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Technical and Design Characteristics of Trammel Nets Used in Lake Manzalah, Egypt

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ABSTRACT

The present research was carried out during Autumn 2016 with the aim of studying the technical and design characteristics of the widely used trammel nets in Lake Manzalah, as an attempt to be one of a data base that describe the different fishing gears used in Egypt. A number of net units were randomly used as samples. Results showed that such nets are used in collaboration with small fishing wooden boats (canoes) reinforced with a layer of fiber glass of the third class with an average number of 2 men. The dimensions of trammel net unit ranged between 20 and 25 meter long and a height of 0.5 to 1 meter. Trammel nets are formed of three netting panels, the stretched mesh size of the middle layer averaged # 40.82 mm while that of the outer layer was 125.24 mm. The upper and lower ropes were locally made of 3- strand staple fibers. Small sized cork floats were mounted on the upper rope (av. # 3 / 1 m) and lead sinkers to the lower rope (av. # 5 – 6 piece / m) of a total weight of 2-3 Kg per net unit. The netting materials were of polyamide monofilament of an average diameter (ϕ) 0.126 mm for the inner layer and ϕ 0.22 mm for the outer one. The horizontal hanging coefficients ranged between 0.60 and 0.70 for the outer layers and between 0.40 and 0.55 for the inner one. The results showed that such nets don't match the criteria for catching moderately sized fish (Average length 15 cm) of tilapia especially the mesh opening of the inner layer for conserving the fishery stocks and sustainable fishery.

INTRODUCTION

Fishing gear can be described generally as any kind of equipment used in harvesting, cropping, or capturing fish from any water body (**Nuhu and Yaro, 2005**), while fishing method (technique) is how the gear is used.

The importance of fishing gear in fishing cannot be over-emphasized without being evaluated or catch obtained isn't enough. The method used to catch fish affects the condition in which the product is landed. This means that a bad-catching method would produce bad fish to the consumer (**Ago and Tafida, 2005**), as using electricity in fishing would lead to accumulation of lactic acid in muscles (i. e. non quality flesh). Also, choosing non-suitable mesh sized-bag for purseseins will lead to increasing gilling for the catch and gill region will be deformed while removing the catch out the meshes. Therefore choosing the appropriate fishing gear material is very important besides gear making is yet form some businesses for livelihood for the peoples involved in gear making.

Among other groups, tilapia fish represents the majority of the landed catch of lake Manzalah (42.4 %) followed by Mullet fish (27.7 %) and they are exploited by 1642 third class canoes (**GAFRD, 2014**) using different fishing gears.

Trammel nets are widely used in both freshwater and marine water fisheries of Egypt, but the use of trammel nets is more common than gillnets especially in northern lakes as well as the Nile River and its tributaries in compination with third class canoes with an average 2 men (**El-Bokhty, 2004**). In principle, because of the nature of its construction, a trammel net is able to catch both small sized and big sized fish, so the catching efficiency is relatively higher than gillnets (**Koike and Matuda, 1988**). Due to the simplicity of trammel net design, construction, operation and low investment cost, it has been very popular among small-scale fishers (**Dinçer and Bahar, 2008**).

Trammel net is a triple walled gill net, in which between the two wide mesh-stretched outer walls (locally called siggn, a rather loose interior one is inserted, badan). Trammel nets, the passive fishing gears, are constructed using monofilament or multifilament materials. The nets are set in the same way as gill nets, but catch a much larger size range of fish by entangling rather than gilling them (**Kalaycı and Yeşilçiçek, 2012**). In gillnet and trammel nets, the fish is; (a) wedged by the mesh around the body, (b) gilled by the mesh slipping behind the opercula, (c) entangled by teeth, spines or other protrusions, without necessarily entering the net. In addition, in trammel nets fishes may become entrapped in pockets of netting (**Hameed and Boopendranath, 2000**). For this main reason, trammel nets are considered less selective than gill nets (**Baranov, 1914; Sparre *et al*., 1989 and Fabi *et al*., 2002).**

The catching efficiency of trammel nets depends on the use of the right materials having least thickness without reduction in strength, lesser visibility, softness, desired elasticity and knot strength. The color of material, mesh size and hanging ratio also influence the efficiency of trammel nets. There is no ideal material having all the desired properties, and therefore, the selection of the best available material for a specific purpose is important (**Klust, 1982**).

