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# Selectivity of *Oreochromis niloticus* and *Oreochromis aureus* caught by trammel nets off El-Salam Canal, Egypt

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**ABSTRACT**

The present study is the first concerning commercial trammel net selectivity in El-Salam Canal. Selection ogives were estimated using Holt's method (1957) for both *Oreochromis niloticus* and *Oreochromis aureus* . $L_{50}$ retention lengths of both species were estimated as 11.1-cm and 11.5-cm corresponding to the inner layer-mesh bar (2.15-cm) for the two species, respectively. With increasing the mesh bar to 2.65cm, $L_{50}$ increased to reach 14.2 and 13.0cm in respective order for both species. The mean selection length calculated by Holt's method for *Oreochromis niloticus* increased from 11.97-cm (opposed to the smaller mesh bar) to 14.76-cm (opposed to the larger mesh bar). The same trend for *O. aureus*, the mean selection length increased from 11.64-cm to 14.34-cm in respective order also. Therefore, it's recommended to use larger inner layer mesh bar length of 3-cm at least to gain extra weight and give more reproduction opportunities.

## INTRODUCTION

El-Salam Canal (Fig. 1) is a unique project bringing the Nile water to the deserts of North Sinai, originated from the River Nile at 210km on the Damietta branch and running south east ca. 89.4km. Then, it crosses the Suez Canal through a siphon to the peninsula extending 175km eastward in North Sinai. **(Othman *et. al.,* 2012)**.

Small-scale fisheries have primary social and economic importance for local Egyptian fishermen. Hence, fishery management requires a good knowledge on fishing gear. There is great divergence in the efficiency of different forms of fishing gear, in terms of their adaptability to certain conditions and their desirability for specific job **(Eyo and Akpati, 1995)**.

It's a significant tool for the fisheries' managers who, by regulating the minimum sizes of a fishing fleet, can more or less determine the minimum sizes of the target species of certain fisheries through studying gear selectivity for the nets used.

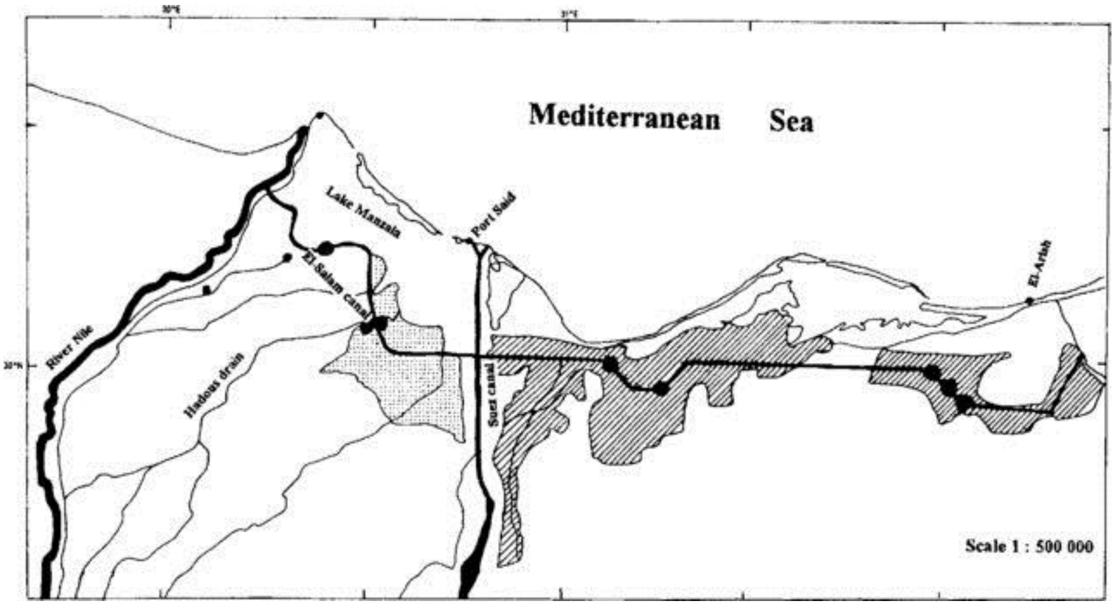


**Fig. 1.** Map showing El-Salam Canal (ca. 88km between Damietta branch of the Nile and the Suez Canal) **(Serag & Khedr, 2001)**

One of the most widely used gears in traditional fisheries in Egypt is trammel net. These nets are similar to those used in Lake Manzala and for a detailed technical features of trammels, a reference to **El-Bokhty (2017)** is efficient. Because of the nature of its construction, a trammel net is able to catch both small and big- sized fish, thus the catching efficiency is relatively higher than gillnets **(Koike & Matuda, 1988)**.

