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Size Selection of *Metapenaeus dobsoni* (Miers) in Stake Net Codends used in Cochin Backwaters

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Stake nets constitute the most important indigenous fishing gear used for the exploitation of penaeid shrimp resources in the estuaries and backwaters of Kerala. Management and conservation measures for this fishing gear by adopting an optimum codend mesh size are proposed so as to minimize fishing mortality of juvenile shrimps. This communication deals with the selectivity experiments conducted using codends of three different mesh sizes viz. 12, 14 and 16 mm with a codend cover of 10 mm mesh size. The catch composition of 10 mm codend used by commercial fishermen was also observed for comparative analysis. Length frequency distribution *of Metapenaeus dobsoni, Metapenaeus monoceros* and *Penaeus indicus* retained in different codends and cover was calculated. Mean selection lengths (L_{50}) of 12, 14 and 16 mm codends were 2.96, 3.95 and 4.21 cm respectively for *M. dobsoni*. The catch of commercial net having 10 mm codend consisted 99.3% of *M. dobsoni* of less than 64 mm in total length, the size at which it attains sexual maturity. Based on mean selection factor derived from the selectivity analysis, the optimum mesh size to exploit *M. dobsoni* of 64 mm total length was estimated as 24 mm.

Key words: Stake nets, Penaeid shrimp, Selectivity, *Metapenaeus dobsoni*, Management

Stake nets are fixed bag nets set in streams and tidal waters, where a strong current runs to filter out shrimps and small fishes that are swept along its course. These nets are also seen operated in the bar mouth and even in inshore areas. The nets are set in position by stakes driven into the bottom. This group of nets comes under 'stow or gape nets without wings', which in turn falls under 'bag nets'. The stake nets prevalent in Kerala backwaters are 'known as '*Oonni vala*' in vernacular. Stake nets constitute the most important gear used for backwater shrimp fishing in Kerala, the southern most coastal state of India. The net is set in position just before or soon after the ebb tide has set in and is usually hauled up when the tide turns. The time of operation is usually in the evenings extending into the early hours of the night or at daybreak. Fishing is generally restricted to about half the period commencing on the 10th or 11th day and ending on the 4th or 5th day after the new and full moon.

The demand for shrimp in the international market resulted in undue pressure on the shrimp resources by way of increasing the number of units operated and reducing the codend mesh size. This is reflected on the increase in number of nets operated, *viz.*, from 6929 in 1975-76 (Rao, 1982) to 12900 in 1993 (Ghosh, 1993) and to 17 724 in late 90s (Vijayan *et al.*, 2000). Of these, only 70% are licensed and the rest are illegally operated. The mesh size of the codend has been progressively reduced over the years viz., from 20 mm in 1930s (Hornell, 1938) to 12.5 mm in 1960s (Menon & Raman, 1961) and subsequently to 8-10 mm in 1990s (Hridayanathan & Pauly, 1993; Thomas *et al.*, 1999). It resulted in landings of immature shrimps to the tune of 90% of the total catch (Thomas *et al.*, 1999). This points out the deleterious effect of the gear on the shrimp resources and the need for conservation.

A management and conservation measure for this fishery by adoption of an

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optimum codend mesh size is urgently required. The large scale capture of undersized shrimp could be prevented by using large mesh size in the codend. George *et al.* (1974) suggested 20-25 mm as the suitable mesh size for stake nets considering *Penaeus indicus* of about 100 mm length as the target group. As around 90% of the present catch comprised of *Metapenaeus dobsoni* which is smaller in size than *P. indicus*, it has to be assertained whether this mesh size holds good for the current condition. Results of a study carried out with the objective of arriving at the optimum mesh size for sustainable exploitation of shrimps by stake nets are detailed in this communication.

