sizes of the two gear units compared for the calculation of (K).

The derived function equations fitting the linear relationship between the log ratios of the number of fish and the corresponding length of fish caught by each pair of gears compared are given in Table (3). The selectivity coefficient of each pair of meshes compared as well as mean selection lengths of the three meshes used are calculated as shown in the same table.

The mean value for the selectivity coefficient is found to be 5.6899. According to this value, the mean selection lengths will be 81.36 cm, 112.09 cm and 167.85 cm for the meshes A, B and C respectively. These mean selection lengths has been calculated according to the formula:

Mean selection length = Selectivity coefficient x mesh size

The third method adopted in the present investigation is that one suggested by Olsen (1959). This method is based on the assumption that when logarithms of the ratios of the catch by similar effort of two gears with different mesh size are plotted against the corresponding lengths, it follows a curvilinear pattern, to which parabola can be fitted.

According to this method the selection coefficient (K) is calculated for each pair of gears according to the formula given by Olsen:

$$K = \frac{b}{2rv - aq} \quad \text{where:}$$

(a) and (b) are coefficients of the equation $Y = a(1)^2 + b(1) + C$ describing the curve of best fit for the log ratios and length of fish.

$$\text{where } q = \varnothing_1 + \varnothing_2, \ r = \varnothing_2 - \varnothing_1$$

$$v = \frac{-3q(b^2 - 4ac) \pm b\sqrt{9b^2q^2 - 24ac(q^2 + 2s)}}{24\ cr}$$

$$s = \varnothing_1 - \varnothing_2$$

$\varnothing_1$ and $\varnothing_2$ are the mesh sizes of the two gears compared for the calculation of (K).

Table (3)
The selection coefficient and mean selection lengths of *Tilapia nilotica* for different mesh sizes, calculated according to Holt's method.

Gears used	Mesh size (mm)	Gears compared	Function equation	Selection coefficient (K)	Mean selection coefficient	Mean selection length (mm)
A	14.3	B/A	Y = 1.1909 (L) - 12.3011	6.0760		81.36
B	19.7	C/B	Y = 0.8775 (L) - 11.8291	5.4798	5.6899	112.09
C	29.5	C/A	Y = 0.3981 (L) - 4.8074	5.5138		167.85

Table (4)
Function equations for the fitted parabola between log ratios and fish length.

Gears used	Gears compared	Function equation
A	B/A	$Y = -0.4002\ (L^2) + 9.5951\ (L) - 55.9229$
B	C/B	$Y = -0.1336\ (L^2) + 4.2175\ (L) - 32.5371$
C	C/A	$Y = -0.5298\ (L^2) + 12.8808\ (L) - 77.3971$

Table (5)
The model, mean selection lengths of *Tilapia nilotica* for the various meshes of wire basket traps.

Gears used	Mesh size (mm)	Model length (mm)	Mean fish length (mm)	Standard deviation	Selectivity coefficient according to:			Mean selection length (mm) according to:		
					Baranov	Holt	Olsen	Baranov	Holt	Olsen
A	14.3	70.0	82.57	16.27				78.53	81.36	87.78
B	19.7	110.0	113.66	20.66	5.4916	5.6899	6.1386	108.18	112.09	120.93
C	29.5	138.90	138.90	22.94				162.00	167.85	181.09

Table (4), shows the derived function equations for the fitted parabola between the log ratios and the corresponding fish lengths caught by each pair of gears used for fishing with equal efforts.

The selectivity coefficients have been respectively calculated as : 6.0464, 5.2791 and 7.0903 for B/A, C/B and C/A units of wire basket traps compared in the calculations. Therefore the mean value of the selectivity coefficient is 6.1386.

Consequently the mean selection lengths of the meshes used are calculated as 87.78 cm for mesh (A), 120.93 cm for mesh (B) and 181.09 cm for mesh (C).

DISCUSSION AND CONCLUSIONS

Fisheries management depend in many cases on determining the design characteristics and mesh size of commercial fishing gears. Mesh selection is considered to be one of the most important factors affecting the length and age composition of any exploited fish population.