Selectivity may be defined as differences in the probability of fish with different sizes to be retained by the gear once they have encountered it **(Pope *et. al.*, 1975)**. Selectivity offers major facilities in stock management **(Öztekin, 2007)**. It provides guidance for fishermen and taking the necessary measures **(Zengin *et. al.*, 1997)**.

On studying the selectivity of trammel net related to the mesh size, it was reported that the selectivity pattern of such nets depends on the mesh size of the inner layer **(Losanes *et. al.*, 1992; Purbayanto *et. al.*, 2000; Erzini *et. al.*, 2006)**. Hence, the mesh size of the inner layer expressed as mesh bar was considered in the present study, which represents the first concerning tilapia-trammel net selectivity at El-Salam Canal.

In Egypt, several studies have been carried out on the selectivity of trammel nets in Nozha Hydrodrome **(Hashem *et. al.*, 1973)**, Lake Edku **(Al-Sayes, 1992; Soliman, 1992)** and Lake Manzalah **(Shalloof, 1999; El-Bokhty, 2004)**. The present study introduced the first concerning trammel net selectivity in El-Salam (Peace) Canal, Egypt.

## MATERIALS AND METHODS

Fish samples were collected during autumn 2018 from commercial trammel nets used in El-Salam Canal. The mesh size* of the inner layer of each gear was measured to the nearest cm and expressed as mesh bar. Fish were separated to the different species and for each fish, the following measurements were recorded: total length in cm and total weight in gm. It's deemed necessary to stress that, the two species ***O. niloticus*** and ***O. aureus*** represented the surface catch of trammels. Hence, they were estimated .

### Method of selectivity calculations

**Holt's method (1957, 1963)** is based on the assumption that, for two units of net A and B (with mesh sizes slightly different), the shape of their selection curves would be the same, and the mean selection lengths would also be proportional to the mesh size. Moreover, according to this method it is assumed that the selection curve of each mesh size would be normally distributed as the fish isometrically grows. Therefore, the logarithms of the ratios of the catch for the successive length groups (for the two units of gears compared) will have a linear relationship.

The selection factor or coefficient (S.F. or K) is calculated for each two units according to the equation given by Holt as: $\mathbf{K = -2a / b\ (m_a + m_b)}$

Where, **a** and **b** are coefficients of the equation **Ln ratio = a + b*L**, describing the line of best fit for Ln ratios; $\mathbf{m_a}$ & $\mathbf{m_b}$ are the mesh sizes of the two gear units compared for the calculation of (K).

The mean selection lengths corresponding to each mesh size were calculated according to the following formula:

**Mean selection length = selectivity coefficient (K) x mesh size**

The optimum fish lengths for the small (ma) and large (mb) mesh sizes were determined respectively from the relations below:

**Lma = S.F. X ma** and **Lmb = S.F. X mb**

The common standard deviation S was determined by the variance ($S^2$)

$$S^2 = (-2 * a*(mb - ma) / (b2 *(mz+mb)) = S.F. *(mb - ma) / b$$

Points of the selection curves were found by inserting values of L into the succeeding equations:

$$Sa(L) = \exp [ - (L- Lma)^2 / (2 * S^2)] \text{ and } Sb(L) = \exp [ - (L- Lmb)^2 / (2 * S^2)]$$

* mesh size = 2 mesh bars

From these calculations and the catches Ca(L) and Cb(L), an index of the numbers in the population was estimated for each mesh size using the equation:

**Na (L) = Ca(L) / Sa(L)** and **Nb (L) = Cb(L) / Sb(L)**

## RESULTS AND DISCUSSION

### Length structure

The length distribution of ***Oreochromis niloticus*** caught by the two different meshed trammel nets is shown at **Table (1)**. The length structure (as approximated to the normal curves) of *O. niloticus* varied between 9 and 19.9-cm for small meshed net with a calculated mean length 11.9-cm and a modal length at 11.5-cm. While the size structure had been shifted from 11-cm to 21.9-cm with increasing the mesh size with a mean length at 14.9-cm and a modal length at 14.5-cm.