Materials and Methods

The selectivity experiments were carried out during1996-1997 off Vypeen of Cochin backwaters (Fig. 1) using covered codend method (Pope *et al.*, 1975). A stake net of commercial design made of polyethylene (PE) knotted and polyamide (PA) knotted and knotless webbing with a circumference of 168 meshes of 200 mm mesh size at the mouth and a codend of PA knotless webbing of 10 mm mesh size with a circumference of 200 meshes was used for the experiments (Fig. 2). Three codends made of 12, 14 and 16 mm mesh size were tested replacing the 10 mm conventional codend. A total of 151 operations; 48 hauls made with 12 mm mesh size codend, 60 hauls with 14 mm mesh size codend and 43 hauls with 16 mm mesh size codend were carried out. The inner codend was of length 1.7 m and circumference of 2.0 m at the mouth while the codend cover was of 2.6 m length and 3.0 m in circumference. The mesh size of the codend cover was 10 mm. Experimental nets were operated along with a standard commercial net having codend mesh size of 10 mm which served as control. The experimental nets and the control net were deployed simultaneously from adjacent stakes fixed 1 m apart. The time of operation was usually in the evenings, extending into the early hours of the night or at day break. After hauling the net, the catch from both the inner codend and cover were brought to the shore separately. At the end of each operation, the catch in codends and cover was sorted, weighed and the total length of individual species was measured to the nearest mm.

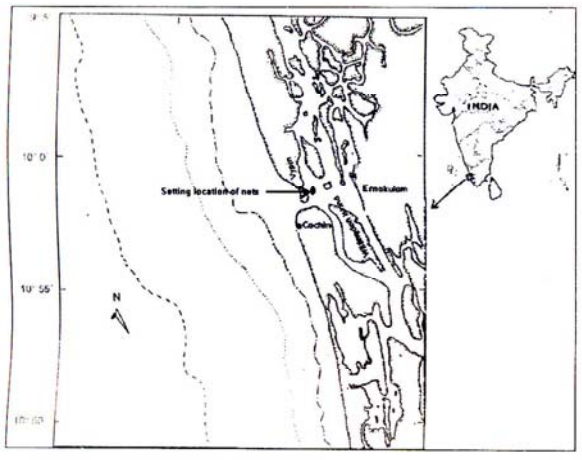

Fig. 1. Map of Cochin showing the area where the study was conducted

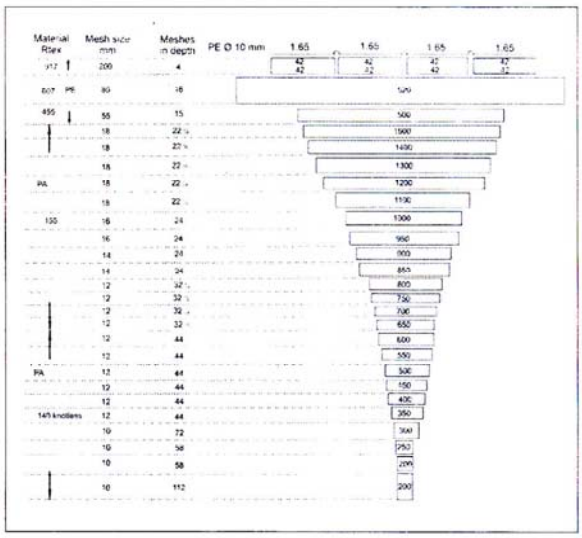

Fig. 2. Design of a typical stake net operated off Vypeen

The total catch, species wise composition and length frequency of shrimps in the control net, codend and cover *viz.*, those caught as well as escaped from the codend, were recorded. The length frequency of *M. dobsoni*, *P. indicus* and *M. monoceros* sampled from the catch was calculated separately for 12, 14 and 16 mm.

The codend selectivity was studied only for *M. dobsoni*, as the other shrimp species and fishes were not found in the codend cover in sufficient numbers to determine selectivity. When the fraction retained is plotted against the mid-point of length classes, the sigmoid curve is approximated by a logistic curve of the form:

$$SL = 1 / [1 + \exp(S_1 - S_2 * L)]$$

where SL is the function of the ogive defining for each length L, the fraction of fish retained in the codend; S_1 and S_2 are constants determined by taking the linear regression of Y, which is natural logarithm of (1/SL-1) and X which is the midpoint of length classes.

S_1 and S_2 values, thus obtained in the logistic model $SL = 1 / [1 + \exp(S_1 - S_2 * L)]$ are used to fit the logistic curve that fits to the observations and to determine L_{50}, L_{25}, L_{75}, selection range and selection factor as below:

$$L_{50} = (S_1 / S_2); \quad L_{25} = (S_1 - 1 \text{ n } 3) / S_2;$$
$$L_{75} = (S_1 + \ln 3) / S_2$$

Selection range = $L_{75} - L_{25}$;
Selection factor = L_{50} / Mesh size

Logistic selection curves were fitted to the frequency data of *M. dobsoni* using selectivity software CC 2000 (ConStat, Denmark). Applying the mean selection factor thus estimated, the optimum mesh size for exploitation of *M. dobsoni* of 64 mm in total length, the size at which it attained sexual maturity, was estimated.