Multifilament trammel nets were used for many years, however the monofilament ones prevailed as many studies indicated that monofilament nets were more efficient than multifilaments (e.g. **Balık and Çubuk, 2000; Balık, 2001; Thomas *et al*., 2003; Thomas and Hridayanathan, 2006**).

Knowledge about gears and crafts being used is deficient and outdated. The design and technical details of the different fishing gears are lacking in Egypt. Howbeit, many local studies have been carried out in studying the selectivity of such nets (e.g. **Al-Sayes, 1976**; **Shawky, 1999 and El-Bokhty, 2004**) without referring to their technical or design characteristics. Therefore, the present study is the first of its kind in registering the design and technical characteristics of such important nets which are widely used in the Nile River and Northern lakes.

MATRIALS AND METHODS

The study was carried out during Autumn 2016 in El-Mataryia city, the main fish landing center of Lake Manzalah (Fig. 1).

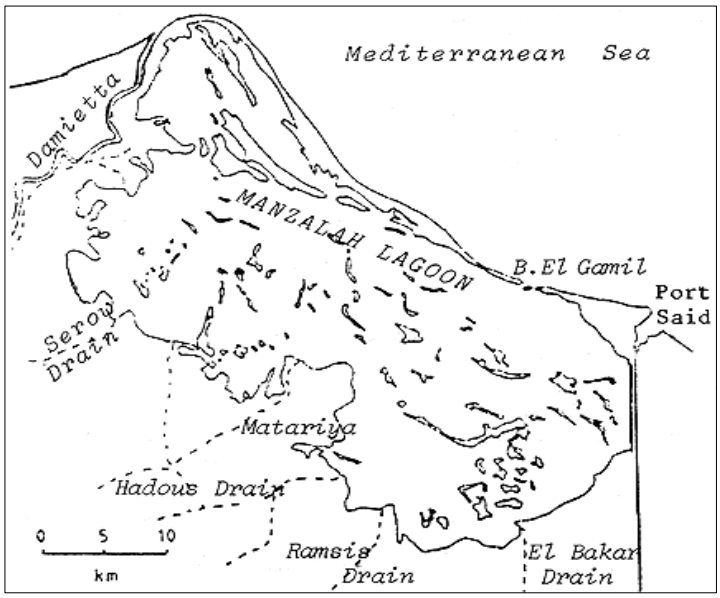

Fig. (1): Manzalah lagoon (**Lemoalle, 1987**)

Five sample units were selected randomly from fishermen and taken to the laboratory at El-Mataryia Research Station for measuring the different parameters. The parameters recorded were the dimensions of each unit as the total length (m) as expressed by the length of the head or float rope, the height or net depth (m) as determined by the hung length resulting from the horizontal hanging coefficient. The mesh size of both inner and outer layers of the netting material used is measured by a digital caliper.

The diameter of the netting twine is measured (mm) also by the same instrument. The horizontal hanging ratio or coefficient is determined according to the relation:

$$\mathbf{E_h = L / L_o = L / (N^o \text{ of meshes x M.S.})}$$

Where: L is the length of stretched head rope and L_o is the length of stretched netting material which equals to the number of meshes along the transverse direction of the netting material multiplied by the mesh size (M.S.).

Type of ropes used either in the head (float rope) or sinker (lead) rope. Type of floats, their size and dimensions as well as type of sinkers used.

RESULTS

Trammel net characteristics

1) Type and characteristics of netting material

Netting material used for the construction of trammel nets at Lake Manzalah are of lightly green nylon (polyamide) monofilament type for both the outer layers and middle one mounted on an upper float line and lower sinker line. As shown in Table (1), the average twine diameter of the outer layer is 0.22 mm, while that of the middle one is 0.126 mm.

