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Substitution of Polyamide Multifilament by Polyethylene Twisted Monofilament in Large Mesh Gill Nets

Saly N. Thomas* and C. Hridayanathan
School of Industrial Fisheries
Cochin University of Science and Technology
Cochin - 682 016, India

Polyamide (PA) multifilament continues to be the material for gill nets for large pelagics in Kerala despite its replacement by PA monofilament and polyethylene (PE) multifilament in many other states of the country. The cost of the gear contributes significantly to the total investment of the fishing unit viz., around 19% in the mechanised sector and 50% in the motorised sector. Results of a study on replacement of costly PA multifilament by cheaper PE without compromising on the production efficiency are discussed in the present communication. Fishing trials using nets of PE of 1.25 mm dia in comparison to PA 210 dx6x3 (R 455 tex) showed no significant difference in catch and the species composition was similar in both the nets. PE net was found to be cost effective than the PA net, the PE net costing only 52.4% of the PA net. Results indicated that PE twisted monofilament of 1.25 mm dia can be considered for replacement of PAR 455 tex in gill nets for seer and tuna.

Key words: Gill nets, polyamide, polyethylene, catching efficiency

The choice of material for a gear depends on its availability, properties and cost. The important properties to be considered while selecting the material are breaking strength, thickness, visibility, elastic properties and softness. The material for gill nets should have the lowest possible visibility with sufficient strength to withstand forces exerted by the fish. The twine must therefore be of small diameter having sufficient breaking strength, depending on the species of fish to be caught (Klust, 1973).

Since the introduction of synthetics in fishing, there has not yet been any other material better than Polyamide (PA) multifilament for fabrication of gill nets. PA multifilament is the first synthetic material to become popular in India replacing hemp and cotton. The material for drift gill nets for large pelagics, viz. seer, tuna and shark also has been replaced by PA multifilament. In many states of India, the PA multifilament is being replaced to a great extent by PA monofilament and by Polyetheylene (PE) multifilament (Pillai, 1989; Pravin *et al.*, 1998).

The PE introduced in India during early 1960s made very little impact on the gill net fishery till the end of 70s. Pillai (1989) reported that shark gillnets of Gujarat coast were made of PE twisted monofilament of 1 to 2 mm diameter having mesh size 150 – 200 mm. Eventhough trials were carried out elsewhere on the improvement of drift nets for large pelagics, much work had not been carried out in India (Pajot, 1980 a, b; Pajot & Das, 1981; Pajot and Das, 1984; Radhalakshmi & Nayar. 1985; Pillai *et al.*, 1989 & Pillai, 1993). Among these only Radhalakshmi & Nayar (1985) conducted experiments in the Kerala waters and recommended PE fibrillated twine as material worth considering for gill nets for large pelagics.

*Present address: Central Institute of Fisheries Technology, Matsyapuri P.O., Cochin - 682 029

In drift gill nets for seer and tuna, the cost of the gear is worked out to be 44 - 56% and 14 - 33% of the fishing unit in motorised sector and mechanised sector respectively. Though the gear has an effective service life of 4 to 5 years, often, it is lost or damaged by ships and trawlers during night, resulting in periodic replacement of gear contributing substantially to the maintenance cost. In such a situation, the replacement of costly PA by cheaper PE without sacrificing the efficiency is considered necessary to be taken up. Hence a study was conducted to make the fishing unit technically efficient by substituting with cheaper PE without any compromise on the production efficiency.

Materials and Methods

PE twisted monofilament of 1.25 mm diameter was selected for substitution (Table 1). The control was commercial standard gear of PA multifilament of 210dx6x3 (R 455 tex). Experimental PE net was designed and fabricated having dimensions identical to the commercial gear.