Results and Discussion

From 151 valid operations carried out during the experiments, a total of about 531.55 kg of shrimps was caught. *M. dobsoni* was the dominant species caught (88.84 % of the total catch) followed by *M. monoceros* (3.24%) and *P.indicus* (2.08%). The rest 5.84% was contributed by *P. monodon* and fishes. Fishes comprised of *Ambassys* spp., *Stolephorus* spp. and *Liza* spp. There was practically no escape of *M .monoceros* and *P.indicus* from the inner codends while in the case of *M. dobsoni* there was escapement from all the three codends.

The size range of *M. dobsoni*, *M. monoceros* and *P. indicus* caught were 20-97 mm, 38-121 mm and 38-191 mm respectively (Fig. 3). The size at first maturity is 64 mm for *M. dobsoni* (George, 1969) and 130.2 mm for *P. indicus* (Rao, 1968). *M. monoceros*

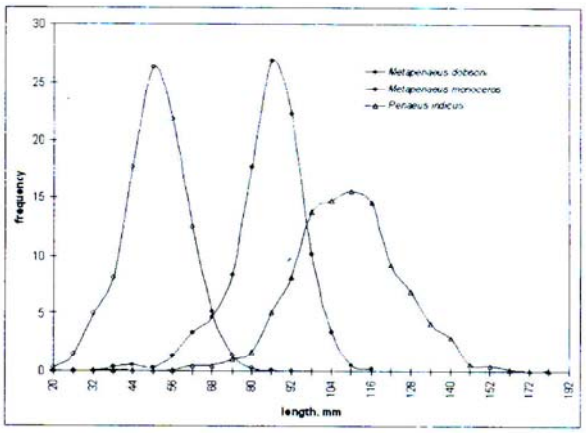

Fig. 3. Length frequency of *M. dobsoni*, *M. monoceros* and *P. indicus*

Table 1. Selection and regression parameters and their standard errors (in paranthesis) for *M.dobsoni* retained in different cod ends

Cod end mesh size (mm)	L_{50}	L_{25}	L_{75}	Selection Range	Selection Factor	S1	S2	Number of hauls	Number of shrimps: Cod end	Number of shrimps: Cover
16	4.21 (0.06)	3.76	4.65	0.891(0.08)	2.629	-10.376(1.01)	2.46(0.22)	43	3620	935
14	3.95 (0.04)	3.45	4.45	1.001(0.06)	2.827	-8.686 (0.59)	2.194(0.14)	60	3075	801
12	2.96 (0.09)	2.31	3.60	1.29 (0.09)	2.467	-5.042 (0.50)	1.703(0.12)	48	2619	183