**Table (1).** Length distribution and estimated selection data of *Oreochromis niloticus* caught by two different inner layered trammel nets off El-Salam Canal , Egypt

| Length Mid-point (X) | Catch by numbers | | Ln (ratio) Cb(L)/Cb(L) | Selection | | Population estimate | |
|---|---|---|---|---|---|---|---|
| | Ca(L) | Cb(L) | Y | Sa(L) | Sb(L) | Na(L) | Nb(L) |
| 9.5 | 4 | 0 | 0 | 0.2993 | 0.00429 | 13 | 0 |
| 10.5 | 48 | 0 | 0 | 0.6518 | 0.028 | 74 | 0 |
| 11.5 | 49 | 7 | -1.946 | 0.9568 | 0.1234 | 51 | 57 |
| 12.5 | 29 | 10 | -1.065 | 0.9467 | 0.3661 | 31 | 27 |
| 13.5 | 15 | 17 | 0.1252 | 0.6313 | 0.7322 | 24 | 23 |
| 14.5 | 7 | 24 | 1.232 | 0.2838 | 0.9871 | 25 | 24 |
| 15.5 | 2 | 22 | 2.398 | 0.0859 | 0.8968 | 23 | 25 |
| 16.5 | 4 | 8 | (0.693)* | 0.0176 | 0.5492 | (227) | 15 |
| 17.5 | 1 | 6 | (1.7918)* | 0.00242 | 0.2267 | (413) | 26 |
| 18.5 | 0 | 3 | 0 | 0.00022 | 0.0631 | | 48 |
| 19.5 | 1 | 1 | 0 | 0.00001 | 0.0118 | | 85 |
| 20.5 | 0 | 2 | 0 | 0 | 0.001595 | | (1253) |
| 21.5 | 0 | 2 | 0 | 0 | 0.000127 | | (15748) |
| Total | 160 | 102 | | | | | |
| Mean length (cm) ± (S.D.) | 11.9 ± (1.63) | 14.9± (3.68) | * values between brackets were not taken in Ln ratio because of deviation from linearity due to entalgement | | | | |

It's evident from the length frequency distribution of *O. niloticus* caught by each mesh has been found to be nearly uni-modal with increasing mean lengths (as well as the modal length) corresponding to the increase of the mesh size of the inner layer of trammel net.

The same trend was followed by ***Oreochromis aureus*** caught by the same nets as shown at **Table 2**. The length structure (as approximated to the normal curves) of ***O. aureus*** varied between 9 and 16.9-cm for small meshed net with a calculated mean length 12.3-cm and a modal length at 11.5-cm. While its size structure had been shifted from 10-cm to 18.9-cm with increasing the mesh size with a mean length at 13.7-cm and a modal length at 13.5-cm. It's evident from the length frequency distribution of ***O. aureus*** caught by each mesh has been found to be nearly uni-modal with increasing mean lengths (as well as the modal length) corresponding to the increase of the mesh size of the inner layer of trammel net as well.

**Table (2).** Length distribution and estimated selection data of *Oreochromis aureus* caught by two different inner layered trammel nets off El-Salam Canal**,** Egypt

| **Length Mid-point (X)** | **Catch by numbers** | | **Ln (ratio) Cb(L)/Cb(L)** | **Selection** | | **Population estimate** | |
|---|---|---|---|---|---|---|---|
| | **Ca(L)** | **Cb(L)** | **Y** | **Sa(L)** | **Sb(L)** | **Na(L)** | **Nb(L)** |
| 9.5 | 1 | 0 | 0 | 0.395 | 0.0086 | 3 | 0 |
| 10.5 | 20 | 1 | -2.996 | 0.768 | 0.0502 | 26 | 20 |
| 11.5 | 56 | 12 | -1.54 | 0.996 | 0.1946 | 56 | 62 |
| 12.5 | 40 | 33 | -0.192 | 0.861 | 0.503 | 46 | 66 |
| 13.5 | 22 | 40 | 0.598 | 0.496 | 0.8666 | 44 | 46 |
| 14.5 | 6 | 25 | 1.427 | 0.1901 | 0.9948 | 32 | 25 |
| 15.5 | 8 | 14 | (0.559)* | 0.0486 | 0.7611 | (165) | 18 |
| 16.5 | 1 | 6 | (1.792)* | 0.0083 | 0.0379 | (120) | 16 |
| 17.5 | 0 | 1 | | 0.0009 | 0.1318 | 0 | 8 |
| 18.5 | 0 | 1 | | 0.0001 | 0.0298 | 0 | 34 |
| Total | 154 | 133 | | | | | |
| Mean length (cm)±(S.D.) | 12.3 ± (1.37) | 13.7± (2.25) | * values between brackets were not taken in Ln ratio because of deviation from linearity due to entalgement | | | | |