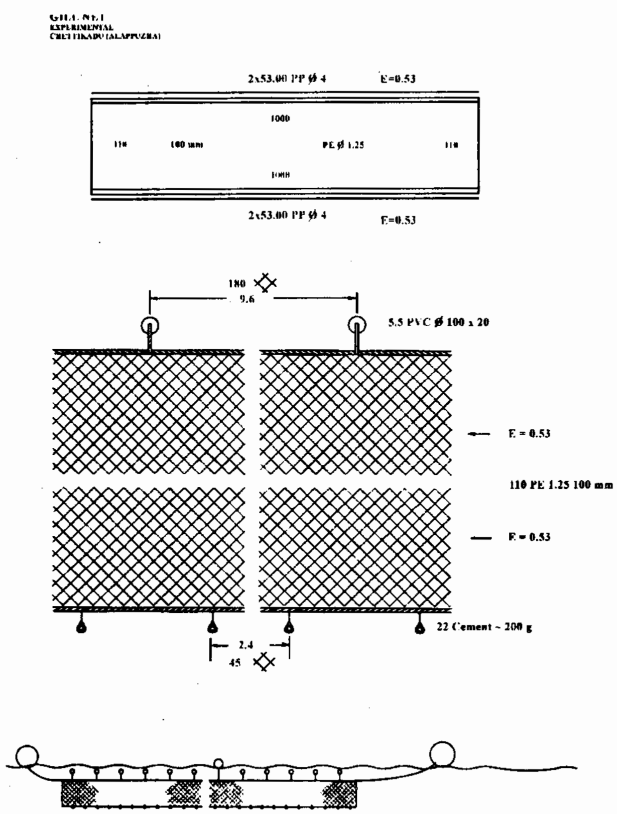

Fig. 1. Design of gill net (PE)

Usually there is no footrope for the standard gear but stones are attached at intervals. This is adjusted in PE to account for the lesser specific gravity as referred by Carter and West (1964). Design specifications of the experimental and standard gear are depicted in Fig. 1 and 2. The experimental gear of PE 1.25 mm diameter was designated as **PE** and the standard gear of 210dx6x3 as **PA**.

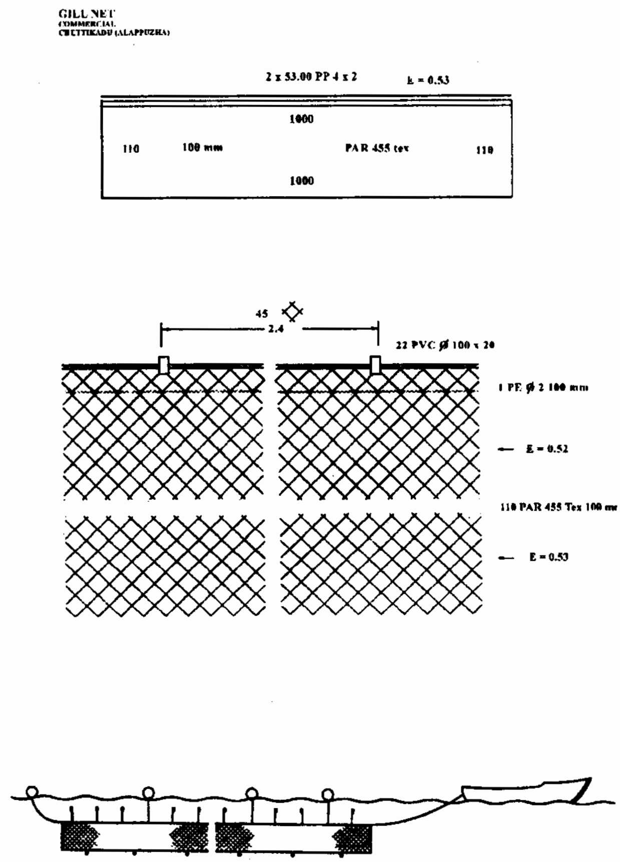

Fig. 2. Design of gill net (PA)

'Relative catching efficiency' of the two materials was evaluated by comparing the catches obtained by the new gear with the standard gear operated simultaneously as suggested by Fridman (1986). Experimental operations were made from a commercial fishing unit based at Chettikadu, Alappuzha. Three units each of PE and PA were connected alternately end to end as part of a fleet of net. The vessel used was a plywood canoe of 9.9 m (LOA) fitted with out board motor of 9.9 horsepower. The nets set between 1730 and 1800 hours were allowed to drift for about 3 to 6 h along with the vessel and lifted. During each operation, the depth of fishing ground, fishing time and catch composition were recorded. The fishing trial covered 65 operations, out of which, the data of 53 valid operations were considered for analysis. An operation was considered as valid if there was catch, at least in one of the nets. Experimental operations covered a full season from August 1999 to May 2000.