Table (1): Technical parameters of the monofilament netting material, floats and sinkers used in trammel nets, Lake Manzalah

Unit / Parameter		1	2	3	4	5	Average
Diameter ϕ (mm)	Inner layer	0.13	0.13	0.12	0.13	0.12	0.126
	Outer layer	0.22	0.22	0.22	0.23	0.22	0.22
Mesh opening(mm)	Inner layer	39.73	40.65	41.02	40.69	42.0	40.82
	Outer layer	124.59	125.04	125.05	125.72	125.08	125.24
Hanging ratio (E_h)	Inner layer	0.45	0.45	0.5	0.5	0.5	0.48
	Outer layer	0.6	0.6	0.65	0.70	0.70	0.65
Floats	Length (mm)	32.11	29.62	29.97	28.95	30.02	30.134
	ϕ (mm)	31.85	29.73	30.02	29.88	31.28	30.552
Sinkers	Length (mm)	44.45	35.78	40.35	39.36	38.44	39.676
	ϕ (mm)	7.6	6.34	8,8	9.2	9.5	8.288

2) Trammel net configuration

Trammel net fleets used by the fishermen in Lake Manzalah are composed of five to ten units, each unit ranges between 15 and 20 meter total length. It is rectangular in shape and hanged between an upper float line and lower sinker line by a 2-strand polypropylene twine, norzel line, of diameter ϕ = 0.14 mm (Fig. 2).

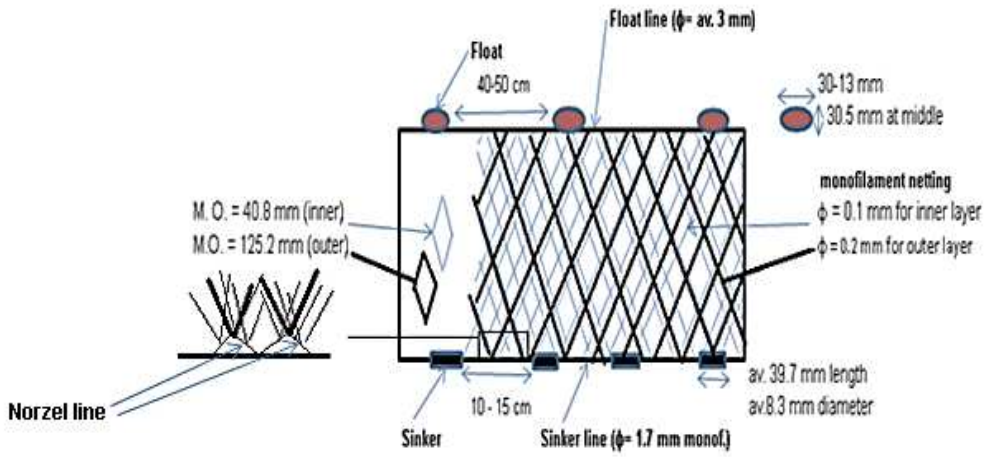

Fig. (2). Sketch showing the design and component characteristics of trammel net used in Lake Manzalah, Egypt

The float rope is of three strands stable fibers (average diameter 3.26 mm) and is carrying small sized cork floats (average length 30.13 mm, average diameter of 30.5 mm and an inner hole diameter 10.32 mm). Some fishermen use norzel line as a gavel line or side line at both ends of the net for protection.

3) Hanging Ratio

The horizontal hanging ratio of the outer layer ranged between 0.6 and 0.7, while that of the inner layer ranged between 0.4 and 0.55.

4) Mesh size

The average mesh size of the outer layers was 125.24 mm. While, the average mesh size of the inner one was 40.82 mm.

5) Float and sinker lines

The float line used, on which the netting material and floats are rigged, is made locally from three strand staple (plastic) fibers with a diameter ranging between 2.94 and 3.07 mm. The same type line is used as a sinker line on which lead pieces are rigged. Howbeit, some fishermen use monofilament line instead of the first one as a ground or sinker line of a diameter (ϕ) 1.71 mm with lead pieces mounted on.

6) Floats and sinkers

Small sized cork floats are uniformly distributed along the float line where 3 corks are mounted per one meter length of the float line. The average size of each reached 30.13 mm in length with nearly an equal diameter at its middle then become narrower at its ends.

