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Trawl Selectivity on *Johnius dussumieri* (Cuvier, 1830) along Gujarat, Northwest Coast of India

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Abstract

The codend selectivity of *Johnius dussumieri,* an important resource targeted by trawlers along Gujarat coast was studied. Covered codend method was used to derive the selection parameters of *J. dussumieri* using a 40 mm diamond mesh codend. Stacked haul method was used to derive the selection parameters which were utilized for deriving the selectivity estimates. The data on the escapement through experimental codend collected from 6 hauls were used for the analysis. The length at 50% retention (L_{50})±SE of the species was derived as 7.55 ±0.12 cm. The selection range was worked out as 3.41 ±0.18 cm, selection factor as 0.19 and the selection ratio as 0.45. Considering the length at first maturity to be 122 mm, the optimum mesh size required in the codend (diamond mesh) for conservation of this species was found to be 64.2 mm.

Keywords: Trawl codend selectivity, diamond mesh, *Johnius dussumieri*, length at first maturity, optimum mesh size

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Introduction

The Northwest coast of India is known for its important trawl fishing grounds. The estimated fish production from Gujarat during the year 2010 was 0.51 million t of which the demersal fishes contributed 32.8%. Gear-wise landing statistics show that mechanized multi-day trawlers contribute between 61-36% of the total catch being landed (CMFRI, 2011). *Johnius* spp., comprising of *Johnius glaucus*, *Johnius dussumieri*, *Johnius borneensis*, *Johnius carouna* and *Johnius carutta* contributed 38% of the total landings of scieanids from Gujarat coast. Among them, sin croaker, *Johnius dussumieri*, is a notable species being exploited by the trawlers along Gujarat coast. It has a wide range of distribution in the Indian Ocean, usually extending from Pakistan to the Andaman Islands (Froese & Pauly, 2012). The length of the fish in the fishery ranged from 62-229 mm and the asymptotic length was observed to be 268 mm with an annual growth coefficient of 0.45 (Manojkumar, 2011). The fecundity of the species is reported to be between 12,744-151,697 (Froese & Pauly, 2012) and the fish is reported to be an active predator feeding on benthic crustaceans, bony fishes, shrimps and polychaetes (Nair, 1980).

Due to the use of small sized meshes, ranging from 15-30 mm, in the codend, the trawlers along Gujarat coast generate disproportionately high quantities of bycatch which also include juveniles of commercially important fish species (Zynudheen et al., 2004; Madhu, 2011). The knowledge of selectivity of commercially important gears is vital for effective monitoring, management and sustainable exploitation of fishery resources. Use of selective gears help to minimize the capture of juveniles by regulating the length at first capture thereby increase the yield per recruit of the targeted species and also help in the reduction of discards in the fishery (MacLennan, 1992). Among different technical measures (Hannah et al., 2011; Broadhurst et al., 2012; Graham & Kynoch, 2001) attempted to improve the selectivity of trawl gears, changes made to the shape and size of the codend meshes was found to be the most adoptable due to its inherent simplicity and easiness to modify (Ragonese & Bianchini, 2006).

Trawl selectivity experiments are often carried out by covered codend technique (Wileman et al.,1996)

and the selectivity estimates derived from the escapement and retention data of the species from multiple tows, lead to variance in the selection parameters derived (Fryer, 1991). The between-haul variation in the selectivity parameters needs to be taken into account to make the selectivity estimates more reliable (Macbeth et al., 2005). Over-dispersion in the data can be quantified using the replication estimate of dispersion (Millar et al., 2004).

Trawl codend selectivity estimates with respect to *Parapenaeopsis stylifera*, *Metapenaeus dobsoni*, *Nemipterus japonicus*, *Saurida tumbil*, *Upeneus moluccensis*, *Rastrelliger kanagurta*, *Leiognathus bindus*, *Dussumieria acuta*, *Thryssa mystax*, *Thryssa purava*, *Caranx para*, *Uroteuthis (Photololigo) duvauceli* and *Pampus argenteus* occurring along the Indian coast were reported by few workers in Indian waters (Kunjipalu et al.,1994; Prakash et al., 2008; Pravin et al., 2010; Remesan et al., 2010; Madhu et al., 2010; Boopendranath et al., 2012). This article reports the results of the selectivity experiments with respect to *Johnius dussumieri*, carried out using 40 mm diamond mesh codend, in a trawl net operated off Veraval coast, Gujarat.