Trammel nets are classified in the same category as gill nets **(Brandt, 1984)**. However, it has a characteristic selectivity curve different from gill nets due to the differences in capture conditions as well as its operation method as fish are caught by pocketing **(Kitahara, 1968)**. Therefore, It's evident from the length frequency distribution that the catch curves are slightly skewed to the right side which is returned to the natural process of entanglement or pocketing of trammel nets towards the larger sizes beside the normal bell shaped curve resulting from gilling and wedging as those of gill nets **(Hamley, 1975; Millar and Fryer, 1999).**

**Estimation of mesh selectivity curves**

When two units of nets A and B with mesh sizes slightly different are fished simultaneously, the shape of their selection curves would be the same and the mean selection lengths would proportional to the mesh size and the selection curve is expected to be normally distributed **(Holt, 1957)**, and the logarithms of the ratios of the catch of two compared nets against the total length for the different fish caught will have a linear relationship.

Consequently, the fitted regression lines resulting from plotting the natural logarithmic ratio of two compared nets against the total length for ***O. niloticus*** and represented by the equation Y = 1.0984 X – 14.68 and Y = 1.0984 X -14.272 for ***O. aureus*** as shown at **figures 2** and **3** respectively.

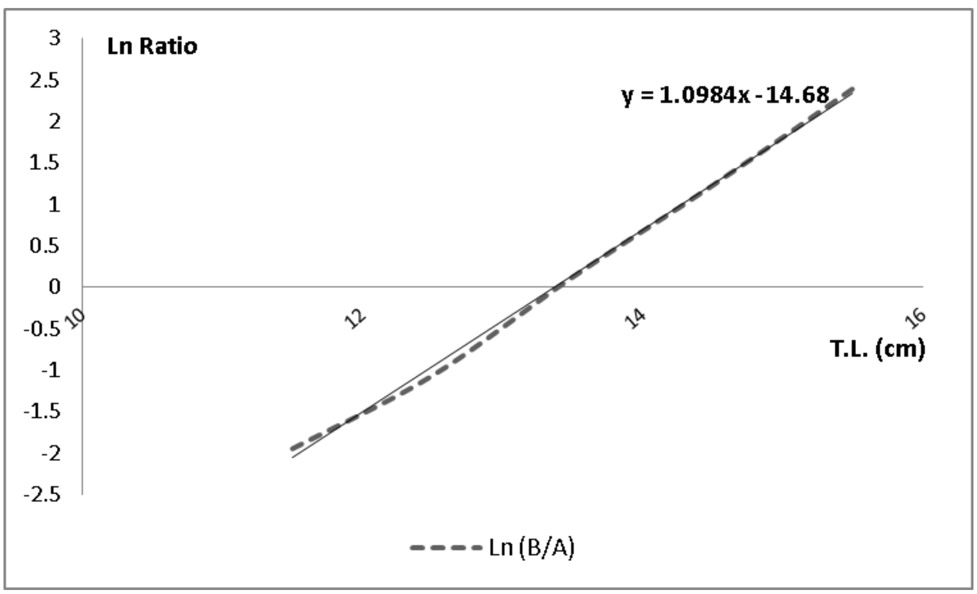


**Fig. (2).** Straight line showing the calculated relationship between Ln ratios and mid total length of *O. niloticus* (according to Holt's method)