Sinkers are small squared lead pieces rolled over the sinker line at arbitrary distances 10-15- cm. The length of each piece is 39.7 mm and average diameter 8.3 mm. The total lead weight ranges from 2 to 3.5 Kg per net unit.

DISCUSSION

According to the International Standard EN ISO 1107- Fishing nets – Netting – Basic terms and definitions (**ISO, 1974** and **Anon, 2003**), netting material could be defined as a meshed structure of indefinite shape and size composed of one yarn or of one or more systems of yarns interlaced or joined, or obtained by any other means, for example by stamping or cutting from sheet material or by extrusion.

The netting material of trammel nets was of the monofilament type as many studies revealed that monofilament type is more efficient than multifilament one. As it was found, the monofilament inner wall and outer walls of the trammel nets were more efficient than other net types; type B (monofilament inner and multifilament outer walls); type C (multifilament inner wall and monofilament outer walls) and type D (multifilament inner wall and outer walls) for capturing carp and silver crucian carp. Effect of monofilament net twine on efficiency of trammel nets was found to be 3.07 and 2.70 times higher than multifilament net twine for capturing carp and silver crucian carp, respectively (**Balık and Çubuk, 2004**). Regarding gillnets, it was also shown that monofilament gillnets catch better than multifilament ones (e.g. **Faife, 2003**).

The monofilament net twine is more elastic and flexible than multifilament. Meshes of a more elastic twine can be stretched to be larger size by a struggling fish (**Hamley, 1975**). However, there was no systematic relation among the sizes of fishes captured in the same mesh-sized nets of the net types. Therefore, trammel net selectivity is affected by the elasticity and flexibility of the net twine (**Balık and Çubuk , 2004**).

In Egypt, Previous studies on the type of netting material revealed that, on studying the species and size compositions of fish caught by monofilament and multifilament trammel nets in Lake Edku, there was no significant difference between them and it was recommended using monofilament one due to its increased catchability than multifilament one (**Al Sayes, 1992**).

The diameter or twine size (ϕ) of the outer walls is nearly twice that of the inner layer as these walls keep the configuration of the rectangular shape of the net. These walls are subjected to the gravity forces generated by the sinkers and weight of the webbing material from one side and buoyancy forces resulting from the floats upwards. Therefore these layers are kept stretched under these opposite forces. It was shown that twine size (diameter) is proportional to mesh size and the average value of twine diameter-mesh size ratio is 0.005 and could be 0.01 in rough and in bottom gill nets, while in calm waters it could be as low as 0.0025 (**Hameed and Boopendranath, 2000**). Also, netting materials for soft bodied fishes should have slightly larger diameter to prevent injury to the fish body. Thus, polyamide monofilament of diameter ranging from 0.1 to 1.0 mm is increasingly used due to their transparency and low visibility under water which increases fishing efficiency (**Hameed and Boopendranath, 2000**).

The present results revealed that the diameter-mesh size ratio (on an average basis) of the inner layer was 0.0031 and that corresponding to the outer layer was 0.0018 which are compatible with the findings of **Hameed and Boopendranath (2000).**

Horizontal hanging ratio (E) is defined as the ratio between the stretched head rope or lead rope relative to the total stretched netting mounted on that rope and it gives the distinctive shape of the mesh. It was shown that the hanging ratio is amongst many factors affecting the selectivity of fishes (**Clarke, 1960** and **Hamley, 1975**). However, the effects in selectivity of changing the hanging ratio are less studied than those of mesh size. It was found generally that nets having low hanging ratio can catch the larger individuals of the same species compared with those caught with the nets having high hanging ratio (**Kumova *et al.*, 2015**).

The increased modal length with lower hanging ratio returns to the higher entanglement property than nets of higher ratios (**Hovgard and Larssen, 2000**).