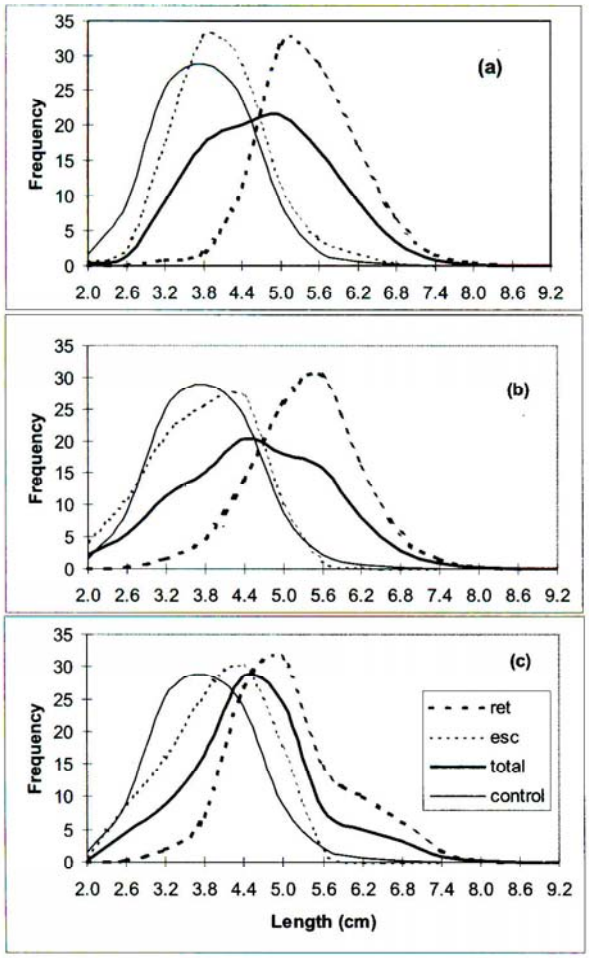

Fig. 4. Length frequency distributions of *M.dobsoni*, retained (bold dash line), escaped (thin dash line), control net (thin straight line) and total (bold straight line) in the trials in which (a) 16 mm cod end; (b) 14 mm cod end and (c) 12 mm cod end

migrates back to sea after attaining a length of about 100 mm. *93.09%* of *M.dobsoni* caught was below 65 mm in length, the modal length being 50-55 mm. In the case of *M. monoceros*, 95.89% was below 97 mm and the modal size was 86-91 mm. The percentage of *P. indicus* below 130 mm total length was 91.7% and the modal length was 110-115 mm. An examination of the length frequency distribution of *M. dobsoni*, *M. monoceros* and *P. indicus* caught in 12, 14 and 16 mm mesh codends was made. The modal length classes of *P. indicus* in 12, 14 and 16 mm mesh size were 105-110, 115-120 and 115-120 mm respectively. In the case of *M. monoceros* the modal length classes were 85-90, 90-95 and 90-95 mm in 12, 14 and 16 mm codend mesh sizes, respectively.

Fig. 4 (a-c) shows length frequency distribution of *M. dobsoni* retained in 12, 14 and 16 mm mesh codends. Figure indicates that the size range of population caught in all the three codends showed similarity while the predominant size group varied from 38-62, 44-62 to 44-62 mm in 12, 14 and 16 mm mesh sizes, respectively. The predominant size group of *M. dobsoni* caught in the control net of 10 mm mesh size was 26-50 mm. The modal length of *M. dobsoni* was 38-43 mm in the 10 mm mesh size, 50-55 mm in 12 mm, 50-55 mm in 14 mm; and 56-61 mm in 16 mm mesh size.

An examination of *M. dobsoni* retained and escaped from different mesh sizes showed that from 12 mm only 6.53% of the shrimps escaped while 93.47% was retained. Of the retained catch, 89.49% had a length of 38-67 mm and 71.58% of the escaped shrimps were of size 32-43 mm. From 16 mm, 20.67% of the shrimps escaped and 79.47% of *M. dobsoni* escaped from 16 mm mesh size were of size 32-49 mm while 85.91% of the retained *M. dobsoni* were of size 44-67 mm. In 14 mm mesh codend, 79. 52% of the *M. dobsoni* escaped were of 32-49 mm size and 88.59% of the retained *M. dobsoni* were of size 44-67 mm. George *et al.* (1974) reported an escapement of 1.48% of *M. dobsoni* from nets of 12 mm mesh size,