Catch from each net was sorted into species and the total length to the nearest cm (Sparre *et al.*, 1989) and weight to the nearest g of each fish were recorded. Data included (i) length frequency of fishes caught in the nets; (ii) breaking strength of netting tested before and after fishing; (iii) wearing rate of the nets after the fishing (Zaucha, 1964); and (iv) evaluation of work rendered by the crew for operating different nets.

Samples of webbing (10 replicates from random position) from the nets before fishing and after fishing were tested to find out the loss in breaking strength. The breaking strength was measured using Universal Testing Machine of model ZWICK 1484 in accordance with 1S: 5815 (Part IV) (1971). The wearing rate of netting was assessed based on the numerical scale reported by Zaucha (1964).

The economic efficiency of the experimental gear over the standard gear was assessed by the index of the economic efficiency (Fridman, 1986). The index of the economic efficiency, Ee is the ratio of the cost efficiency of the new system to that of a standard or established system. If the economic efficiency is greater than unity the new system is most effective than the standard one, and Ee shows the relative economical efficiency under corresponding fishing conditions.

$$Ee = Ecn/Ecs$$

Where, Ecn = Cost efficiency of the new gear; Ecs = cost efficiency of the standard one.

$$Ee = \frac{Ecn}{Ecs} = \frac{an}{as} \times \frac{CTn}{CTs} \times \frac{Tn}{Ts} \times \frac{bs}{bn}$$

Where 'an' and 'as', characterizes the value of the catch.

CTn/CTs, the relative catchability of the system (CT = catch obtained/unit time)

$\frac{Tn}{Ts}$ = duration of operation

$\frac{bs}{bn}$ = operation cost + cost of the net

In all cases 'n' characterises new system and 's' the standard system.

Results and Discussion

Table 2. shows the species composition of catch in the nets. The two nets together caught sixteen groups of fishes. Of these, seer contributed 66.84%, shark 13.72%, tuna 8.69%, barracuda 8.85% and miscellaneous fishes 2% of the total catch by weight. While PE net caught 330.14 kg of fish, PA net caught 232.45 kg. The fish species caught in the gear are grouped into three grades (A, B, C) based on commercial value. Seer fishes (*Scomberomorus commersoni* and *S. guttatus*) and pomfret (*Parastromateus niger*) are grouped into grade A as these species fetched the highest price. Barracuda (*Sphyraena* spp.), tuna (*Euthynnus affinis*, *Auxis thazard*, and *Thunnus albacares*) and shark (*Scoliodon* spp.) were grouped into grade B. Mackeral (*Rastrelliger kanagurta*), caranx (*Scomberoides* sp.), catfish (*Tachysurus* sp.) and other miscellaneous fishes are classified as grade C. Table 3 shows the weight of fish assigned to grade A, B, and C and the return by net type. Approximately

Table 1. Comparative properties of materials selected

Properties	PA	PE
Diameter (mm)	1.04	1.25
Breaking strength (dry) N	211	218
Breaking strength (wet) N	157	154
Elongation (%)	30	30-35

70% of fishes caught in both the nets consisted of grade A fish.

Table 2. Fishes caught during experimental fishing

Sl. No.	Scientific name	Common name	Local name
1	*Scomberomorus commersoni*	seer	arka/neimeen
2	*S. guttatus*	seer, spotted spanish mackerel	arka/neimeen
3	*Euthynnus affinis*	little tunny	choora/kudutha
4	*Auxis thazard*	frigate tuna	choora/kudutha
5	*Thunnus albacares*	yellow fin tuna	kera/manja choora
6	*Scoliodon sorrokawah*	yellow dog shark	naramban sravu
7	*Carcharhinus spp.*	shark	sravu
8	*Rastrelliger kanagurta*	mackerel	aila
9	*Parastromateus niger*	black pomfret	karuthavoli/machan
10	*Pampus argenteus*	silver pomfret	avoli/machan
11	*Caranx spp.*	trevally	vatta
12	*Megalaspis cordyla*	horse mackerel	vankada
13	*Strongylura spp.*	full beaked gar fish	kola
14	*Scomberoides spp.*	leatherskin	palameen
15	*Tachysurus spp.*	marine cat fish	valiya etta
16	*Sphyraena spp.*	barracuda	Cheelavu