Wire basket traps are one of the most common fishing gears in the northern delta lakes of Egypt. It is of utmost importance to study the selectivity of these gears for Tilapia fish which constitutes more than 70% of the fish population in these lakes.

Three of the methods for studying the selectivity of gill nets have been tried in the present study. Adoption of these methods may be encouraged by previous conclusions about their validity in determining the selectivity of other gears rather than gill nets.

It is aimed in the following discussion to compare the values resulted from the application of the three methods of calculation and to find out the most convenient method to be adopted in the calculation of the selectivity coefficient of wire basket traps.

The calculated selectivity coefficients as well as the mean selection lengths of three groups of wire basket traps with different mesh sizes are given in Table (5).

The application of these methods for determining the selection coefficient of trammel net, lead Ezzat *et al.* (1980) to conclude that, although the three methods are valid for this purpose, Olsen's one is the most convenient.

It is obvious from Table (5) that the calculated values of either selectivity coefficient or mean selection length of *Tilapia nilotica* vary in a narrow range when calculated according to any of the proposed methods.

The choice of one of these suggested methods for application in case of wire basket traps selectivity studies can be attributed to the advantages as well as the accuracy of each method.

Baranov's method of calculation has the advantage of being simple application. This method gives direct and comparable values to those resulted from the application of Holt's method. The calculation of selectivity coefficient according to this method is dependent on the hand fitted graphical representation of length distribution data. Such hand fitted graphical representation may introduce errors in the calculations, therefore the estimates will not be fully efficient. However, it is difficult to obtain similar values for the selectivity coefficient when the same length distribution data are analysed more than once.

Calculation of selectivity coefficient in both methods proposed by Holt or Olsen depends upon plotting the log ratios of the number of fish belonging to the various size classes caught by two meshes against the corresponding lengths of fish. Holt proposed that a linear equation is the best fit of this relationship. This linear relationship is attributed to the assumption that the selection curve for each mesh size has to be symmetrical normal curve. Olsen modified the method of calculation according to his proposal that the selection curves are not symmetrical in all cases, but slightly skewed. Due to the skewness of the selection curve, Olsen suggested that the relationship between the log ratios and fish length is curvilinear to which parobala is the best fit.

It appears therefore that skewness of the selection curve has to be taken in consideration for chosing a convenient method of calculation.

The coefficient of skewness is therefore calculated according to the formula:

Coefficient of skewness = Mean - mode / Standard deviation

It is found that the coefficient of skewness of the selection curves is 0.7726, 0.1694 and 0.3880 for meshes A, B and C in respective.

This slight skewness may mean that Olsen's method although needs more calculations, is more convenient for application.

On the other hand it is attempted to compare the fitness of both the first order and parabola equations to the log ratios, length relationship through a comparison between the summation of deviations ($\Sigma\ d^2$) of log ratios from these two proposed patterns.

The derived function equations as well as $\Sigma\ d^2$ for each pair of meshes compared are given in Table (6).

The summation of deviations seems less in case of curvilinear function equations. This support the proposal that the parabola fits best the relationship between the logarithms of the ratio between the number of fish caught by two gear units and fish length.

It might therefore be concluded from the above discussions that due to the slight skewness of the selection curves of the three meshes used, Olsen's method may lead to more accurate results when determining the selectivity coefficient of wire basket traps.

On the other hand, it is essential to confirm the normality of the selection curves before adopting Holt's method to calculate the selection coefficient.

Table (6)
The summation of deviations of log ratios ($\Sigma\ d^2$) from both linear and curvilinear patterns of different lengths of fish caught by two year units.

Gears compared	Linear function equation	$\Sigma\ d^2$	Curvilinear function equation	($\Sigma\ d^2$)
B/A	$Y = 1.0909\ (L) - 12.3011$	0.7311	$Y = -0.4002\ (L)^2 + 9.5951\ (L) - 55.9229$	0.0895
C/A	$Y = 0.8775\ (L) - 11.8291$	0.0948	$Y = -0.1336\ (L)^2 + 4.2175\ (L) - 32.5371$	0.0235
C/B	$Y = 0.3981\ (L) - 4.8074$	1.1262	$Y = -0.5298\ (L)^2 + 12.8808\ (L) - 77.3971$	2.1002

In those cases, where the selection curves are skewed Olsen's method of calculation can be considered as the most convenient one for adoption.