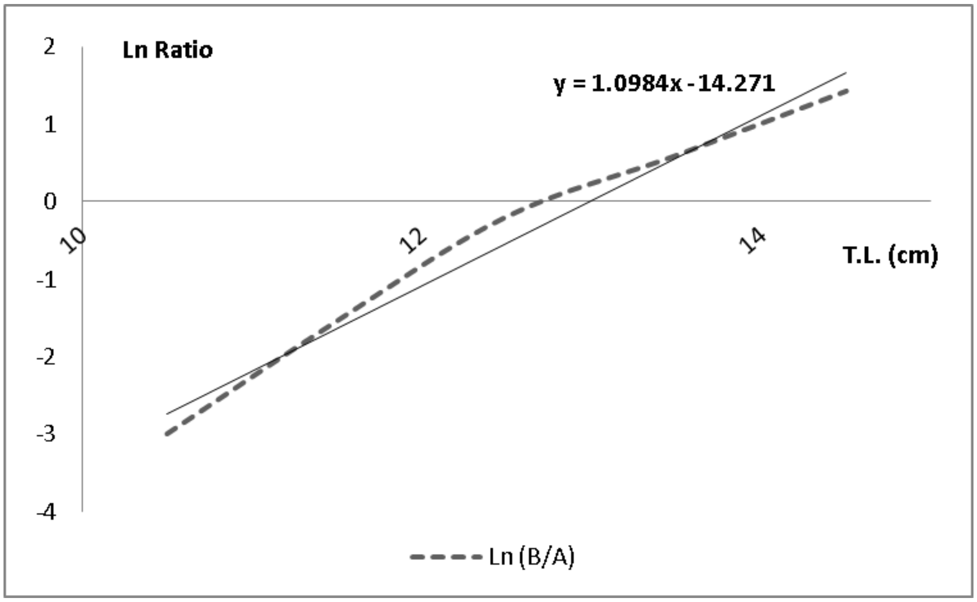


**Fig. (3).** Straight line showing the calculated relationship between Ln ratios and mid total length of *O. aureus* (according to Holt's method)

From **Table (3)** and **Figures (4 -7)**, It's clear that 50 % ($L_{25}$ – $L_{75}$) of the total catch ranged between 10.25 cm and 12.1-cm for ***Oreochromis niloticus*** and from 10.8-cm to 12.4-cm for ***Oreochromis aureus*** caught from the small meshed net a . With increasing the mesh size of the inner layer (net b), half of the catch ranged between 13.0-cm and 15.25-cm for ***Oreochromis niloticus*** and between 12.1-cm and 14.0-cm for ***Oreochromis aureus*** .

**Table (3).** Modal, retention, selection factor and mean selection lengths of *Oreochromis niloticus* and *O. aureus* caught by different trammel nets off El-Salam Canal, Egypt

| Net's inner layer (Mesh bar length) | *Oreochromis niloticus* | | | | *Oreochromis aureus* | | | |
|---|---|---|---|---|---|---|---|---|
| | Modal length | $L_{25}$ | $L_{50}$ | $L_{75}$ | Modal length | $L_{25}$ | $L_{50}$ | $L_{75}$ |
| Net a (2.15-cm) | 11.5 | 10.25 | 11.1 | 12.1 | 11.5 | 10.8 | 11.5 | 12.4 |
| Net b (2.65-cm) | 14.5 | 13.0 | 14.2 | 15.25 | 13.5 | 12.1 | 13.0 | 14.0 |
| Selection Factor | 5. 569 | | | | 5. 413 | | | |
| Mean selection length (cm) (Holt's method) | 11. 97 for mesh bar 2.15 cm | | | | 11. 64 for mesh bar 2.15 cm | | | |
| | 14.76 for mesh bar 2.65 cm | | | | 14. 34 for mesh bar 2.65 cm | | | |

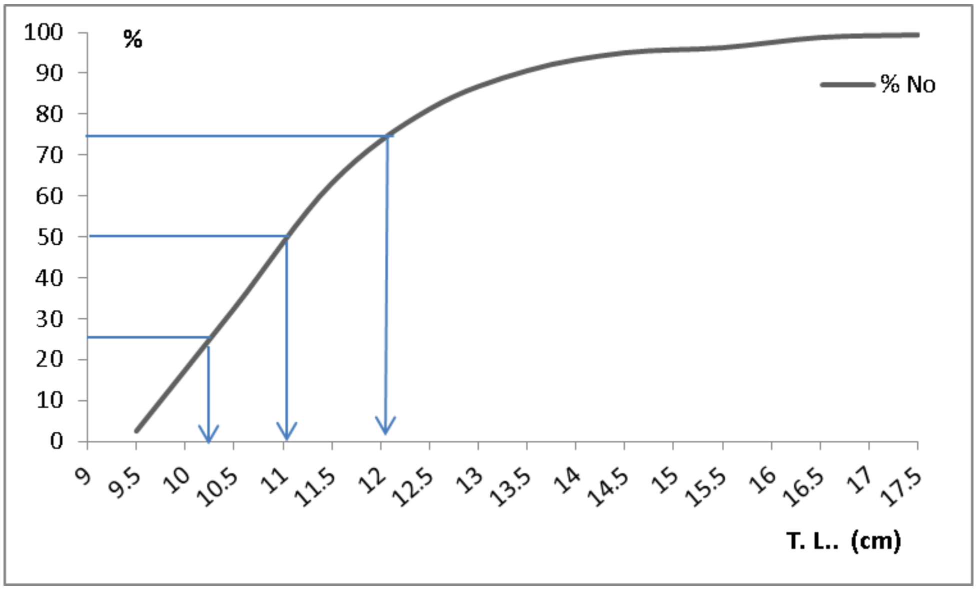


**Fig. (4).** Cumulative % curve showing retention lengths ($L_{25}$, $L_{50}$ and $L_{75}$) of *O. niloticus* caught by 2.15 cm mesh bar inner layer trammels