The larger ratio of the outer layer (0.65) helps in attaining a similar square like shape beside its large meshes will help facilitating the passage of fish through the outer mesh to encounter the middle layer. At the same time, that ratio of the inner or middle layer is relatively smaller (0.48) to help providing more slackness to the inner layer beside the increased number of mesh rows than the outer layer, thus easily tangles fish and giving more corresponding vertical hanging ratio resulting in larger hung depth which will help formation of pockets. It seems that increasing the vertical slack leads to an increase in net efficiency, but this is valid only within a certain range of values for this parameter. **Losanes *et al.* (1992a)** stated that the excess netting gathering at the lower part of the nets due to high values in slackness can increase visibility, thus lowering net efficiency. Vertical slack can be controlled by the height of the walls in a trammel net.

The relationship between the horizontal hanging ratio (E_h) and the vertical one (E_v) is as following:

$$\mathbf{E_v = \sqrt{(1- E_h^2)}}$$

The resulted hung depth[1] of the net (net depth) can be estimated from the relation:

$$\mathbf{D\ (net\ depth) = E_v\ x\ (N^o\ of\ meshes\ x\ M.S.)\ *}$$

Mesh is defined as a design-formed opening, surrounded by netting material (**Anon, 2003**). The main factor playing an important role in the selectivity of fishing gears is the mesh size (**Von Brandt, 1975**).

The mesh size of the outer layer is nearly three times that of the inner one to facilitate passing the different sizes of fish through these meshes and then intercepting it by the looser inner (middle) layer which forms pouches that in turn pass through the opposite side. Hence, the fish is trapped (**Hameed and Boopendranath, 2000**).

It was revealed by many authors (e.g. **Bishara, 1973, Hosny, 1987, El-Ghobashy, 1990 and Shawky, 1999**) that tilapia fish spawns at an average size 10-cm and even less than that length which was determined as a minimum legal landing size. Furthermore, others call for increasing this size to reach at least 12-cm (**Hosny, 1987**) and 15-cm (**El-Zarka *et al.*, 1970**) for both giving more opportunities for spawning and getting an extra weight.

On studying the selectivity of trammel net relating to the mesh size, as the selectivity pattern of such nets depends on the mesh size of the inner layer (**Purbayanto *et al.*, 2000**), **El-Bokhty (2004)** found that the mean selection lengths of *Oreochromis niloticus* were 10.87 cm, 12.54 cm and 14.53 cm corresponding to inner layer mesh bar lengths 2.14, 2.47, and 2.86 cm. While those of *Oreochromis aureus* were 11.93, 13.77 and 15.94 cm respectively. The lengths of *Tilapia zillii* were 9.39 and 10.83 cm corresponding to the mesh bars 2.14 and 2.47 cm only. He finally concluded that, to get an extra-weight of fish (i.e. larger sizes of fish) and hence more economic return, the mesh size of the inner layer

* The hung depth or net depth resulted mainly according to the horizontal hanging ratio of the outer layers of trammel net.

of trammel nets shouldn't be less than 3 cm mesh bar or 6 cm stretched mesh opening to get fish of an average total length 15 cm, besides giving more opportunities for fish breeding and conserving the stock. It was revealed also that, the use of higher mesh sizes can lead to a higher capture of entangled fish belonging to the higher length classes which is more frequent in entangling nets (**Koike and Takeuchi, 1985; Koike and Matuda, 1988; Fujimori *et. al.*, 1992**).

Trammel nets used in Lake Manzalah as well as the Northern Delta lakes of Egypt are surface fishing nets due to the shallowness of these lakes. Shooting and hauling the nets back onto the canoes are carried out manually and worked in calmly conditions as there is no strong currents in the lake, therefore such staple fiber-float lines are used beside its elasticity which can withstand the hauling process.

Small sized cork floats are uniformly distributed along the float line (Av. Length = 30.13 mm with nearly an equal diameter at its middle then become narrower at its ends). Such floats attain the net the required floatation on the water surface.

It was found that the number of floats per meter of the float line is three which is quite enough for giving the required floatation for surface fishing. This coincides with the findings of **Thomas and Hridayanathan (2006)** who stated that the distance between floats shouldn't be more than 75 % of the net depth to prevent useful area of the net to sagging between adjacent floats.