To find out whether there was any significant difference in the yield between the nets and between different days of operation, the results were analysed using analysis of variance (ANOVA). Total catch as well as the dominant group viz., seer were analysed numerically and by weight separately. The log transformation was made for constructing the ANOVA. Results showed no significant difference in catch between the nets. It is inferred that the performance of the experimental gear is on par with the standard gear. Between days of operation also there was no significant difference in catch.

As there was no significant difference in catch between the nets, the mean catch/trip was considered for comparison. Table 4 shows the month wise catch per trip of each net. The relative catch rate of experimental and standard gear was calculated as the ratio obtained by dividing the catch per unit effort of one gear by that of other gear (Collins, 1979). Thus, comparison of the average catch/trip of the PE net was made with the standard PA net. The relative catch rate of PE net was 1.19 times more than PA net. The better performance of PE net can be due to the non-visibility of PE monofilament nets. Steinberg (1964) while determining visibility through under water observations found that only knots of PE nets were visible while PA nets were clearly visible.

Table 3. Catch and returns in respect of the two net types

Fishes	PE		PA	
	Wt of fish (kg)	Total revenue* Rs	Wt of fish (kg)	Total revenue (Rs)
Group A	228.20 (69.13)**	13692.00	163.1 (70.17)	9786
Group B	101.38 (30.69)	2027.60	63.35 (27.25)	1267
Group C	0.56 (0.17)	5.60	6 (2.58)	60
Total	330.14 (100)	15725.2	232.45 (100)	11113

* Price of fish (Rs/kg): Group A: 60, Group B: 20, Group C: 10

** Percentage to the total catch in each net

Length-frequency curves in respect of seer *(S. commersoni)*, which was the dominant group in the nets, are drawn and presented (Fig. 3). The length range of seer caught in PE net was narrow (35 to 95 cm)

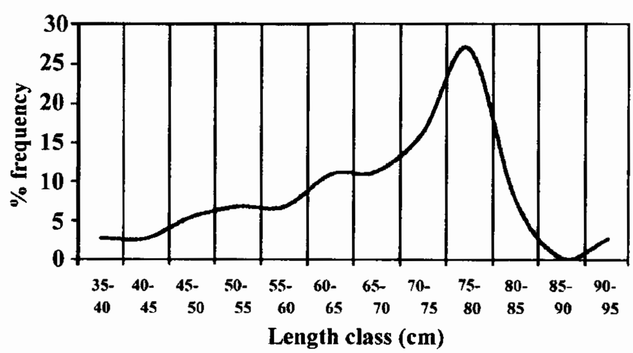

Fig. 3. Length frequency curve of seer caught in PE net

with 75-80 cm as the modal class. In PA net, the length range was 25 to 105 cm and the modal class was 55-65 cm (Fig. 4). This showed that the PE net caught a narrow size class of seer while PA net caught a wide size class. This is due to the fact that the softness of PA multifilament resulted in more entangling of fishes in this net while in PE net more fishes were caught by gilling.

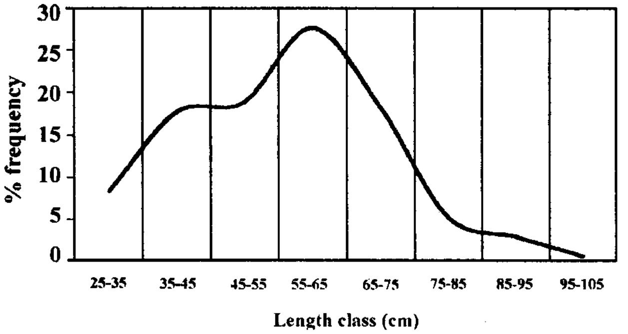

Fig. 4. Length frequency of seer caught in PA net

Comparative durability of the two materials was assessed by measuring (i) the wearing rate of netting after fishing and (ii) the retention of breaking strength of material of each gear.