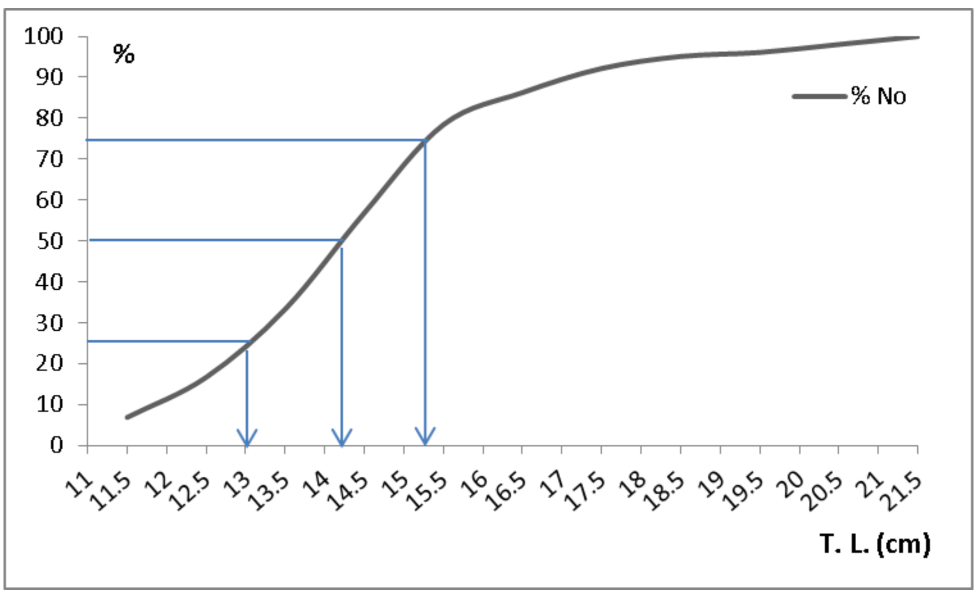


**Fig. (5).** Cumulative % curve showing retention lengths ($L_{25}$, $L_{50}$ and $L_{75}$) of *O. niloticus* caught by 2.65 cm mesh bar inner layer trammels

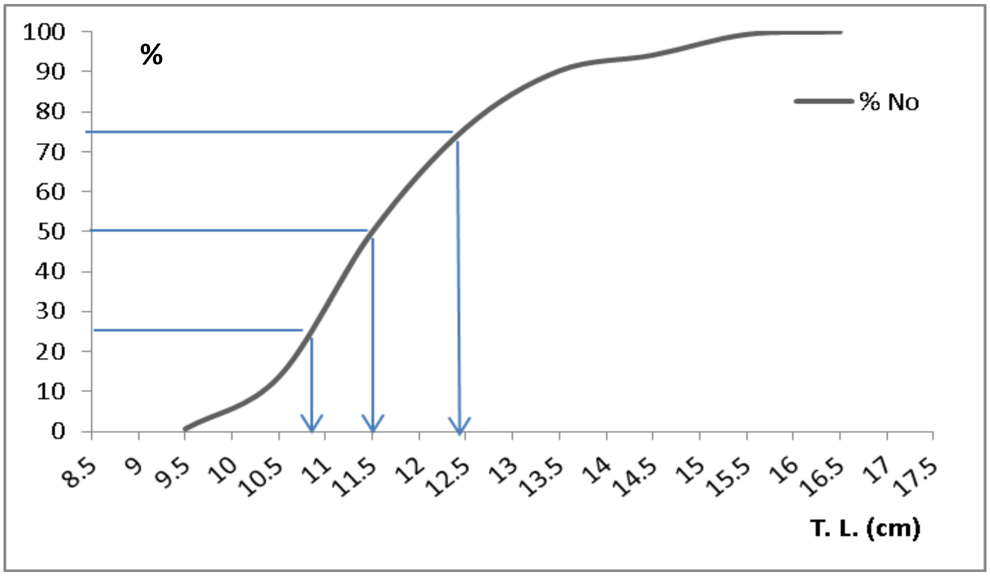


**Fig. (6).** Cumulative % curve showing retention lengths ($L_{25}$, $L_{50}$ and $L_{75}$) of *O. aureus* caught by 2.15 cm mesh bar inner layer trammels