Sinkers, used to help facilitate the vertical orientation of surface fishing trammel nets, are lead pieces rolled over the leadline (foot rope). Large lead sheets are cut into small squared pieces arbitrarily by the net sellers and then rigged over the lead rope during the net mounting at non pattern distances from each other. The total lead weight ranges from 2 to 3.5 Kg per net unit. It was observed that some fishermen use polystyrene pieces as floats and some form of cement stones as sinkers for saving costs. The number of floats and sinkers used depend on the fisherman experience but on definite buoyancy to ballast ratios according **Fridman (1986)**. Unfortunately studies concerning floatation and sinking forces are lacking in Egypt.

CONCLUSION

Trammel nets are unlike gill nets in selectivity. This property increased the catch efficiency of such nets with increasing entanglement and pocket formation which resulted from the rigging pattern of the three layers of trammel net. However selectivity studies revealed that the inner layer plays the important role in the fishing process of these nets either by tangling or trapping the fish inside the pockets formed. Therefore, the mesh size of inner net should be increased than the present recorded mesh size used commercially so as to target tilapia fish of sizes not less than 15-cm as a criterion of gaining an extra weight and help conserving the fish stocks in Lake Manzalah. Further studies should be carried out for studying effects of hanging ratios, fineness and color of nettings upon tilapia catchability.

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ARABIC SUMMARY

الخصائص التصميمية و التقنية للشباك الثلاثية المستخدمة فى بحيرة المنزلة – مصر

العزب العزب بدر البختى
معمل شباك و طرق الصيد – المعهد القومى لعلوم البحار و المصايد

أجرى البحث خلال خريف ٢٠١٦ حيث تم دراسة الخصائص التصميمية و التقنية لشباك الدابة أو ثلاثية الطبقات المستخدمة فى بحيرة المنزلة من خلال خمسة عينات عشوائية أخذت من الصيادين لتكون أول دراسة مرجعيه لشباك الصيد المستخدمة فى مصر. أظهرت النتائج أن الشباك المستخدمة من الخيوط الأحادية poly amide (PA) monofilament وأن طول الوحدة من الشباك يتراوح بين ٢٠ – ٢٥ متر طولي و ارتفاع بين 0.5 الى ١ متر و أن متوسط سعة العين للطبقة الداخلية 40.8 مم و 125.24 مم للطبقتين الخارجيتين . طبقات الغزل هذه معلقة على حبل علوى مكون من ثلاث شرائط بلاستيكية (staple fibers) حاملا أيضا قطع من الفل من الحجم الصغير (متوسط عدد ٣ لكل متر) بينما الحبل السفلى قد يكون من نفس نوع العلوى أو من نوع PA monofilament حاملا قطع من الرصاص الصغيرة (متوسط ٥-٦ قطعة لكل متر) ذات وزن كلى من ٢ الى ٣ كيلو جرام للشبكة الواحدة . كما وجد أن قطر الخيط للطبقة الخارجية (0.2) ضعف قطره للطبقة الوسطى(0.1) ذلك لأنها تتحمل عبء القوى التى يتعرض لها الغزل من قوى الطفو لأعلى و قوة الجاذبية لأسفل تحت تأثير وزن الغزل نفسه مع الرصاص . تبين أيضا من الدراسة أن معامل التعليق للطبقة الخارجية يتراوح بين 0.6 و0.7 مما يعطيها الشكل المربع ليسهل دخول الأسماك خلالها بينما الداخلية يتراوح بين 0.45 الى 0.50 مما يعطيها شكلا معينيا أكثر يناسب الأسماك المضغوطة جانبيا مثل البلطي و كذلك يزيد من ارتخائها بجانب عمقها الزائد عن الطبقتان الخارجيتان مما يسهل من تكوين الجيوب و التي تحيط بالأسماك عندما تصطدم بالطبقة الداخلية . تبين أيضا أن سعة عيون الطبقة الداخلية و التي تحدد الحد الأدنى لحجم الأسماك المصادة ينبغي زيادتها لتصيد أحجاما يصل طولها ١٥ سم كمتوسط لأسماك البلطي الشائعة بهدف المحافظة على المخزونات السمكية و مصيد مستدام .