The fisheries management of this fish species in the delta lakes can be based on the criterion of gaining extra weight. This is due to the fact that Tilapia fish are commercially caught with an average length 11.0 cm (El-Zarka *et al.* 1970). This size does not affect the breeding success of Tilapia because this fish reaches its first maturity and spawns at this size and even at smaller size.

It is recommended by El-Zarka *et al.* (1970) that this fish must be caught at an average total length of 15.0 cm, the weight of fish at this length averages 75 gm compared with 20 gm at 11.0 cm length. By this approach it is expected to increase the total catch of Tilapia by more than three times annually.

To reach such target, and according to the present estimation for selectivity coefficient, it is recommended to allow commercial fishing in the Egyptian lakes with wire basket traps of not less than 3.0 cm mesh bar.

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كما ان طريقة أولسن تعتبر أكثر ملاءمة عند معالجة نتائج الصيد المقارن بواسطة الجوابي وان كانت تحتاج الى عمليات حسابية اكثر وذلك بالمقارنة بطريقة هولت .

وبناءا على هذه الدراسة أمكن اقتراح والتوصية بأن لا تقل سعة عيون نسيج السلك التى تصنع منه الجوابي عن ٣ سم ، حيث تكفل هذه التوصية تنظيم عمليات صيد أسماك البلطي في البحيرات المصرية كما أنها قد تؤدي الى رفع الأنتاج السنوى من هذا النوع من الأسماك الى ثلاثة أضعاف المنتج منه حاليا .

معامل اختيارية الكمائن (الجوابي) لاسماك البلطى

عبده السايس

تستلزم اجراءات تنظيم مصايد الأسماك في أى منطقة من مناطق الصيد ، دراسة التكوين الحجمى والعمرى لمجاميع الأسماك في هذه المنطقة ، ولما كان من المعروف أن لكل فرد في مجموعة من الأسماك في منطقة ما فرصة متكافئة للوقوع في براثن شباك الصيد ، يصير المصيد عاكسا لتكوين المجموعة المذكورة ، فاذا أظهرت نسبة الأسماك في الصيد غير ذلك فان هذا يعنى ان اداة الصيد المستخدمة قد انتقت جزءا معينا من هذه المجموعة ويتضح من ذلك أنه لا يمكن الألمام بالتكوين الحجمى والعمرى لمجاميع الأسماك في منطقة ما دون دراسة اختيارية أدوات الصيد المستعملة في هذه المنطقة .

ومن المتعارف عليه ان معظم شباك الصيد تصيد الأسماك في مدى محدود من الأطوال، فلا يمكن لاداة مصنعة من نسيج مكون من عيون ذات سعة معينة ان تصيد الأسماك في مدى اطوال جميع الأفراد المكونة لمجموعة من الأسماك ، وعلى ذلك يكون من المجدي اجراء عمليات الصيد المقارن التى تهدف الى دراسة العلاقة بين سعة عين النسيج المستخدم في صناعة أداة الصيد والطول الأختياري للأسماك المصادة بهذه الأداة .

يتعرض هذا البحث الى دراسة معامل اختيارية الكمائن (الجوابي) التى تعتبر اكثر طرق صيد الأسماك انتشارا في بحيرات مصر الشمالية وذلك بالنسبة لأسماك البلطي المكون الرئيسي لمخزون هذه البحريات من الأسماك .

وفي هذا السبيل امكن اتباع ثلاث طرق لحساب هذا العامل وهى الطرق التى اقترحها كل من بارانوف عام ١٩١٤ ، وهولت عام ١٩٥٧ وأولسن عام ١٩٥٩ ، واجريت مقارنات بين النتائج التى تم التوصل اليها عند اتباع كل طريقة على حدة . وعلى أثر ذلك أمكن استنتاج انه بالرغم من سهولة تطبيق طريقة بارانوف والحصول على نتائج مباشرة الا أن هذه الطريقة يعوزها الدقة في حساب معامل الأختيارية .