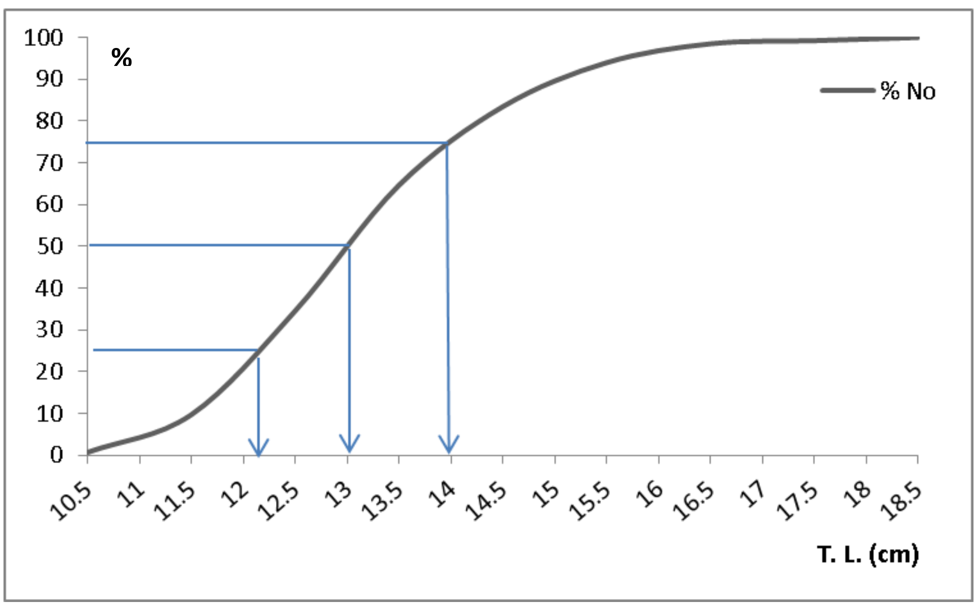


**Fig. (7).** Cumulative % curve showing retention lengths ($L_{25}$, $L_{50}$ and $L_{75}$) of *O. aureus* caught by 2.65 cm mesh bar inner layer trammels

The selection factor S.F. **(Table, 3)** as calculated by **Holt's method (1957)** was calculated as 5.569 for ***O. niloticus*** and 5.413 for ***O. aureus*** for the two nets compared. Therefore, the calculated mean selection lengths of ***O. niloticus*** were 11.97-cm and

14.76-cm corresponding net a and net b respectively. While, those of ***O. aureus*** were 11.64-cm and 14.34-cm in respective order also.

The indices (Na and Nb) of population estimate corresponding to the two nets are in fair agreement for the points taken in the regression analysis where most of the catch curves are simitrical and for the large sized fishes, they are unreliable because the catch curves are skew due to entanglment for the two species.

According to **Hamley (1975)**, the efficiency of a fishing gear is defined as the area under the selection curve of that gear. Therefore, by comparing the selectivity curves **(Figures 8 & 9 )** of the two nets, it seems that, trammel net b which has the wider mesh size can catch a wider range of the available fish sizes while, the smaller one cuts the the smaller sizes at a certain size as it prevents the much smaller ones from being gilled or wedged by the net. That means that, smaller fishes (under a certain size) are not fully exploited because of selectivity of net (a) more than net (b).