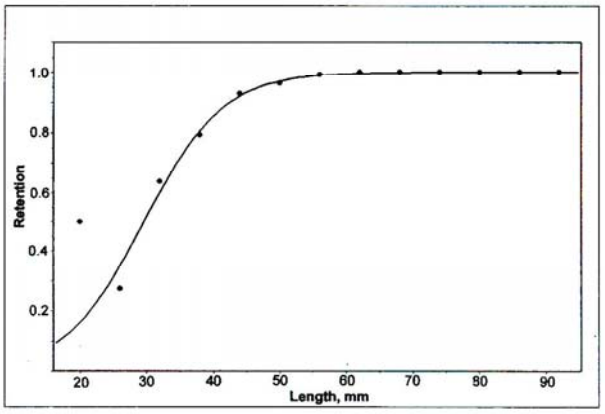

Fig. 5. Selectivity curve of *M. dobsoni* in codend of 12 mm mesh size

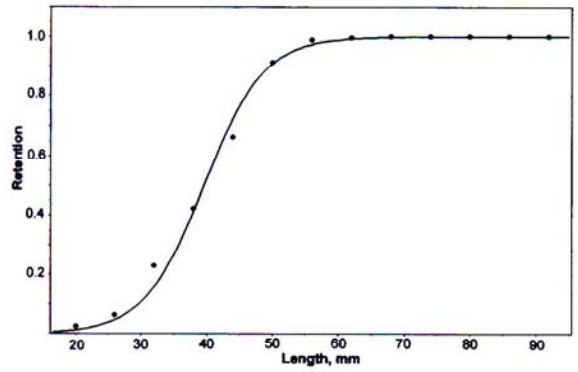

Fig. 6. Selectivity curve of *M. dobsoni* in codend of 14 mm mesh size

31.34% from 16 mm mesh size, 40.59% from mesh size of 20 mm and 60.24% from 24 mm mesh size.

Being the dominant species in the catch for which retention and escapement data was available, selectivity analysis was carried out for *M. dobsoni* only. Table 1 depicts the 50% selection lengths (L_{50}), selection ranges (SR), their 95% confidence intervals (in brackets) and regression parameters S1 and S2 of *M. dobsoni*. It also gives the number of *M. dobsoni* caught in codend and cover. The selectivity parameters, L_{50} and SR were statistically significant ($P<0.05$) for all three codends. Fig. 5 demonstrates the selection curve of *M. dobsoni* for the codend of 12 mm mesh size while Fig. 6 depicts the curve for 14 mm cod end mesh size. Fig. 7 represents the selectivity curve of *M.dobsoni* caught in

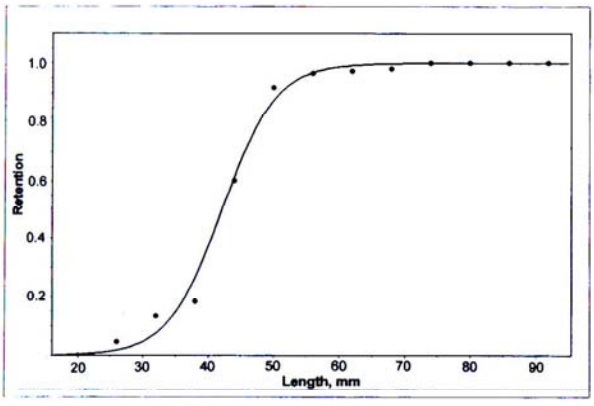

Fig. 7. Selectivity curve of *M. dobsoni* in codend of 16 mm mesh size

codend mesh size of 16 mm. Codend of 16 mm mesh size has higher L_{50} value than 14 and 12 mm codend (Table 1). L_{50} of 16 mm, 4.21 (range 4.07- 4.34) is 6.5% higher than that of 14 mm, 3.95 (range 3.85-4.06) and 42.2% higher than that of 12 mm, 2.96 (range 2.96-3.17). SRs of *M. dobsoni* in 12, 14 and 16 mm codends are 1.29 (1.092 – 1.488), 1.001 (0.865-1.138) and 0.891 (0.716-1.066) respectively. When selection factors are compared, 14 mm codend gives higher value than 16 and 12 mm codend mesh sizes.

The optimum mesh size for protecting *M. dobsoni* which has not attained sexual maturity was worked out using the mean selection factor derived from the selectivity analysis. The mean selection factor for the three codends was 2.64. The mesh size for exploiting *M. dobsoni* of 64 mm total length was estimated as 24 mm. This points out that the mesh size of 20-25 mm used in 1930s were optimum for the sustainable exploitation of the shrimp resources. The results conform to the recommendations of George *et al.* (1974) to use 20-25 mm codend mesh size for stake nets. Females of *M. dobsoni* attain the length at first maturity at 64 mm and males at a slightly less length (Rao, 1968). The present study shows that 99.3% of *M. dobsoni* caught in the commercial nets with 10 mm codend mesh size was below 64 mm length. In the experimental codend nearly 96% of *M. dobsoni* caught were below 64 mm length. This shows that the codend mesh size of 10 mm presently used by the fishermen is deleterious to the shrimp resources. It also reiterates the earlier reports (Mamman, 1984; Kurup *et al.*, 1993 and Thomas *et al.*, 1999) that this fishing gear is harmful to the fishery resources.

As the present practice of using 10 mm codend mesh size is deleterious to the shrimp resources, the operation of this gear should be restrained and the codend mesh size should be set at a minimum of 24 mm so that this species would not face the threat of resource depletion.

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