Materials and Methods

Selectivity experiments were carried out onboard the Central Institute of Fisheries Technology Research Vessel MFV Sagarkripa (15.5 m L_{OA}, 124 hp stern trawler). The study was carried out in the commercial fishing grounds off Veraval, Gujarat, in the depth zone of 20-45 m (Fig. 1). A 34 m high opening bottom trawl (HOBT) rigged with 40 mm diamond mesh codend was used for the selectivity experiments. The wings to the square of the net were fabricated using 200 mm meshes and the length of the codend was 8 m with a circumference of 170 meshes. V-form otterboards with dimensions of 790x1360 mm weighing 85 kg each were used with the experimental trawl. Codend with 40 mm diamond mesh was constructed with high density polyethylene (HDPE) netting of 1.5 mm twine size. The cover for the codend was fabricated using 20 mm (Rtex 630) polyamide netting and proportionately 1.5 times longer and larger than the codend to minimize the masking of codend by cover (Lök et al., 1997). All the trawling operations were carried out during day time and identical shooting and hauling procedures were adopted during the entire fishing operations. The duration of a single tow

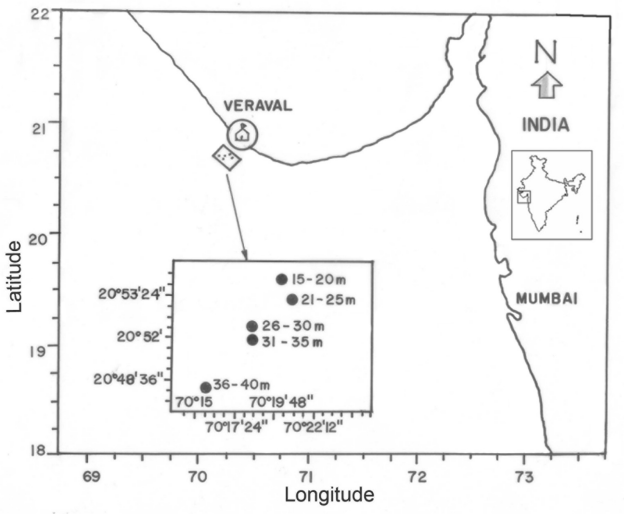

Fig. 1. The study area

varied from 1.5 to 2.0 h and the speed of trawling varied from 1.03-1.13 m s^{-1}. At the end of each tow, the catches from the cover and codend were separately sorted, individual species were weighed and the total length (TL) measured to the nearest 0.5 cm.

"Stacked haul method" (Millar et al., 2004), which accounts for the between-haul variation by implicitly keeping the replications of length classes from all hauls separately and allows the estimation of replication estimate of dispersion (REP) to be estimated was used in the estimation of variance. Data from all the hauls were stacked into a single dataset, which was then handled as a single (artificial) haul (Macbeth et al., 2007). Scaling of data was carried out wherever necessary. Logistic selection curve was fitted to the stacked data for each species using ccfit (Millar, 2006). The standard error (SE) of all the estimates was REP-corrected for the between-haul variations (Macbeth et al., 2007). Selectivity parameters were estimated using the coefficients "a" and "b" derived by maximum likelihood method (Wileman et al., 1996). The 50% retention length of a species was calculated as L_{50} = -a / b, selection range (SR) = L_{75}-L_{25}, selection factor (SF) = L_{50}/mesh size, and selection ratio (SRA) = SR/L_{50}. Model fits were assessed by comparing REP-corrected deviances and associated degrees of freedom (df) against a chi distribution and the appropriate model was selected (Macbeth et al., 2007). For calculation of the SF and SRA, the nominal mesh size of 40 mm was used.

Results and Discussion

Codend escapement data of *J. dussumieri* collected from 6 hauls using the 40 mm diamond-mesh codend was used for the analysis. The size selection curve for this species in 40 mm diamond-mesh codend along with the population retained by the codend and cover is shown in Fig 2. The total number of individuals encountered in the net during the operations was 696. The results showed that major portion of the population encountered was to the left of the line indicating the Lm_{50}. The length at 50% retention (L_{50}) ± SE of the species was noticed as 7.55 (± 0.12) cm. The selection range was worked out as 3.41 (± 0.18) cm. The selection factor and the selection ratio were 0.19 and 0.45 respectively. Total of 310 individuals were retained in the codend while 386 individuals escaped to the cover. The details of the estimated parameters and the covariance matrices are shown in Table 1. Considering the length at first maturity to be 122 mm (Manojkumar, 2011), the optimum mesh size required in the codend (diamond mesh) for conservation of this species was estimated as 64.2 mm.