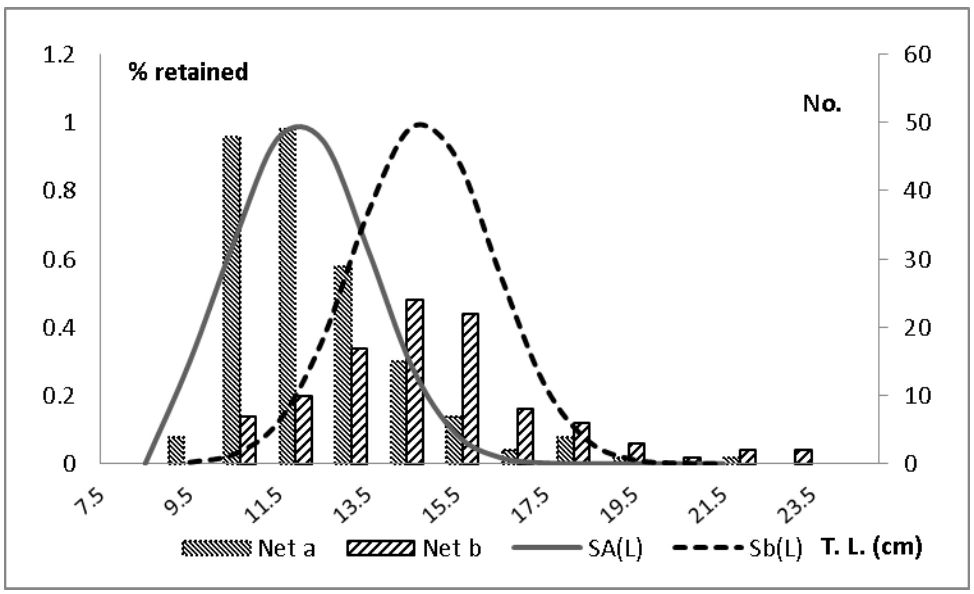


**Fig. (8).** Selectivity and catch curves of ***O. niloticus*** caught by two different inner layered trammel nets

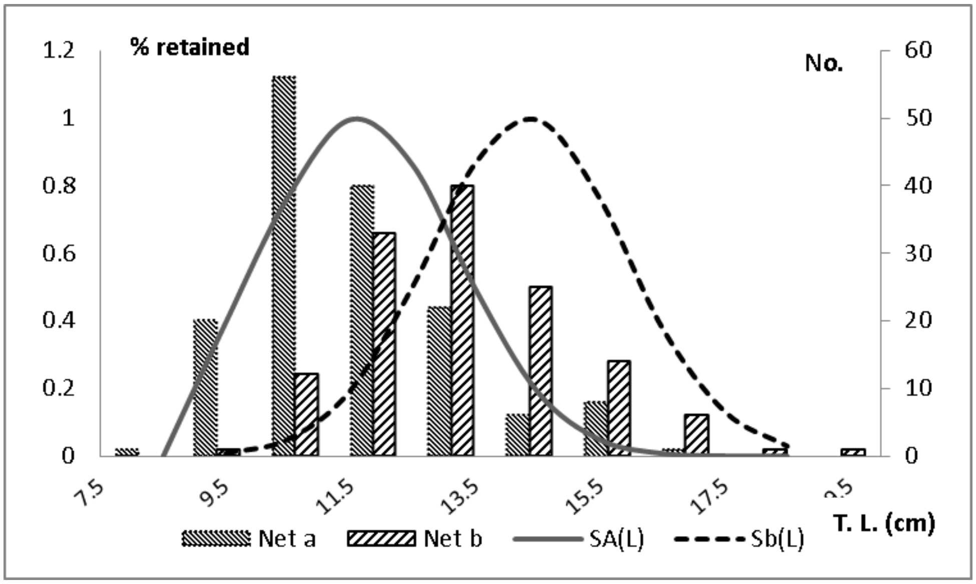


**Fig. (9).** Selectivity and catch curves of *O. aureus* caught by two different inner layered trammel nets

According to **El-Bokhty (2006)**, the weight-length relationship of ***O. niloticus*** (combined sexes) was $W = 0.01745\ L^{3.01043}$ . Therefore, the mean calculated fish weight would to be 30.70 gm for the length 11.97 cm and 57.71 gm for length 14.76 cm. Thus for increasing the mesh bar to 3 cm (or 6 cm stretched mesh size), the mean fish weight would reach 83.85 gm (i.e. increasing in weight by 45.3 % over net b ). Similar results were achieved by **El-Sayes (1976).** At the same time, **Soliman (1992)** recommended to increase the minimum legal size of tilapia fish from 10-cm to 15-cm to increase the total fish production of Lake Edku as well as other Delta Lakes. Also, **Shalloof (1999)** recommended that the inner layer of trammel net should be not less than 6.4-cm nd 5.8-cm stretched mesh to catch a mean selection length of 15-cm for ***O. niloticus*** and ***O. aureus*** respectively. But it's difficult to make a species specific net so the inner stretched mesh size of inner layer should be 6-cm at least.

Also, the length-weight relationship of ***O. aureus*** (combined sexes) was $W = 0.01332\ L^{3.0939}$ . Thus, the mean calculated fish weight opposed to the mean selection lengths 11.64-cm and 14.34-cm would be 26.45-gm and 50.44-gm respectively for the nets a and b. By increasing the mesh bar length to 3-cm, the mean ***O. aureus*** weight would reach 74.12-gm corresponding to 16.24-cm mean selection length (i.e. increasing by 47.13 % more weight than that of net b).

## CONCLUSION

It's recommended to increase the mesh bar length of the inner layer of trammel nets working at El-Salam Canal to reach 3-cm (i.e. 6-cm stretched mesh size) for increasing production of the two species as well as providing more opportunities for fish reproduction and conservation of the stock.

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