The results showed that PE net had less damage compared to PA net (Table 5). This may be due to entangling of more fishes in

Table 4. Monthwise catch/trip in the nets

		Weight (kg) of fish/trip in	
Month	No. of trips	PE	PA
Aug '99	10	2.7	6.56
Sept '99	17	4.83	8.79
Oct '99	13	2.09	5.15
Nov '99	3	12.3	5.19
Dec '99	5	8.35	3.5
Jan 2000	3	3.57	0.87
May 2000	2	1.41	3.70

Table 5. Estimation of mechanical wear of nets

Sl. No.	Gear	Degree of damage	Remarks
1	PE	5	After 20 voyages
		5	After 60 voyages
2	PA	5	After 7 voyages
		10	After 12 voyages
		25	After 60 voyages

Table 6. Cost of construction of experimental and standard net

Material Specification	Dimensions	Quantity (kg or no.)	Price/unit (Rs)	Total cost (Rs)
		PE		
Webbing HDPE 1.25 mm dia	1000x110 meshes	13.75	154/kg	2199.12
Rope	PP 6 mm dia	1.8	99	178.20
Float	PVC 100x20 mm	5.5	8	44.00
Master float	Plastic can 5l capacity	0.5	9.50	4.25
Sinkers	Concrete	22.22	1.80	40.00
Labour cost		2 man days	100	200.00
Total				2665.57
		PA		
Webbing 210 d x 6 x 3	1000x110 meshes	16.48	275	4510.28
Rope	PP 6 mm dia	1.8	99	178.20
Float	PVC 100x20 mm	22.1	8	176.66
Master float	Plastic can 5l capacity	2	9.50	19.00
Sinkers	Concrete	1	1.80	1.80
Dyeing of webbing				100.00
Labour cost		1 man day	100.00	100.00
Total				5085.94

PA net than in PE net. PA net being softer than PE net enabled better entangling of fishes. Since the catch comprised of large and fast moving fishes, their entangling and struggle to escape damaged the net more. Zaucha (1964) also reported PA nets suffering significant mechanical wear despite their high initial strength.

Breaking strength is an important property and a loss in strength would adversely affect the fishing efficiency of a material. Hence this property was considered for comparison of the two materials. The loss in strength after actual fishing was assessed. After 65 fishing operations, PA webbing retained 92.59% of the breaking strength while PE webbing retained 80.76%. This showed that PE webbing has less durability than PA webbing.

Table 6 presents the comparative cost of the PA and PE nets. It shows that for a unit each (1000 x 110 meshes), the total cost was Rs. 5086/- for PA net while the cost was Rs. 2665/- only for PE net, i.e., PE net costs only 52.4% of PA net. The life of a PA net is 5 years while that of a PE net is 3 years.

The index of the economic efficiency, Ee, was worked out and was 1.05. Since Ee is 1.05 it can be considered that the new PE net is cost effective than the standard PA net.

The requirement of manpower differed for the two materials. For handling PA and PE nets, the crew requirement was 2 and 3 respectively. The increase in manpower requirement for PE was due to its bulkiness, higher buoyancy and also the weight of footrope. Handling and storing of PE nets during heavy rains in the open deck was also found difficult.

The better performance of PE net showed that PE twisted monofilament twine can be considered for replacement of PA multifilament twine for seer gillnets and is in agreement with Pajot (1980 a), Pajot & Das (1984) and Radhalakshmi & Nayar (1985). Many boats are operating with fewer nets than their actual capacity, which is not the most economic use of capital, labour and fuel. Besides financial constraint and theft (personal communication) the main reason was shortage of supply of nets. The estimated gap between the demand and supply of nets in the Indian fishing industry in 2000 was 7201 tons (Anon, 1992). Hence the replacement of PA by PE which is a cheaper material is a cost-effective innovation.

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