The L_{50} values derived for *J. dussumieri* in this study for 40 mm diamond-mesh codend was 7.55 ± 0.12 cm. Though studies with respect to 40 mm mesh are not available, the selectivity estimates for 55 mm and 60 mm diamond mesh codends for this species have been reported by Pinto (1999). The L_{50} value for 55 and 60 mm diamond mesh codends were estimated as 9.8 and 9.3 cm respectively while the selection factors were found to be 1.8 and 1.7 respectively. The selectivity estimates of a closely related species, *Johnius borneensis* for 40 and 55 mm diamond mesh codend was reported by Liu et al. (1985). The L_{50} for the 40 mm codend was reported as 11.1 cm and for the 55 mm meshes the value was 16.8 cm. Kunjipalu et al. (2001) have reported the selective properties of 40 mm square mesh codend for *Johnius* spp. for which the L_{50} and the selection factor was reported as 10.20 cm and 2.56 respectively. The results of the present investigation cannot be fully compared with that of Kunjipalu et al. (2001), since the earlier study dealt with *Johnius* spp. collectively and square mesh had been used instead of diamond meshes. However, it is in general agreement with other findings, that square-mesh codend are more selective than the diamond-mesh codends of the same size. Morphological differences of the species and changes in the gear and vessel characteristics could be the reason for the large variation in the L_{50} values noticed in the 40 mm diamond-mesh codend for the species studied elsewhere (Krag et al., 2011).

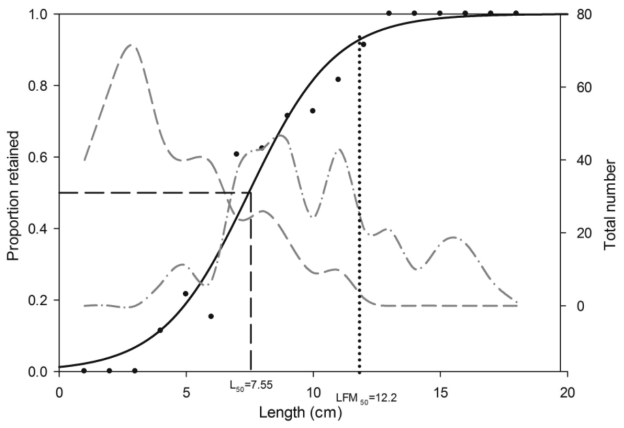

Fig. 2. Selection curve of *Johnius dussumieri* in 40 mm diamond mesh codend. Thick continious line (selectivity curve), medium -dash curve (numbers escaping into cover), dash-dot-dash curve (population retained in codend), thick dashed line (L_{50})

The study suggests that the currently used codend mesh size in the trawl fishery (ranging from 15-30 mm (Madhu, 2011)) is grossly insufficient for the conservation of the species. Chakraborty (1997) has reported the age of capture of the species as 0.676

Table 1. Selectivity estimates of *Johnius dussumieri*

Number of hauls	6
Total individuals in the codend	310
Total individuals escaped to cover	386
(L_m) (cm)	7.55 (0.12)*
Selection Range (cm)	3.41 (0.18)
Selection Factor	1.9
Selection Ratio	0.45
Parameter estimates	
a	-4.86 (0.31)
b	0.64 (0.05)
R_{11}	0.096
R_{21}	-0.0119
R_{22}	0.00162
Length at first sexual maturity (L_m) (mm)	122#
Optimum mesh size based on (L_m) (mm)	64.2

* Standard errors are given in parenthesis and are corrected for the between-haul variation using the replication estimate of dispersion. # Manojkumar (2011)

years. Significant quantities of juveniles of this species have also been encountered in the bycatch (CMFRI, 2011; Madhu, 2011). From the estimates of selection factor, it can be concluded that the codend mesh size of 65 mm can be used for conservation of this species along the Gujarat coast, based on the assumption that 50% of the individuals would be retained as breeding biomass.

The L_{50} derived for *J. dussumieri* in 40 mm diamond mesh codend, by covered codend method was 7.55 (±0.12) cm, which is lower than the length at first maturity values reported for this species, indicating that large quantities of juveniles are being caught by trawling, which is not desirable considering the sustainable fishery of this species along the Gujarat coast. The most ideal mesh size of diamond meshes to be used in the codend with the view to conserve *J. dussumieri* was found to be 65.0 mm. The study suggests to take up further investigations with square mesh codends taking into account of other related species that form fishery along with *J. dussumieri* in order to draw a suitable strategy for the implementation of mesh size regulations for the trawl gears operated along Gujarat coast.

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